Benchmarking and additional environmental information in the context of Type III environmental declarations

Final report

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Summary

The report addresses the possibilities for benchmarking of consumer products and provision of additional environmental information beyond that normally found in Type III Environmental Declarations.

First, a review is made of existing approaches to Environmental Product Declarations (EPD), focusing on existing standards and national/international schemes as well as the concept developed by 2.-0 Consultants in a project for ANEC. The review shows that the existing schemes in all essence aims at providing neutral information, which is also one of the basic intentions with the ISO 14025 standard. Neutral information means in this context that the information given to consumers in EPD's are not put in any perspective, e.g. by comparing products within a given product group or by comparing across product groups. The consumers are thus not given significant decision support from conventional EPD's, unless they have a good insight into different environmental issues/impacts and how they can be quantified and compared. A short review of consumer perception of environmental information indicates strongly that only very few consumers are able and willing to make use of environmental information at this level of detail.

A study performed by 2.-0 Consultants for ANEC has resulted in a new way of providing comparable information to consumers. The basic feature of this approach is that environmental impacts are related to monetary units, e.g. showing the environmental impacts per Euro spent on a specific product as compared to spending an Euro on an average product in the product group and spending an Euro an average consumer goods. In order to present this information, the results from environmental input-output analysis are combined with conventional LCA-techniques in a so-called hybrid LCA approach.

The approach provides a scale for benchmarking and comparison of products, which is regarded by many as a precondition for the use of environmental information in consumer decision-making. How the monetary approach is perceived by consumers is virtually unknown – it has not been discussed with consumer groups – but it will under all circumstances require that consumers are educated in how the results shall be interpreted and used in everyday decisions. Furthermore, the approach may in some cases also lead to doubtful or wrong decisions, as is shown by an example of purchasing and using cars with different environmental properties. It is judged that this will not be a common finding when using the approach, but if the findings in the example also emerge when the full methodology is applied, this will most certainly compromise the approach and lead to non-acceptance by consumers.

Another – and probably more important – issue addressed in the present report is the provision of additional environmental information. Neither the standards applicable to EPD's nor the national EPD-schemes aim at providing additional environmental information to a significant extent; they all have their focus on the provision of life cycle related information. It is acknowledged that life cycle

related impacts often are important and should be used to make the “good” choice wherever possible and relevant. It is, however, evident from the screening of eight product groups made in the current project that the order of magnitude of the life cycle impacts (e.g. contribution to climate change, acidification, energy consumption, etc.) differ significantly between product groups. Using a personal computer thus accounts for about 2% of the environmental impacts caused by a consumer while the average use of a mobile phone only constitutes about 0.1%. It is therefore a very basic conclusion that efforts should primarily be devoted to choosing the best product in a life cycle perspective when it is known that the product group as a whole is known to give a significant contribution in the impact categories conventionally addressed in life cycle assessments. This is in accordance with the finding that consumers are more willing to make environmental considerations when purchasing relatively expensive and complex products.

For less complex products with relatively small life cycle environmental impacts, the consumer needs simple tools to make an informed choice. However, the information should still be sufficiently comprehensive and precise for the consumer to make the “right” choice. In order to meet the needs of different types of consumers in relation to different types of product groups, a range of tools were developed and implemented in what is called Environmental Data Sheets (EDS). The EDS-concept as presented in the project is a first suggestion of how environmental information can be presented in a condensed way, which is still comprehensive and readily understood by most consumers.

In short, the outlined EDS consist of two pages. On the first page, environmental and technical information related to the specific product is presented. On the second page, a brief overview of the most environmental aspects related to the product group is provided, together with a table putting the life cycle environmental impacts of an “average” product in the product group into perspective by comparing it to other product groups. The second page is thus fixed for all products within the product group, giving the possibility of pinpointing which environmental issues, the individual consumer finds most important.

The first page of the EDS combines technical information (“the sales arguments”) with different types of environmental information, as appropriate. The following elements are available for inclusion of environmental information:

- A checklist, where the product properties are related to relevant eco-label criteria as they appear in multinational (EU, Scandinavia) and national (German) eco-labelling schemes. In general, these eco-label schemes address a wide range of environmental aspects, and by stating whether a product complies with each specific criterion, the consumer is provided with a quick overview of its environmental performance. Using colour codes for illustrative purposes (green for compliance, red for non-compliance) directs the attention to potentially problematic issues, but is also helpful in providing the quick overview (e.g. checklists with only green codes signals that the product is “good” in environmental terms).
- Energy-labelling schemes are used where relevant to give a quick indication of life cycle performance. There is of course a certain overlap

between eco-labelling and energy labelling, but for some product groups (e.g. refrigerators and dishwashers) the energy label may allow for a better distinction between products. “Worst case”, i.e. that the information on energy performance is given twice, it not seen as a drawback, rather the opposite.

- For building products, the results from Indoor Air Quality certification schemes is used to give information on, whether the product is approved or not. Again, a colour code is used to attract the attention of the consumer to potentially problematic properties (red colour) – or for a quick assurance of that the properties are OK (green colour). For the sophisticated consumer, the test results can be presented in a condensed version, allowing for a quantitative comparison of specific properties. For the EDS’ established in the current project, the criteria in the German AgBB-scheme have been used. Other schemes most probably provide equally useful results, and it can be considered in a refinement of the concept whether fibre emissions and odour properties should be included. If so, the present report gives a suggestion for a more detailed rating system which makes it possible to assign one of seven ratings (from “Unacceptable” to “Excellent”) to a product. In such a system, the same colour codes as used in energy labelling can be used to provide a quick graphical indication of the overall properties in relation to indoor air quality.
- The content of chemicals in consumer products is a main concern for many people, and a rating system for this was developed on request from ANEC. The rating system assigns one of seven ratings (from “Very problematic” to “Excellent”, with corresponding colour codes) to a product, depending on the amount of hazardous chemicals found in the product on the one hand, and the seriousness of their effects on the other. It is acknowledged that the rating criteria used in the current project are more or less arbitrary, but it should be remembered that the main purpose has been to demonstrate that such a rating system can be developed and implemented in practice, rather than to develop a rating system which can gain acceptance from all stakeholders from the start. As for the rating of Indoor Air Quality the suggested approach can as a minimum be regarded as a well-documented input to the issue on how “additional environmental information” on chemical aspects can be communicated to consumers.

Environmental Data Sheets have been prepared for eight fictive products, five energy-using products and three building products. The main purpose of the EDS developed here has been to demonstrate how technical and environmental information can be combined in just one information sheet. It is acknowledged that some of the information which could potentially have been included may be regarded as important by some stakeholders. It is also possible that some stakeholders (both producers and consumers) will find the information too comprehensive. Again it is emphasized that the EDS-concept presented here is first suggestion, showing how existing and verifiable environmental information on a broad range of aspects can be communicated to consumers in an easily understandable way. Future developments and refinements may offer even better possibilities, but the current project shows clearly that it is possible to go beyond the rather limited ambitions outlined in the current standards for Environmental Product Declarations.

1 Introduction

1.1 Background

The provision of environmental life cycle information plays a key role in the concept of Integrated Product Policy (IPP), the newest and perhaps most visible development being the implementation in the proposed Directive on Energy-using products (EuP). In the near future an increasing amount of Environmental Product Declarations (type III declarations – in short EPDs) of building products, based on a series of standards based on ISO 14025 and ISO 21930 is believed to appear on the market, providing some basic environmental information to private and public consumers. The information provided by these declarations is, however, produced by business-driven initiatives and will not provide the full environmental overview unless focused normative requirements are integral to the standards. This can with good reason be assumed to be the case for both the EPD-schemes already existing in many countries and the future scheme(s) being more or less coordinated by the EU Commission.

Another drawback of Environmental Product Declarations as we know them today is that they are more concerned with establishing technical information than providing an operational decision-support for the consumers. In a recent study by 2.0 LCA Consultants it was suggested to use monetary units for normalisation of the environmental impacts. The resulting concept is not fully satisfactory from a consumer comprehensibility perspective, although the scientific background represents recent developments within the EU LCA community. It must thus be recognized that advanced LCA-technical developments are not necessarily best suited for providing environmental information to consumers. This is in particular the case for the semi-quantitative "additional environmental information" needed to provide an overview of all relevant environmental aspects, but also the general approach suggested, mixing monetary and environmental units in the communication, should be reconsidered.

1.2 Purpose

The purpose of the study is to develop an improved framework for provision of environmental information to. The framework will combine the environmental information produced through a traditional LCA approach (type III declarations) with the semi-quantitative information used in the award criteria for type I eco-labels, ensuring that all relevant environmental aspects are covered, including the identification of relevant hazardous substances. Consumer comprehensibility should be improved in relation to existing concepts by:

- Ensuring comparability between products by selecting appropriate units of consumption, scenarios or concentration units.

- Facilitating the identification of preferable products by selecting appropriate benchmarks, derived e.g. from type I eco-labels (thresholds for acceptability) and scales, e.g. as they are known and accepted in energy labelling schemes.
- Displaying the information in a comprehensible manner, e.g. using graphic displays.

1.3 Approach

The basic approach of the study was to examine a broad range documents relating to provision of environmental information to consumers and make use of single elements as appropriate. A review was made of

- Standards dealing with Type III environmental labels
- Type I eco-label criteria and background documents for construction products and energy-using products
- Other eco-label criteria
- The ANEC 2005 study "Consumer demands on Type III environmental declarations" by 2.-0 Consultants
- Literature on consumer perception and understanding of eco-label information

The review focused on identifying elements and approaches, which can be considered as useful in the communication of environmental information.

Special attention was given to the issue of providing "additional environmental information", i.e. information which is more related to chemical properties of consumer products than to the life cycle environmental impacts which are the conventional focus is environmental product declarations.

Inclusion of "additional environmental information" is existing EPD-approaches is, however, relatively modest, and dedicated tools for this were therefore developed in dialogue with ANEC and exemplified in eight cases in the form of so-called Environmental Data Sheets (EDS).

The core information in an EDS is

- A checklist, where the environmental properties of a product is related to the demands established through relevant eco-label criteria
- Environmental performance in relation to energy-labelling criteria (only relevant for energy-using products)
- Indoor Air Quality, as reflected by verifiable testing schemes (only relevant for building products)
- Rating of chemical content, using a newly developed approach (only tested on building products, but also relevant for other types of consumer products)
- A summary of the most relevant environmental aspects for the product group, including an overview of the relative importance compared to other product groups as reflected by life cycle studies

An EDS is thus not directly comparable to an EPD. Some elements are common to both concepts, but the EDS contains information elements which are not commonly found in EPD's but these do on the other hand also contain much information which cannot be found in the EDS. An EDS in the format suggested may thus not be the final solution for provision of environmental information consumers, but the elements included in the EDS fulfil the basic consumer demands as they appear from many studies, going beyond the rather limited ambitions outlined in the current standards for Environmental Product Declarations.

2 Review of EPD related standards and other documents

2.1 Introductory remarks

The review concerns general standards relevant for making Environmental Product Declarations (EPD) of products, especially building products (ISO 14025, CEN TC 350 and ISO 21930) as well as the general guidelines and specific PCR-documents established in existing EPD-schemes (AUB (DE), BRE (UK), Inies (F), EPD-system (SE/Int.) and MRPI (NL). It also includes the suggestions made by 2.-0 Consultants for ANEC with respect to which information to include in EPD – and how.

The purpose of the review is to create an overview of the similarities between the different standards – and on the differences. Especially the knowledge about the differences can be useful in determining the most useful approach from a consumers' perspective, making it possible to identify e.g. the most stringent criteria, the best way of presenting results, etc.

The review focuses on selected elements, i.e. life cycle approach used (stages included, consequential/attributional LCA, cut-off rules and allocation rules) and the requirements regarding additional environmental information. Other elements may be equally relevant in the present and other contexts, but are omitted because of time and budgetary constraints. It is underlined that the review does not evaluate or rate the different approaches in relation to each other. It may, however, pinpoint single elements which are judged to be more or les controversial.

2.2 ISO 14025

The ISO 14025-standard (ISO, 2006a) is the basic standard when dealing with Type III environmental product declarations. ISO 14025 is in turn based on the requirements in ISO 14040 (ISO, 2006b) and 14044 (ISO, 2006c), dealing with Life cycle assessment.

It has a broad scope, being universal to all types of products and comprising in principle both business-to-business and business-to consumer environmental information.

2.2.1 Life cycle approach

In the development of Type III environmental declarations, all relevant environmental aspects of the product throughout its life cycle shall be taken into consideration and become part of the declaration. If the aspects considered to be relevant do not cover all stages of the life cycle then this shall be stated and justified. The data shall be generated using the principles, framework, methodologies and practices established by the ISO 14040 series of standards (i.e. ISO 14040 and ISO 14044).

Life cycle stages

The development of an EPD shall be based on modularity. ISO 14025 thus specifies that LCA-data for materials, parts and other inputs that are used in the manufacture or assembly of other products may be used to contribute to Type III environmental declarations for those other products. In such circumstances, the LCA-based data for the materials, parts and other inputs shall be referred to as information modules and may represent the whole or a portion of the life cycle for those materials and parts. If the information modules combined to develop a Type III environmental declaration for a product do not cover all stages of the life cycle of the product, then any omissions shall be stated and justified in the PCR-document (Product Category Rules).

Attributional or consequential LCA

The main difference between attributional and consequential LCA is that in the attributional approach, average data are used to describe the environmental impacts, whereas in the consequential approach, the processes actually affected by the decision to buy an additional product is used in the calculations. The issue is discussed in some detail in the study by 2.-0 Consultants, giving a number of examples of how the different ways of modelling the life cycle can lead to different results.

The ISO 14040 and 14044 standards do not give specific provisions as to which approach shall be used. The interpretation of ISO 14040 and ISO 14004 by Danish LCA and EPD practitioners is that both approaches are allowed within the general framework.

Cut-off rules

Requirements or guidance regarding cut-off criteria are not included in ISO 14025.

Allocation rules

The ISO 14025 standard does not give provisions for how to handle allocation, only that Product Category Rules (PCR) shall include allocation of material and energy flows and releases. No specific mention is made of whether the subject shall be treated by normative requirements, but it is inferred from the overall concept that the allocation rules shall be established in accordance with the framework, principles and requirements in ISO 14040 and ISO 14044.

2.2.2 LCA/LCI-information to be included

A Type III environmental declaration shall include the relevant data from LCA-studies, LCI-studies and/or information modules. These may include, but are not limited to, the following categories derived from the life cycle stages or additional environmental information. These data shall be clearly separated in the following three categories:

- data from life cycle inventory analysis (LCI), according to the PCR, including
    - consumption of resources, including energy, water and renewable resources, and

    - emissions to air, water and soil;

- indicator results of life cycle impact assessment (LCIA), if applied, including
    - climate change,
    - depletion of the stratospheric ozone layer,
    - acidification of land and water sources,
    - eutrophication,
    - formation of photochemical oxidants,
    - depletion of fossil energy resources, and
    - depletion of mineral resources;

- other data such as quantities and types of waste produced (hazardous and non-hazardous waste).

2.2.3 Additional environmental information

According to ISO 14025, a Type III environmental declaration shall include, where relevant, additional information related to environmental issues, other than the environmental information derived from LCA, LCI or information modules. Identification of the significant environmental aspects should, as a minimum, take into consideration the following:

- Information on environmental issues, such as
    - impact(s) and potential impact(s) on biodiversity;
    - toxicity related to human health, the environment or both
    - geographical aspects relating to any stages of the life cycle, e.g. a discussion on the relation between the potential environmental impact(s) and the location of the product system
- Data on building product performance, if environmentally significant
- Organisation's adherence to any environmental management system, with a statement on where an interested party can find details on the system
- Any other environmental certification programme applied to the building product and a statement on where an interested party can find details of the certification programme
- Information that is derived from the LCA but not communicated in the typical LCI- or LCIA-based formats.
- Instructions and limits for efficient use
- Hazard and risk assessment on human health and the environment;
- Information on absence or level of presence of a material in the building product that is considered of environmental significance in certain areas [see ISO 14021, 5.4 and 5.7 r];
- Preferred waste management option for used building products;
- Potential for incidents that can have impact(s) on the environment

Additional environmental information shall only be related to environmental issues (*sic*). Information and instructions on product safety unrelated to the environmental performance of the product shall not be a part of a Type III environmental declaration.

2.3 ISO/FDIS 21930

The ISO FDIS 21930 standard (ISO, 2007) is one in a suite of International Standards dealing with sustainability (of buildings). The purpose of the International Standard is to describe the principles and framework for environmental product declarations of building products, including consideration of the reference service life of the building products, seen over a building's life cycle.

The standard builds on the requirements outlined in ISO 14025 – and as a consequence of this – also on ISO 14040 and ISO 14044. The environmental information produced using the requirements in the standard is intended mainly for business-to-business communication, but it is acknowledged that some EPD may be used in the business-to-consumer marketplace.

2.3.1 Life cycle approach

Being based on the framework and principles outlined in the ISO standards mentioned above, the main approach of course follows these closely. To establish a crude overview, the most important provisions are stated.

Life cycle stages

The environmental impacts of a building product may be given for any part of the life cycle, where appropriate and justified. It is thus possible to address only the production stage ("cradle-to-gate" or "cradle to gate with option"). In such cases, the resulting EPD is not based on a LCA but on one or more information modules. The results are expressed per declared unit, e.g. kilo or m^3, which is different from the functional unit, in which the performance of the building product in the life cycle of a building is a key element.

Environmental information of an EPD covering all life cycle stages ("cradle to grave") shall be subdivided into at least four life cycle stages:

- Product stage, including information modules from raw material supply, transport, manufacturing of product and all upstream processes from cradle to grave
- Construction process stage, including information modules from transport to building site and building installation/construction
- Use stage/operation, including information modules from installed services and appliances, maintenance, repair, replacement and refurbishing, and all transport
- End-of-life stage, including information modules from deconstruction, reuse, demolition, recycling and disposal, including all transport

Consequential or attributional LCA

The EPD of a building product shall be based on an LCA, LCI and/or information modules conducted according to the guidance given in ISO 14040 and ISO 14044. The standards do not give specific provisions as to which approach shall be used. The interpretation of ISO 14040 and ISO 14004 by Danish LCA and EPD practitioners is that both approaches are allowed within the general framework.

Cut-off rules

Cut-off rules shall be defined in a way that has the minimum influence on the result obtained. For material flows, a cut-off rule of 5% by mass (i.e. inclusion of at least 95% of the total mass of inputs), energy or environmental relevance per impact category shall be a maximum starting point. It is, however, stressed that the cut-off rule does not apply to hazardous and toxic substances, all of which shall be included.

Allocation issues

Allocations, including those dealing with systems involving multiple building products, shall be treated in accordance with the provisions of ISO 14040. The materials and energy flows, as well as associated emissions, shall be allocated to the different products according to clearly stated procedures, which shall be documented as part of the PCR. Rules for allocation across product systems, e.g. recycling processes, shall be described in the PCR.

Judged from experience, this normative requirement allows for a large flexibility, e.g. as demonstrated by the way different EPD-schemes have established more precise provisions as described in the subsequent sections. There is little doubt that this flexibility in a key obstacle for the possibility of comparing LCA-related EPD-information across different systems. It is, however, outside the scope of the review to go into any detail on the appropriateness of the different approaches or to make suggestions for how a uniform approach should be.

2.3.2 LCA/LCI-information to be included

The following environmental information shall be included in the EPD.

- Environmental impacts expressed in terms of the impact categories of LCIA
    - climate change (greenhouse gases);
    - depletion of the stratospheric ozone layer;
    - acidification of land and water sources;
    - eutrophication;
    - formation of tropospheric ozone (photochemical oxidants).

- Use of resources and renewable primary energy — Data derived from LCI and not assigned to the impact categories of LICIA
    - depletion of non-renewable energy resources;
    - depletion of non-renewable material resources;
    - use of renewable material resources;
    - use of renewable primary energy;
    - consumption of freshwater.

- Waste to disposal — Data derived from LCA and not assigned to the impact categories of LCIA. The waste allocated to the building product during its life cycle shall be classified in the EPD as
    - hazardous waste, or
    - non-hazardous waste

The division between the various categories shall be expressed in percentage terms or as mass per functional or declared unit.

2.3.3 Additional environmental information

The requirements on additional environmental information are similar to those in ISO 14025, one exception being that the potential for incidents that can have impact(s) on the environment is suggested to consider the following elements

- The end-of-life stage, from deconstruction, reuse, recycling and disposal
- Energy-, water-saving etc. and other improvements, such as acoustical improvements
- Energy content of the building product for energy recovery in the end of life
- Recycled content (see ISO 14021:1999, 7.8.1.1) or recycling data

2.4 CEN TC 350

CEN is currently developing a harmonised system for producing environmental product declarations. The basic intention is to establish a modular system, allowing at the system top level to make a quantified assessment on environmental performance of buildings.

The task involves a large number of activities in three working groups, addressing single elements and combining them to an overall framework. The work is on-going and only early drafts are available for the moment being. The time horizon for the development of the full set of standards is 2010. The short review below is based on working draft WI 00350004, ”PCR for construction products” (N 0027, dated 2006-07-13).

2.4.1 Life cycle approach

Life cycle stages

The methodology for assessment of environmental performance of buildings in the working draft allows for some flexibility with respect to definition of system boundaries. The basic requirement is that the EPD shall be made according to the ISO 14040 series, but where appropriate and justified, the environmental impacts of the building product may be given for any part of the life cycle, e.g. only the production stage, “cradle to gate” or as a “cradle to gate with options”.

Consequential or attributional LCA

Neither the PCR document nor ISO 14040/ISO 14044 discuss whether a consequential or an attributional LCA approach shall be applied. The interpretation of ISO 14040 and ISO 14004 by Danish LCA and EPD practitioners is that both approaches are allowed within the general framework.

Cut-off rules

Cut-off rules shall be defined in a way that has the minimum influence on the result obtained. For material flows, a cut-off rule of 5% by mass (i.e. inclusion of at least 95% of the total mass of inputs), energy or environmental relevance per impact category shall be a maximum starting point. It is, however, stressed that the cut-off rule does not apply to hazardous and toxic substances.

Allocation issues

As a specific detail, the PCR-document specifies that for materials that do not change their inherent properties during recycling, the end-of-life actual recycling rate usually is the environmentally more appropriate parameter to quantify the recycling aspect instead of recycled content.

2.4.2 LCA/LCI-information to be included

The following environmental information is suggested to be included in the EPD.

- Environmental impacts expressed in terms of the impact categories of LCIA
  - climate change
  - destruction of the stratospheric ozone layer;
  - acidification of land and water sources;
  - eutrophication;
  - formation of tropospheric ozone (photochemical oxidants).
  - depletion of non-renewable energy resources;
  - depletion of non-renewable material resources;

- Use of resources and renewable primary energy — Data derived from LCI and not assigned to the impact categories of LICIA
  - use of renewable material resources;
  - use of renewable primary energy;
  - consumption of freshwater.

- Waste to disposal — Data derived from LCA and not assigned to the impact categories of LCIA. The waste allocated to the building product during its life cycle shall be classified in the EPD as
  - hazardous waste, or
  - non-hazardous waste

- Emissions to water and indoor air
  - To be declared in accordance with national standards and practice. Information on human health and comfort due to chemical, biological and physical emissions is required for further evaluation on the building level of human health and comfort.

When compared to ISO 14025 and ISO/FDIS 21930 it can be noticed that there are some differences in the assignments and terminology used. In CEN TC 350 depletion of non-renewable energy and material resources is thus considered to be an impact category, while in the ISO-standards it is considered as inventory information. Another difference is that CEN TC 350 addresses the “destruction” of the stratospheric ozone layer, whereas the ISO-standards address its “depletion”.

2.4.3 Additional environmental information

CEN TC 350 has in its working draft suggested general requirements that in essence are similar to those provided in ISO 14025, the only difference being that CEN TC 350 does not include the requirement to include data on product performance, if environmentally significant. When compared to ISO/FDIS 21930 there is another difference, i.e. that CEN TC 350 does not specify what to consider when addressing the potential for incidents that can have impact(s) on the environment.

In the description of the framework for assessment of integrated buildings performance (CEN/TC 350/Task group N36, dated 2006-11-28), the general considerations regarding dangerous substances are formulated as "Horizontal standards for measurement of release of dangerous substances from construction products into indoor air and to soil and water, developed by CEN TC 351 are expected to be relevant for purposes of the assessment of health & comfort performance of buildings (TC 350 WI 350001:2006 (E))"

Neither of these documents are very specific about how to handle dangerous and hazardous substances in products or as emissions to e.g. indoor air, where they may of concern to consumers, nor can the requirements in the PCR working draft be regarded as fully normative since the phrase "where relevant" allows for a discussion and interpretation. It should, however, be acknowledged that the suggested framework provides the opportunity of including additional environmental information on a rather detailed level, if so desired.

2.5 BRE methodology (UK)

The UK scheme for establishing environmental profiles of construction materials and components was developed by BRE in collaboration with the UK materials industry and government, providing a single life cycle assessment methodology for the evaluation of construction materials, elements and buildings (Howard *et al*, without year). An international peer review panel has confirmed that the choices used in the methodology conform with ISO 14041.

2.5.1 Life cycle approach

Life cycle stages

The BRE methodology is flexible with respect to how many life cycle stages are to be included. Basically, the BRE method accounts for burdens and impacts on a cradle-to grave basis, but in some applications BRE results are also presented for some intermediate stages, i.e. cradle-to-gate and cradle-to-site. The different boundaries are judged by BRE to be useful to different decision makers at different times.

Consequential or attributional LCA

The BRE methodology does not address the question of consequential or attributional LCA directly. It is, however, obvious from experience and the description of allocation rules that the LCA approach is attributional.

Cut-off rules

In the BRE methodology, data should be included on all materials with a mass greater than 2% of the output from the process. Information should also be provided for materials which contribute less than 2% by mass, but possibly have:

- Significant effects in their extraction, their use or disposal, or
- Are highly toxic, or
- Classed as hazardous waste

Materials with a low mass input but which contribute a significant proportion of the energy input should also be included, e.g. adhesives used in the manufacture of window frames.

Allocation issues

The BRE methodology recognises the desirability of avoiding allocation and therefore separate processes into sub-processes wherever possible. If this approach is not possible, then allocation by physical property is preferred and next to that by product value. The methodology details the allocation procedure for a number of situations:

- Sequential processes
- Two processes in parallel
- Recycling into same process
- Recycling into another use
- Separate recycling processes
- Recycling home and new scrap

It follows from the rules that all materials arising from a process (also future waste) that have a financial value attract a proportion of the burdens associated with the production processes. Where repeated recycling occurs, for example for metals, the primary burden carried forward through each recycling decreases until after an infinite number of recycles it reaches zero.

2.5.2 LCA/LCI-information to be included

In the BRE environmental profiles, no inventory information is presented. However, the environmental profiles present characterized and normalised environmental impacts for the following categories:

- Climate change
- Acid deposition
- Ozone depletion
- Pollution to air: Human toxicity
- Pollution to air: Low level ozone depletion
- Fossil fuel depletion and extraction
- Pollution to water: Human toxicity
- Pollution to water: Ecotoxicity
- Pollution to water: Eutrophication
- Minerals extraction

- Water extraction
- Waste disposal
- Transport pollution and congestion: Freight

2.5.3 Additional environmental information

The BRE methodology does not include any requirements on “additional environmental information”. The LCA calculations, performed by BRE consultants using their own database and impact assessment based primarily on the CML-methods, do however include a broader range of impact categories than most other EPD-approaches, *viz.* human toxicity via air and water and ecotoxicity.

2.5.4 Presentation of results

The BRE scheme uses a fixed two-page format. A few inventory data, addressing minerals and water extraction, waste disposal and primary energy consumption are presented in one table, together with the contribution to environmental impacts as calculated using the Dutch CML-method. In a second table, all environmental impacts are normalised by relating them to the annual impacts caused by a UK citizen. This approach is similar to that suggested in the Danish EDIP methodology and in Nissinen *et al.* No “additional environmental information” is presented.

2.6 The German AUB-scheme

AUB (Arbeitsgemeinachaft Umweltsverträglischer Bauprodukt e.V.) is a voluntary association of German building product producers and distributors with about 30 members representing more than 100 businesses. The AUB has developed a program that established environmental product declarations according to ISO 14025. The general guidelines (AUB, 2006) presented in short in the following paragraphs are used to establish Product Category Rules for well-defined building components.

2.6.1 Life cycle approach

Life cycle stages

The AUB-scheme includes all life cycle stages from cradle-to-grave. It has been chosen to present the results in semi-aggregated form, i.e. by providing separate results for the production and disposal stages

Consequential or attributional LCA

The general guidelines for establishing Product Category Rules does not address the question of consequential or attributional LCA specifically. It is, however, evident from the guidelines and the EPD’s available that the LCA approach is attributional.

Cut-off rules

All inputs of material constituting more than 1% by mass or accounting for more than 1% of the total consumption of primary energy shall as a general rule be included. The sum of excluded flows must not exceed 5%. Deviations from these rules shall be motivated.

Allocation issues

The guiding principle for allocation over life cycle stages (open and closed loop recycling) is that it shall reflect current conditions with respect to production and future conditions with respect to recycling. Current conditions are addressed by using market averages for the proportion between primary and secondary materials. Future conditions with respect to the recycling potential are established using the economic value after recycling. How this is done in practice is not described in any detail. However, each PCR-document provides a description of the calculation rules applicable to the material or product in question.

For multi-output processes the economic value of each of the outputs is used to allocate the environmental burdens. For multi-input processes like waste incineration, the allocation is made based on physical properties like lower heat value.

2.6.2 LCA/LCI-information to be included

The AUB-scheme specifies the following elements to be included in the EPD:

Inventory information

- Consumption of non-renewable primary energy
    - Coal, lignite, natural gas, crude oil, uranium
- Consumption of renewable primary energy
    - Hydro power, wind power, solar energy/biomass
- Consumption of secondary energy
- Consumption of non-renewable resources
- Consumption of water
- Land use (if quantifiable)
- Generation of waste
    - overburden, etc.
    - household and industrial waste
    - hazardous waste

Impact assessment information

- Global Warming Potential
- Ozone Depletion Potential
- Photo-oxidant Creation Potential
- Acidification Potential
- Eutrophication Potential

2.6.3 Additional environmental information

The general guidelines include the heading “Weitere angaben, Nachweise, Prüfergebnisse” which is considered to cover the same as the heading “additional environmental information”. Furthermore, there are detailed requirements to information presented under other headings, being relevant for consumer health and the local environment. Most important is that the following issues are addressed:

- The composition of the product shall be declared. The level of detail of the declaration is determined by a product forum specific for each product category.
- Materials and substances which are listed as dangerous or hazardous substances shall be listed, irrespective of the amounts in which they occur.
- The interaction between the product, human health and the environment shall be described.
- Products to be used in-door with a content of organic substances shall be tested in the AgBB-scheme for potential emissions of VOC.
- Health and environmental product properties in relation to unusual situation like fire shall be addressed. The same information is requested with respect to storage and disposal.

2.6.4 Presentation of results

The German AUB-scheme does not have a fixed format for presentation of results. The amount of information to be included depends on the product category rules, but the inventory and impact assessment information stated above shall be declared as a minimum, together with the additional environmental information.

2.7 The French EPD-standard (NF P 01-010)

The official French standard NF P 01-010 (AFNOR, without year) applies to the content of declarations of the environmental and health-related characteristics of construction products.

2.7.1 Life cycle approach

Life cycle stages

The French EPD scheme includes all life cycle stages. Data are collected and presented in an un-aggregated format for the whole life cycle as well as normalised to a one-year period.

Consequential or attributional LCA

The NF P 01 010 standard is considered as the French product category rules for all products. It does not address the question of consequential or attributional LCA specifically but it is evident from the standard that the LCA approach is attributional.

Cut-off rules

A 2% cut-off rule based on mass is applied, i.e. at least 98% of mass input must be accounted for. Excluded flows shall be identified, and substances classified as highly toxic (T+), Toxic (T), Harmful (Xn) and environmentally harmful (N) according to applicable EU Directives shall be included in the inventory.

Allocation issues

The NF P 01-010 standard defines rules for treatment of recycling and end-of-life aspects in the LCA. Internal recycling is considered to be without environmental in- and outputs. Open loop recycling is treated with a stock approach, where all waste recycled is considered to be sent to a stock. The system generating the waste is responsible for all impacts of processes upstream to the stock (e.g. waste treatment needed before a durable stocking and transport), while a system using waste as a secondary raw material is responsible for all impacts occurring downstream of the stock.

The general rule for (unavoidable) co-product allocation is that physico-chemical or economic relationship be used. Avoiding allocation by extending the system boundaries is explicitly excluded by the standard. The reason given for this is that it the approach can lead to negative impact values that are considered to be deceptive by lots of EPD-users in France (Chevalier, 2006).

2.7.2 LCA/LCI-information to be included

The French standard requires the reporting of inventory results at a very high level of detail, including in practice all available inventory information for each of five life cycle stages examined. The following headings indicate the level of detail:

- Consumption of non-renewable primary energy
    - Wood, coal, lignite, natural gas, petroleum, uranium, etc.
- Energy indicators
    - Total primary energy, renewable energy, non-renewable energy, process energy, feedstock energy, electricity
- Consumption of natural non-energy resources
    - Includes elements as well as mineral and vegetable and animal raw materials
- Consumption of water
    - Lake, sea, groundwater, river, drinking water, unspecified
- Consumption of recovered energy and recovered materials
    - Includes e.g. energy, steel, aluminium, cullet plastic, biomass, mineral
- Emissions to air
    - Minimum list of 36 flows
- Emissions to water
    - Minimum list of 28 flows
- Emissions to land
    - Minimum list of 13 flows
- Production of waste
    - Recovered waste. Includes e.g. energy, steel, aluminium, cullet plastic, biomass, mineral
    - Eliminated waste. Includes hazardous waste, safe waste, inert waste, radioactive waste

With respect to impact assessment information, the following categories shall be reported:

- Global Warming Potential
- Ozone Depletion Potential
- Photo-oxidant Creation Potential
- Acidification Potential
- Air pollution
- Water pollution
- Consumption of energy resources
- Resource depletion
- Water consumption
- Solid waste

2.7.3 Additional environmental information

The French standard includes an evaluation of health-related risks as well as the quality of life inside a building. The scope of the standard does not extend to the expression of health risks, and it is acknowledged that emissions or characteristics data are often expressed other than by the functional unit and the LCI.

In practice the following data regarding health risk assessment shall be declared:

- Quantitites of dangerous substances intentionally used in the manufacture of the product and labelled highly toxic (T+), Toxic (T), Harmful (Xn) and environmentally harmful (N) according to the decree of 20 April 1994.
- Data relative to the emission of chemical compounds to water, air and land
- Data relative to the emission of ionising radiation
- Data relative to the growth of micro-organisms

With respect to the health-related quality of interior areas, the following emissions and sources of pollution are mentioned as examples of possible contributors:

- CO; CO_2; NOx, SOx;
- hydrocarbons;
- radon and radiation;
- VOC;
- dust;
- non-viable particles, such as breathable and non-breathable suspended particles and fibres;
- viable particles, including micro-organisms such as small insects, protozoa, mould, bacteria and viruses;

A number of performance characteristics can be added to the above list of emissions and sources of pollution, e.g. regarding resistance to biological agents, ultraviolet radiation, thermal impact and high velocity air, organoleptic properties, fitness for contact with drinking water, etc.

For comfort aspects relevant characteristics (mechanical, physical, chemical, thermal, acoustic properties …) shall be selected and declared for each type of comfort (hydrothermal, acoustic, visual, and olfactory). Suitable test methods are suggested in an Annex to the standard.

2.7.4 Presentation of results

EPD's established according to NF P-0-010 are presented in an (almost) fixed format with the headings indicated above coming in the same sequence. With the requirement of reporting the inventory results in detail, the EPD's become very extensive being in the range of about 40 pages.

2.8 The Swedish EPD® scheme

The general requirements for environmental product declarations in the Swedish EPD system have been defined by the Swedish Environmental Management Council (Miljöstyrningsrådet, 2000) (MSR 1999:2). The system has a broad scope, including common consumer products like roof boxes for cars, cooker hoods and sanitation goods as well as B2B products like basic metals and transformers. In total, 25 product categories have been defined so far and different sets of product category rules have been developed within these product groups.

2.8.1 LCA approach

The general LCA approach conforms to the requirements in the ISO 14040 series and ISO 14025.

Life cycle stages

According to MSR 1999:2, the EPD shall consider all stages from cradle-to-grave. However due to lack of detailed information on how a product is distributed, used and handled at the end of its life cycle, the quantitative information shall be separated for the phases that describe the results of the LCA study from raw material acquisition to manufactured product on one hand, and distribution to the market, product use, recovery, recycling and waste handling on the other. Based on a quick examination of available EPD's, this approach is not followed in all cases. In fact, it seems like the way of presenting results is chosen somewhat arbitrarily – perhaps as a consequence of deviations from the general approach in the specific product category rules.

Consequential or attributional LCA

The data shall be expressed as annual average values. Plant-specific data from manufacturing processes should always be used, and generic data should be used in cases where they are representative for the purpose of the study, e.g. purchase of bulk and raw materials on the spot market and in the use- or waste handling stages. This approach is considered to be attributional.

Cut-off rules

The loss of information, as a result of omitting processes from the LCA study can be accepted provided that the sum of the loss of information corresponds to a contribution to the relevant environmental impact category not exceeding 1% of the total contribution. It is acknowledged that this rule-of-thumb may prove to be far too strict and it should therefore be regarded as a first recommendation.

Allocation rules

Avoiding allocation by expanding the system boundaries, as advocated in ISO 14041, is not applicable in the Swedish EPD system. When choosing allocation rules, the following principles are recommended:

- Multi-output processes: Allocation based on economic relations or physical causal relationships
- Multi-input processes: Allocation based on physical causal relationships
- Open-loop recycling: No allocation shall be made for materials subject to recycling. Instead, inputs of recycled materials or energy to a product system shall be included in the data set without adding their data about environmental impacts caused in “earlier” life cycles.

2.8.2 LCA/LCI-information to be included

The general requirements specify the following mandatory headings to be included:

- Resource use
    - Non-renewable resources
        - With and without energy content
    - Renewable resources
        - With and without energy content
    - Electricity consumption

- Pollutant emissions
    - Emission of greenhouse gases
    - Emission of ozone-depleting gases
    - Emission of acidifying gases
    - Emission of gases that contribute to the creation of ground-level ozone
    - Emission of substances to water contributing to oxygen depletion

- Waste generation
    - Hazardous and other waste

2.8.3 Additional environmental information

The Swedish EPD-system does not have normative requirements with respect to additional environmental information. The declaration can include information on the existence of an environmental management system, and on the product level, it can include a content declaration and/or specially requested information from customers and the market, e.g. if the product is “free of” a special hazardous material.

It is, however, also acknowledged that special requirements may prevail in conjunction with purchasing and procurement by industry and public authorities. Suggestions for such information can be made by participants present at the open consultation meetings.

2.8.4 Presentation of environmental results

The Swedish EPD-system does not have a fixed format for presentation of environmental performance.

2.9 The Dutch MRPI-scheme

The Dutch MRPI-scheme is established on the basis of the Dutch standard NEN 8006 (NEN, 2004). Its scope is building materials, building products and building elements.

2.9.1 LCA approach

The LCA approach is based on the framework laid down in ISO 14040.

Life cycle stages

Environmental Product Declarations established in the MRPI-scheme do not necessarily have to include all life cycle stages. The following stages are obligatory:

- The production stage, starting with extraction of resources and ending with the building material, product or element shall be included.
- Transportation to the customer, ending at the arrival (to be handled by means of scenarios)
- The construction stage (to be handled by means of scenarios)
- The processes in the use and maintenance stage (to be handled by means of scenarios)

Demolition and disposal stages are only obligatory by or in request of the producer, and shall in such cases be handled by scenarios.

Consequential or attributional LCA

The Dutch standard does not address the question of consequential or attributional LCA specifically but it is evident from its elements that the LCA approach is attributional.

Cut-off rules

Materials which constitute less than 2 % by weight of the average building material, product or element need not to be taken into account. The maximum of all exclusions shall not exceed 5 %, and materials which contribute more than 5 % to the environmental impacts shall always be included.

Allocation rules

Allocation is applied to processes shared by different product systems, i.e. in the case of

- Multi-output processes
- Multi-input processes
- Recycling and re-use processes

The first step in allocation is to divide up the system, ensuring that the allocated sums of input and out flows corresponds to the unallocated inputs and outputs flows of a unit process.

For Multi-output processes, the second step in allocation shall be based on mass. For Multi-input processes, the allocation shall be based on the physical composition of the product and stoichiometry of the reaction.

For recycling and re-use processes a special allocation procedure has been developed, taking into consideration whether an economic turning point occurs, i.e. whether the object in question changes from having a negative economic value to a positive value. The standard then specifies a number of scenarios from which to choose the most appropriate for the product in question. It is outside the scope of this review to go into any detail, other than a thorough knowledge on market mechanisms and market prices is needed in order to make the allocation according to the standard.

2.9.2 LCA/LCI-information to be included

There are no requirements as to inclusion of inventory information in the environmental profiles. The LCA results are presented as aggregated values for the following impact categories:

- Abiotic depletion
- Global Warming Potential
- Depletion of the ozone layer
- Acidification Potential
- Eutrohication Potential
- Smog
- Human toxicity
- Ecotoxicity
    - Aquatic
    - Terrestrial

As a special feature, the environmental impacts are converted to so-called environmental measures, using a dedicated weighting system. The following headings are addressed:

- Raw materials
- Energy
- Emissions
- Hazardous waste
- Non-hazardous waste

2.9.3 Additional environmental information

There are no normative requirements with respect to additional environmental information. The standard allows, however, for supplementary, qualitative environmental information, “if necessary”. The information must be relevant for the building material, product or element.

2.9.4 Presentation of results

The MRPI-declarations are presented using a standard 2-page template.

2.10 2.-0 LCA Consultants. ”Consumer demands on Type III environmental declarations”

The review of the study by 2.-0 Consultants (Christiansen, Wesnæs and Weidema, 2006) differs from the review of the general standards and the national EPD-schemes with respect to focus and detail. The main reason is that the study by 2.-0 Consultants primarily aims at introducing new approaches to establishing LCA/LCI-information and presentation of results. It is acknowledged that the 2.-0 study also discusses a wide range of other aspects related to EPD’s, but due to time and budgetary constraints most of these aspects are not dealt with in any detail.

2.10.1 Introduction to the study

2.-0 LCA Consultants was in 2005 commissioned by ANEC to perform a study on Environmental Product Declarations (EPD), examining state-of-the-art for Life Cycle Assessment and EPD and suggesting formats and procedures for establishing EPD’s fulfilling consumer demands with respect to information needs.

The study addresses most of the issues currently being discussed in the LCA society, most notably the issues of

- Attributional or consequential LCA
- Use of Environmental Input-Output analysis (EIO)
- Impact categories to be included (method availability)
- Data availability and quality

The result of the study is a LCA approach which in priciple allows for a cost-efficient way of producing the requested information for (almost) all products or product groups as well as ways of communicating the information to consumers. As such it shows a way to a standardized approach for future work in the EPD-area. It should, however, also be recognized that the suggested approach must be seen as a unity, having little or no flexibility with respect to producing and communicating the basic quantitative information. Furthermore, the databases necessary to produce the information are only limited available to the scientific community and this may at least on the short-term be a barrier for introduction and acceptance of the approach.

2.10.2 LCA approach

The LCA approach suggested by 2.-0 LCA Consultants is to a very large extent based on the relation between monetary flows and environmental exchanges. The core element is a background database, in which national (or EU) Input/Output statistics on the trade between up to 480 industrial sectors are combined with corresponding environmental accounts for air and water emissions and generation of waste into so-called NAMEA's (National Accounting Matrices with Environmental Accounts) and further converted into the standard format of LCA databases. According to 2.-0 LCA Consultants such databases on a relatively high level of details are available for the EU and USA, The Netherlands and Denmark, and more are on their way. It is outside the scope of this review to provide any details regarding the theory and practical procedure in the development of EIO-databases. A very detailed description of how the Danish EIO-database was developed and what it contains can be found in Weidema *et al*. (2005) and a detailed description of the EU database developed in the EIPRO-project can be found in Tukker *et al.* (2005). These reports also include discussions about the inherent uncertainties in the general approach.

The background database is suggested to be used in a hybrid LCA, combining conventional LCA data for foreground processes (e.g. site-specific "gate-to-gate" data for a manufacturer) with EIO-data for upstream, use and end-of-life activities, and thereby providing the desired level of detail for EPD-information. At the same time the background database can be used to establish similar information for an average product within the same product group, simply by using the generic information in the database as a substitute for the information otherwise provided by the manufacturer. Finally, the database can be used to calculate the environmental impacts from an "average consumer good".

The public versions of the EIO-databases express the environmental impacts per monetary value spent on a given commodity. It may be possible through manipulation of additional statistical data to establish figures for environmental impacts per physical unit (e.g. kg, MJ or "piece"), but the extent to which this has been done is unknown. Hybrid databases have according to 2.-0 Consultants been developed by consultants for internal use, but are not commercially available. It is also unknown whether the hybrid databases have the option of expressing environmental impacts per physical unit. 2.-0 Consultants envision the development of a common database in small steps, one industry at the time, as resources become available.

It is the opinion of the reviewer that the hybrid LCA-approach suggested by 2.-0 Consultants is theoretically feasible as described. With an EIO-database being available, the efforts in producing multiple LCA's will probably be significantly less demanding than when using conventional LCA-databases. At the same time, the results will provide a more complete picture of the product-related environmental impacts, because virtually all economic activities and their impacts on environment are included in the background database. It is argued by 2.-0 Consultants that cut-off rules and system boundaries vary between industries in their LCA-work, compromising the comparability of results. This observation is also the experience of the reviewer, but the drawbacks of EIO-data should not be neglected.

The most prominent question in this respect is probably how the low level of detail influences the results. At its best, EIO data are currently found for 480 industrial sectors, and this is not very satisfying when considering that these data are used to calculate the environmental impacts of tens or hundreds of thousands of products coming from the same sectors. Some examples of the consequences of this can be found in Schmidt *et al.* (2003), e.g. that it is not possible to distinguish between the impacts from production, use and disposal of different types of plastics.

2.10.3 Life cycle stages

All stages from cradle to grave are considered in the approach suggested. It is remarked that the geographical boundaries for the market on which the EPD is valid are considered to be an important element, needing special attention. The importance is especially related to the use stage (differences in local electricity supply) and disposal stage (differences in local/national waste disposal systems).

In the reporting of the results, the following four stages should be distinguished:

- "Before our gate", including all suppliers to "Our production" as well as purchased electricity
- "Our production", including only the production plant
- "Use", including all complementary products needed in the use stage
- "End-of-life" (waste disposal and recycling)

2.10.4 Attributional or consequential LCA

The recommendation by 2.-0 Consultants is to use consequential LCA, especially in relation to the site-specific parts of the study, e.g. where data are supplied by an individual company. 2.-0 Consultants also suggest that the general I/O-database be adjusted to consequential modelling, at least for sectors with important constraints on specific technologies or production routes.

The main argument for using consequential LCA is that this approach identifies the processes affected by a purchase of the declared product and, accordingly also gives information about the environmental consequences of the decision.

2.-0 Consultants are aware that the consequential LCA approach has gained limited acceptance in connection with EPD's, despise the fact that it is judged to be widely used in product development and policy-making, and is emerging in relation to Type I environmental Labels. Accordingly, it is foreseen by 2.-0 Consultants that it will take time to reach a consensus on the use of the consequential approach.

2.10.5 Cut-off rules

Using the I/O-based LCA approach obliterates the need to include cut-off rules in an EPD-scheme. The simple reason for this is that I/O-based LCA includes all environmental flows related to a given economic activity.

2.10.6 Allocation rules

Using the I/O-based LCA approach allows for a complete allocation of all activities to all products. There is thus no need for developing and implementing specific allocation rules as is the case for attributional LCA.

2.10.7 LCA/LCI-information to be included

2.-0 Consultants does not recommend that inventory information is presented to the user, the reason being that he/she does not have the tools to assess these data. The result could therefore add more to confusion than to clarity. For business-to-business communication these data may be of interest, but out of the large number of possible data (all individual substance flows of an LCI) the limited selection of data that can fit into an EPD is bound to be incomplete and therefore not fulfilling for this purpose, where an electronic communication of the complete LCA information in a standard format may be more suitable.

The following impact categories are suggested to be reported:

- Nature occupation
- Global warming
- Invasive species dispersal
- Acidification
- Nutrient enrichment
- Photochemical ozone formation
- Human toxicity, including particles and carcinogens
- Injuries

In relation to the requirements in ISO 14025, the impact categories “Nature occupation”, “Human toxicity” and “Injuries” are additional. However, 2.-0 Consultants argue that “Nature occupation” to a large extent corresponds to the ISO-heading “Impact(s) and potential impact(s) on biodiversity, “Human Toxicity” to the heading “Toxicity related to human health and/or the environment”, and “Injuries” to the heading “Hazard and risk assessment on human health and the environment”, all of these being reported in the ISO 14025 framework as Additional Environmental information”. It is outside the scope of the review to go into details about the precise coverage of each of the headings, but it is obvious that the suggestion from 2.-0 Consultants may add more dimensions to the quantitative content of an EPD.

Invasive species dispersal is, although regarded as important by 2.-0 Consultants, not included in the examples provided by 2.-0 Consultants since no operational life cycle indicators have yet been developed.

2.10.8 Additional environmental information

2.-0 Consultants suggests that materials and chemical substances above 0.1% of weight of the product shall be declared, also indicating eventually content of substances eligible to labelling according to EU legislation on hazardous substances. (0.1% has been chosen as a typical "lower" labelling requirement; for specific substances even lower levels can be substantiated).

2.10.9 Presentation of LCA-results

2.-0 Consultants has developed an (almost) fixed format for EPD's. Much of the information to be presented is similar to that presented in the existing EPD-schemes, but 2.-0 Consultants also discusses three ways of normalising the LCA-based results in order to make them more comprehendible and useful for consumers:

1) Normalising by using Person Equivalents. This approach – with small differences - is used both in the Danish EDIP-method and the Finnish benchmark study by Nissinen *et al*, (2006). The approach can be used for all products and once explained it is easy to understand. The approach also allows for a comparison between different product groups. Normalisation data are readily available for the most interesting impact categories, and the main effort is thus to produce reliable LCA-information, either through conventional or hybrid LCA. The main argument of 2.-0 Consultants against using the approach is that for many product groups it will not be possible to distinguish between two products within the group.

2) Normalising by using Environmental Impacts per Euro spent relative to overall consumption. This approach is based on 1), but extended by using the cost (price) of the product and the costs of the total consumption per person in one year. In short, the normalisation compares the environmental consequences of using one Euro on a product to the average impacts of using one Euro. The price of the product is included in order to avoid the bias that is introduced by price differences: When comparing two products which have the same environmental impacts but a different price, the consumer will save money by buying the cheaper product. These saved money will be spent on another consumption that should be included in the product system for the cheaper alternative, and by including the price, i.e. getting the impacts per Euro, this bias is reduced.

   The results are presented on a percent scale, where 100% is the average impact, while small %-values indicate that the product is not demanding in environmental terms – and *vice versa*. The approach allows for a comparison with other products, although not in terms of absolute values but percentages as indication of relative impact. Furthermore, products with different prices can be compared without bias, and the comparison to overall consumption is judged by 2.-0 Consultants to increase environmental awareness in a broader sense. According to 2.-0 Consultants the main drawback of the approach is that

– as was the case for option 1) – that it is difficult to distinguish between two products within the same product group on this large scale.

3) Normalisation by using Environmental impacts per Euro spent relative to average of the specific product group. This approach is basically similar to 2), however the environmental impacts and price of a product are normalised in relation to the environmental impacts and average costs of the product group it belongs to. In other words, a product is compared to the average product of the product group. As in option 2), the price is included in order to avoid the bias introduced by price differences.

   The results are presented on a percent scale, where values less than 100% indicates that the product performs better than the average product of the product group, and values over 100% indicates the product performs worse than the average product. According to 2.-0 Consultants, the main benefit of this approach is that it allows for a distinction of even small differences between products within the same product group, also if there are price differences. The drawback of the approach is that it does not allow the consumer to judge whether the product in questions contributes little or much to the overall environmental impacts.

Based on their discussion of the three options for normalisation, 2.-0 Consultants suggest using both Option 2) and Option 3) to communicate the life cycle environmental impacts to consumers. In doing so, the consumers get an answer to the following relevant questions:

- What are the environmental consequences of using 1 Euro on this product, compared to using 1 Euro for “average consumption”? In other words, the consumer is given an indication of whether he/she is going to spend money on products with a high or low environmental impact.
- What are the environmental consequences of using 1 Euro on this product, compared to using 1 Euro on the average product within the same product group? In other words, the consumer can easily see whether there is a potential to buy a product with less environmental impacts – or if he has made the “right” choice with the product at hand.

Comments to the normalisation approaches by the reviewer

Option 1. This approach is one of the core elements of the Danish EDIP-methodology, where it is used with the main purpose of identifying which environmental impact(s) should be regarded as the most important for a given product. The EDIP-methodology also provides the information necessary for the subsequent weighting step, which has not yet been addressed in relation to EPD.

When used in an EPD, it allows the consumer to identify the most important environmental properties of a product – and how important they are in relation to his or hers overall annual impacts. Given the fact that information of all types of environmental impacts are provided on the same scale (using the Person Equivalent) it is judged to be a simple and yet meaningful way of communicating environmental information. Furthermore, the simple information is readily used to compare the impacts of two or more products.

The results can easily be presented in more detail with respect to where in the life cycle the impacts arise, e.g. by using stacked bar diagrams.

Option 2. This option has been "invented" by 2.-0 Consultants, using the same basic approach as in the EIPRO project (Tukker *et al*., 2005). A main – but somewhat controversial – element is that by including the price/cost of the product, buying a cheaper alternative with the same environmental impacts as a more expensive one will show to be more demanding on the environment, simply because the saved money will be used for "average consumption": It is acknowledged that the approach is a possible way of reflecting the ultimate consequences of a purchasing decision, but explaining it to common consumers is judged to be difficult, and it is probably even more difficult to gain their acceptance. As illustrated by the example in Box 1 and discussed below, the most serious concern is however that the approach in practice may lead to purchasing decisions which are not in favour of the environment.

The main argument of 2.-0 Consultants against using the approach is that for many product groups it will not be possible to distinguish between two products. This is true - unless a very detailed scale is applied – which leads to the question whether such information should be presented to consumers at all, if their choice of one product or the other does not affect the environment to any significant extent.

Option 3). The approach in Option 3) makes further use of the database developed through EIO, comparing the impacts per Euro spent on a specific product to the impacts per Euro spent on the average product within the same product group. The results of this approach are also examplified in Box 1 and discussed below.

The EIO-results can fairly easily be manipulated in order to produce somewhat crude results for an average product, whereas it is much more demanding to produce the information if a bottom-up approach is used, as it is done in the MEEUP-studies (Kemna *et al.* (2005)). The use of EIO-data is therefore a crucial element in using Option 3), unless large resources are devoted to produce the same results for the broad range of product groups relevant to common consumers. It is remarked, that this also applies to Option 2), although not necessarily to the same extent.

Suggestion from 2.-0 Consultants. The suggestion of 2.-0 Consultants is to use Options 2) and 3) above to produce graphical information which is additional to the conventional presentation of LCA-results in EPD's. Whether this way of presenting environmental information can be comprehended by common consumers is most probably a question of education, as is also the case for presentation of conventional results. More serious is, however, the risk that "wrong" decisions can be taken when the price/cost of the product is used for normalisation.

A hypothetical, but realistic example of the suggested approach is given in Box 1. The example concerns the purchase of a car, the possibilities examined being to buy an energy-efficient car, an energy demanding car or an "average" car.

Box 1. EPD-results for different cars

A crude comparison was made between three cars using the approach in Option 2) and Option 3). The three fictive cars compared over their life of 15 years (20,000 km/year) were

- A Lupo-type car, being energy efficient (30 km/l) and cheap (assuming a future price of only 15,000€ because of its fuel efficiency)
- A Hummer-type car, being very energy-consuming (3 km/l) and expensive (100.000€)
- An average car, driving 15 km/l with a retail price of 25.000€

It is emphasized that fuel efficiencies and prices are fictive, but probably sufficient realistic for illustrative purposes. Gasoline is assumed to cost 1.5€/l, emitting 2.4 kg CO_2 per litre. With the above assumptions the total and annual CO_2-emissions and expenses (excluding taxes etc.) can be calculated:

	Fuel efficiency (km/l)	Distance driven	Gasoline consumption (l)	CO2- emission - use stage (kg)	CO2 – emission production stage	Total CO2-emissions	Total CO2-emissions per year
Lupo	30	300000	10000	24000	5000	29000	1933
Hummer	3	300000	100000	240000	10000	250000	16667
Average	15	300000	20000	48000	7500	55500	3700

	Retail price	Gasoline expense	Total expense	Total expense per year (€)
Lupo	15000	15000	30000	2000
Hummer	100000	150000	250000	16667
Average car	25000	30000	55000	3667

Based on information from Wikipedia, the CO_2-emission per € of the EU GDP (equal to impact from "average consumption") was roughly calculated to 0.35 kg/€. When normalised as suggested by 2.-0 Consultants for options B and C, the following results are seen:

	kg CO2/€	In % of average consumer goods (Normalisation option B)	In % of average car (Normalisation option C)
Average consumption	0,35	100	
Lupo	0,97	276	96
Hummer	1,00	286	99
Average car	1,01	288	100

The results are discussed in the text

When looking at Normalisation option B, "Environmental impacts per Euro spent relative to overall consumption", the results seems to be much in line with common sense, indicating that using money on a car has a much larger environmental impact than using money for average consumption. It is, however, surprising that there seems to be very little difference between the three types of cars.

When looking at Normalisation option C, "Environmental impacts per Euro spent relative to the average of the specific product group", this surprising picture is confirmed. In fact, the average car has the largest impacts per Euro spent, while the energy-efficient car only performs slightly better than a very energy-demanding car. It is thus a very poor message being sent to the consumer who – well-knowing from Option B that it is not a good idea to use money on a car – nevertheless wants to buy the product with the least environmental impact.

Using the price of a product for normalisation purposes as suggested by 2.-0 Consultants is therefore judged not to give the environmentally conscious consumer the information needed to make the right choice, at least not in all cases.

Furthermore, it must be recognized that the consumer is not provided with the information which by many is considered to be a core element, namely "How important for the environment is it that I purchase this product and not its alternative"? This question is answered in Option 1) and the answer could probably easily be integrated in the overall format suggested for EPD's.

2.11 Review summary

The standards used for establishing EPD-information operates at different levels as indicated in Table 1.

Table 1. Level of documents used for establishing Environmental Product Declarations or Environmental Profiles.

Document level	Document reference	Comment
Overall Level – LCA	ISO 14040 ISO 14044	Not discussed in review
General EPD-level	ISO 14025	Regards all types of products
EPD-level buildings	ISO/FDIS 21930 CEN TC 350	Under development
General EPD/PCR-level	BRE-methodology AUB-Leitfaden MRPI-standard (NEN 8006) AFNOR-standard (NF P 01-010) Swedish EPD-system (MSR 1999:2)	Examples of national EPD-schemes
PCR-documents	PCR-documents are developed in the AUB and Swedish EPD-schemes, whereas in the other schemes the general PCR-document applies to all product groups	Only few, selected excerpts are discussed
EPD's	Not examined	Not discussed in review

Table 2 presents an overview of how selected elements are handled in the European EPD-schemes examined. The overview is subsequently discussed in brief, pinpointing the most significant or "interesting" differences.

Table 2. Overview of how selected elements are handled in the reviewed schemes.

Aspect	Swedish EPD	French standard	German AUB-scheme	UK BRE scheme	Dutch MRPI-scheme	2.-0 Consultants
Scope	All products	Building products and components	Building products and components	Building products and components	Building materials, product and elements	All products
Life cycle stages	Cradle to grave or cradle to gate, as appropriate	Cradle-to-gate	Cradle-to-grave	Cradle to grave or cradle to gate, as appropriate	Cradle-to end of use	Cradle-to-grave
Consequential or attrbutional	Attributional	Attributional	Attributional	Attributional	Attributional	Consequential
Cut-off rules	1 %, based on importance	2 %, based on mass; hazardous substances to be included	Inputs, accounting for more than 1 % by mass or primary energy shall be included. Sum of excluded flows less than 5 %.	2 %, based on mass as a general rule; materials with a significant impact on extraction, use or disposal to be included, likewise for toxic substances and hazardous waste	2 %, based on mass. Sum of excluded flows less than 5 %. Materials contributing more than 5 % to be included	All flows included in a hybrid LCA
Allocation rules (open-loop recycling)	No system expansion; recycled materials without impacts	No system expansion; recycled materials without impacts	Current and future recycling conditions to be considered	Allocation based on number of loops	Allocation based on market conditions and prices	Not necessary
LCA/LCI information included	Resource consumption, generation of waste, characterised data for global and regional impacts	Detailed LCI, characterised data for global, regional and local impacts, additional environmental information	Resource consumption, generation of waste, characterised data for global and regional impacts, additional environmental information	Characterized and normalised data, incl. human toxicity and ecotoxicity	Characterised data, incl. human toxicity and ecotoxicity. "Environmental measures" as a special feature.	Characterised data; Impacts per Euro spent on similar and average product
Additional environmental information	No normative requirements	Declaration of content of hazardous substances; Data relating to assessment of health risks and comfort	Product composition, incl. hazardous and dangerous shall be declared in detail; Tests of indoor products; unusual situations described	No normative requirements	No normative requirements	Can be included as appropriate and relevant
Presentation of results	Large variations	(Almost) fixed format	Small variations, depending on PCR-document	Fixed format	Fixed format	Fixed format

2.11.1 Scope

The Swedish EPD-system is the only reviewed scheme with the possibility of making EPD of products from other sectors than the building industry. This is also reflected by the number of product category rules available, being very high for the Swedish system, whereas for the UK, French and Dutch systems only one standard or PCR document covers the whole product range. The German AUB-scheme has a general PCR-document which is "translated" into specific PCR-documents, covering a narrow range of products, e.g. building metals or mineral insulation. The approach suggested by 2.0-Consultants also covers a wide scope, i.e. also other products than building-related products can be handled.

2.11.2 LCA approach

Some of the schemes (UK, S, (DE)) examined allow some flexibility with respect to life cycle stages included. The French scheme is very strict in its requirements, i.e. the full life cycle must be addressed. This approach is made possible through a simplified allocation of recycling and re-use, using the so-called stock approach. The Dutch scheme applies a scenario technique for the life cycle stages following the production stage; for the demolition and disposal stage however only by or in request of the producer.

2.11.3 Consequential or attributional LCA

All systems examined apply an attributional LCA approach, except for the suggestion from 2.-0 Consultants. The Danish EPD-system, which is currently being developed, will in contrast to this use consequential LCA. As no PCR-documents or EPD's are available it is not possible to address the experiences from this system.

2.11.4 Cut-off rules

The cut-off rule is in general 1 or 2 %, based on mass, with 5 % being the maximum for total exclusions. As a general rule, materials/substances contributing significantly to one or more of the impacts considered, must not be excluded, and in some schemes, products with unwanted properties, broadly defined, must be included.

2.11.5 Allocation rules

The allocation rules for Multi-input and Multi-output processes are rather similar in all schemes. When dealing specifically with recycling and re-use, however, significant differences are observed. The Swedish and French systems specify that secondary materials enter a system with (almost) no impacts from earlier life cycles. The UK system allocates according to the number of loops, the Dutch system according to market prices and the German system according to an examination of current and future conditions with respect to collection of and markets for secondary products. With the given procedural differences it is judged that this aspect can lead to large differences in the environmental profiles produced. In contrast to this, the approach by 2.-0 Consultants avoids allocation, i.e. all allocation is assumed to be done when establishing the Input-Output database used to describe the environmental impacts from background processes.

2.11.6 LCA/LCI-information included

The EPD-schemes examined vary considerably with respect to their requirements regarding which results to present. The basic elements required are tabulated below.

Table 3. Comparison of reporting elements in the examined schemes.

Element	Swedish EPD	French standard	German AUB-scheme	UK BRE scheme	Dutch MRPI-scheme	2.-0 Consultants
Life Cycle Inventory	Selected, basic elements	Very detailed	Selected, basic elements	Not included	Not included	Selected, basic elements
Life cycle Impact Assessment	Global and regional impacts	Global, regional and local impacts	Global and regional impacts	Global, regional and local impacts	Global, regional and local impacts	Global, regional and local impacts
Extra features	No	No	No	Normalisation	Environmental measures	Normalisation

As indicated in Table 3, the requirements regarding inventory information vary from no requirements to reporting of full inventory tables for all types of environmental exchanges.

With respect to impact assessment, all schemes requires that the contribution to global and regional impacts are reported, whereas local impacts (e.g. human toxicity) is only required to be reported in the French, Dutch and UK schemes – using different methodologies. The reporting format from 2.-0 Consultants includes as the only one also headings like land use and incidents,

Two of the schemes examined (UK, F) requires an additional handling of the inventory and impacts assessment result. In the UK scheme it is required that the results are normalised, using the annual impacts of an average UK citizen as the reference, whereas the Dutch scheme applies a specially developed approach, calculating the so-called environmental measures. The suggested approach from 2.-0 Consultants introduces a special way of normalising the results, using the impacts per monetary unit as the reference.

It is remarked that the French standard is the only one fully conforming to the requirements in ISO 14025 with respect to inventory information. It is, however, evident from general and specific PCR-documents in the other schemes that full inventory information is established in the LCA's underlying the resulting EPD; the results are just not presented in the EPD.

2.11.7 Additional environmental information

The French system is most demanding in terms of normative requirements for additional environmental information. The French requirements thus comprise presentation of data relative to a health assessment as well an assessment of indoor air quality and comfort for the consumer. The German AUB-system is less strict in the requirements, but its EPD's will in practice present much of the same information as the French system, although comfort aspects are not necessarily addressed specifically. Declarations from the Swedish and Dutch systems can, if "necessary" or "relevant" include qualitative environmental information, while the UK declaration format does not include such aspects. The suggestions made by 2.-0 Consultants are not reviewed here.

3 Consumer perception of environmental information

Environmental Product Declarations from national EPD-schemes differ significantly with respect to the amount of information they convey to the users. There is little doubt that the main target group for the declarations in all schemes are professional consumers/purchasers, taking an informed decision on behalf of many people, e.g. colleagues, administrators, etc.

It is, however, obvious that EPD's for some product groups also have the common consumer, or at least the environmentally conscious consumer, as their target. Examples are consumers purchasing refrigerators wanting to be sure that the refrigerants and foaming agents do not deplete the ozone layer, consumers purchasing electronic devices wanting to be sure that they do not emit hazardous flame retardants during their use, etc.

Even though both professional and private consumers may have a high level of awareness on the relation between their consumption and environmental impacts, there is an upper limit for much environmental information they can and will handle in the purchase situation.

The issue has been discussed in a number of reports, some of which are reviewed in short in the following paragraphs. A main source is a dissertation from 2000 (Jönsson, 2000), in which the author gives an overview and discussion of studies relating to communication of environmental information to both private and public consumers.

The author thus cites a Norwegian study regarding consumers' response to environmental product information, which shows that "private consumers desire environmental product information in the form of simple symbols, without detailed information and text sections". Complementary studies showed that consumers were positive to this type of information, but were confused as to whether it was neutral information or a form of eco-labelling based on environmental requirements. The information was still often considered to be technical and difficult to interpret.

The author also cites Swedish studies, in which some of main conclusions are:

- The environmental consequences of purchasing decisions rarely affect consumers individually and immediately.
- Environmental aspects are likely to receive higher attention when they are connected to individual aspects such as personal health (e.g. organic food products) and private economy (e.g. energy efficiency).
- Consumers ability and motivation to assimilate the (environmental) information in the form of graphic or quantitative environmental product declarations are very limited.
- Consumers acceptance of detailed and complex environmental information is higher for more complex and expensive products.

- There is an apparent risk of detailed quantified environmental product declarations creating a false sense of control that could benefit products with an environmental product declaration, regardless of the content of the declaration.

A Danish study (Stranddorf *et al*., 2001) describes the development of an environmental product declaration of consumer electronics, from an expert-based screening of the environmental impacts through two hearing rounds, where manufacturers, branch organisation and consumer organisations were asked for input, to a simplified declaration, addressing only few, selected parameters:

- Energy consumption
    - On-mode and stand-by mode (Consumption in Watt to be stated)
- Unwanted substances
    - Halogenated compounds (Yes/No)
    - Heavy metals (Yes/No)
- Waste handling
    - Recycling potential (in %)

It is acknowledged in the study that "conventional" LCA-based Type III Environmental Product Declarations are a good starting point for filling-in of the information of the simplified declaration. Producers with eco-labelled products will fairly easily be able to find and document the requested information. Finally, it is stressed that although the declarations are very simple they should still be verified by a third-party organisation. However, the possibility of using a statement of truth is kept open, because 3rd party verification is regarded by industry as costly.

In another Danish study (Jensen *et al*, 2003), a number of consumers answered a questionnaire on the subject, and two focus group meetings were held to further detail the arguments. The study concludes that consumers are willing to require environmental information, but that their willingness needs to be turned into practice. To persuade consumers to do so, they must be made aware of why it is essential and what questions they should ask. This can be realised through general environmental information to consumers through the sources they use to find product information: newspapers, adverts, the Internet, special interest magazines and consumer magazines.

Since consumers may have many motives for purchasing green electronic products, information needs to be multi-facetted. Arguments can emphasise the facts that green electronic products are a quality parameter, that they are healthier and that they save money.

In addition, consumers are asking for environmental product information that they can use in purchasing situations. Consumers want comparable and reliable environmental information on environmental product qualities, e.g. as outlined in the study by Stranddorf *et al*, 2001. Many consumers in the survey are familiar with the Swan label, and an evident possibility is to expand the use of the label to cover electronic products in Denmark. As the Swan is not widely used for electronic products in Denmark, it is recommended that work continues on developing a simplified environmental declaration. Consumers are positive about the idea of a simplified environmental declaration, as it would help them base their choice on the environmental qualities they find most important, e.g. chemical substances, energy consumption or reusability. Finally it is remarked that the consumers interviewed in the study want the information in the simplified environmental declaration to be verified.

A more recent review of Nordic studies on environmental product information (Leire *et al.*, 2004) concludes that both consumers and professional purchasers confronted with EPD's find them difficult to interpret and use. The EPD's sometimes raised more questions than they answered as respondents started to ask follow-up questions on the meaning of information. Recurring calls for simplifications and/or guidance such as benchmarks and reference values were however reported in order to be able to use them properly. In addition, the self-declarations appear to have a weak trustworthiness as the information is not controlled or certified. A recurring conclusion from these studies is that the users need to be educated in using them. Despite the difficulties in interpreting declarations, an interesting finding was that some consumers expressed that the extensive and quantified information gave a reliable impression even if they could not evaluate it.

A potential use also among consumers was, however, also considered. In contrast to grocery shopping, which can be seen as everyday actions often guided by routines and already set purchasing criteria, capital goods investments of durable products are larger and occur more seldom, and therefore allows more careful decision-making processes. In these processes, it may therefore be possible also for private consumers to include and evaluate the complex and substantial environmental information declarations.

Although the reviewed studies are not conclusive it can with good sense be deduced from them that private consumers in general prefer declarations which are much more simple than those developed from the framework described in ISO 14025 and implemented in national or international EPD-schemes. Selecting environmental information and presenting it in a way which is understandable for common consumers is therefore seen as a main challenge. On the one hand, the information should be simple, e.g. as suggested in Stranddorf *et al*, 2001, but on the other hand it should be sufficiently comprehensive and precise for the consumer to make the "right" choice, distinguishing between products with different environmental characteristics.

It should, however, also be recognized that "very green" consumers seem to be willing to use detailed environmental information, e.g. as found in standardized EPD's. One important element in this is that the information should be 3rd-party certified, because self-declared information is not considered as trustworthy. There may thus be a future demand for differentiated environmental information, targeted at consumers with different needs and will to use the information.

4 Development of Environmental Data Sheets (EDS)

In dialogue with ANEC it was decided to develop and test a new way of communicating environmental information by using so-called Environmental Data Sheets (EDS).

The basic idea behind the Environmental Data Sheets is that only the most relevant information is presented, i.e. the focus is on parameters which allow consumers on the one hand to identify the environmental issues at a quick glance and – on the other hand – to choose between two product in the appliance store or at the building market.

An EDS is thus not an Environmental Product Declaration in the strict sense, following the ISO 14025 or similar standards, but rather a presentation of selected elements, allowing a large degree of freedom as to which information is selected for presentation to consumers. The primary target group for an EDS is sophisticated consumers, i.e. consumers with some knowledge of environmental issues and how they can be assessed. The common consumer may, however, also benefit from the information provided, either by the full EDS or through excerpts from the EDS, communicating core information in just a few lines.

It is acknowledged that the environmental information provided by an EDS does not give the full environmental picture. Some stakeholders may find a need for e.g. more technical information (e.g. which standards do the product comply with), while others may request more information on how to handle the product in an environmentally proper way during use and disposal. Such information is of course also important when choosing and using an environmentally preferable product. The EDS therefore also includes some technical information, e.g. describing the features which the producers put weight on in their product appraisals. In this way, environmental and technical information is available at the same time, allowing the consumer to make an informed choice taking all relevant elements into consideration. With respect to best possible installation, use and disposal of the product it is a general feature of the EDS that the producer shall state whether such information is included or not.

In the context of providing the “most relevant” environmental information, life cycle impacts are of course important for many product groups, but for some products their content of chemicals and/or the impacts on indoor air quality is probably of equal or larger importance. Four tools were therefore integrated to establish an overview of the relative importance of selected environmental impacts for the product groups investigated:

- Life Cycle Assessment performed with the Danish EDIP-method (Hauschild & Wenzel, 1998), allowing in this case global and regional environmental impacts to assessed and compared over single impact categories as well as over product groups.

- Criteria for assessment of the environmental performance of products within the selected product groups were derived from eco-label criteria. The EU Flower, the Nordic Swan and the German Blue Angel are all assumed to cover a wide range of relevant environmental issues in their award criteria, and these were therefore used to establish a check-list for each of the selected product groups, giving consumers the possibility to identify where a given product comply with the criteria – and where not. The EU eco-label was preferred for this purpose, but where these lacked, national/regional criteria were used. Where no such eco-label criteria can be found, e.g. in the case of insulation, the approach was to use criteria for products with similar features, e.g. relating to use/non-use of chemical substances, labelling of plastics, etc.
- A scoring system for the potential impact on indoor air from the use of (building) products, using either a simple system ("approved" or "non-approved") or a more elaborate system in which the potential impacts are demonstrated by a colour code similar to that used in energy labelling.
- A scoring/ranking system for the content of chemicals in a given product, allowing consumers to assess the toxicity of a chemical product at a quick glance, using a colour code similar to that found in energy labelling.

The format for an EDS is two pages, where the first page contains technical and environmental information on the product in question, while the second page gives a short life cycle perspective on the product group (what are the environmental impacts compared to other products?), and describing the selected environmental issues briefly.

4.1 Selected product groups

Eight product groups, i.e. five energy-using products and three products used in building and construction, were selected for development of Environmental Data Sheets.

For illustrative purposes, FORCE Technology was asked by ANEC to include a reference product/service, i.e. driving 10 km per day in an average car.

4.2 Life Cycle Information

In the examples, a limited number of environmental impacts are quantified in a life cycle perspective, primarily due to lack of good inventory data and/or adequate assessment methodologies. In a dedicated EPD-scheme, LCA information can be standardized without significant problems, simply because they in general will comprise an extract of the full information made available through calculations.

In the LCA part of the example EDS, the following types of environmental exchanges and impacts are included, where possible:

- Total energy consumption, either calculated by using the Gross Energy Requirements as is the case for energy-using products or by the conventional LCA approach as is the case for building and construction products. Both approaches yield a result in MJ, but it is outside the scope of the present report to go into any detail about the differences in calculation methods. The focus is to present environmental information to consumers, and the decision of which approach to be used will be taken either in a political forum (as in the MEEUP-project) or through standardisation (as envisioned for building and construction products).

- Generation of waste, expressed in grams. No international consensus exists on how to characterise and classify different types of waste in LCA, and we have chosen the simplest approach possible, i.e. to calculate the total amount of waste as reported in the original sources. The reason for this is to allow a normalisation step (see below), but it is strongly emphasized that any result related to waste generation should be interpreted with extreme caution.

- Global Warming Potential (GWP), reflecting the contribution from a given product to climate change, one of the most important environmental issues. The calculation methodology is the same as used in all other types of assessment, being developed with an international consensus and resulting in GWP-values being expressed in CO_2-equivalents.

- Acidification Potential (AP), indicating the impact from acidifying substances on ecosystems, e.g. as visible changes in forest productivity and clear lakes without aquatic life, and on building and construction work being degraded by acid rain. The calculation methodology is the same as used in most LCA-methods, resulting in AP-values being expressed in SO_2-equivalents.

- Eutrophication Potential (EP) (or nutrient enrichment potential), indicating the impact on the aquatic environment from introducing an excess amount of nutrients, leading to increased production of e.g. plankton and algae which degrade by using available oxygen at the bottom layers of lakes and fjords and causing bottom-living organisms to flee or die. Two calculation approaches are commonly used, resulting in EP-values being expressed in NO_3^- - equivalents or in PO_4^{3-} - equivalents. The latter approach has been used, converting where relevant NO_3^- - equivalents to PO_4^{3-} - equivalents by multiplying with 0.1.

- Photochemical Ozone Creation Potential (POCP), indicating the impact from increased air concentrations of reactive substances, so-called photo-oxidants, which are injurious to the health of living organisms. The photo-oxidants include a large number of unstable oxidizing substances formed when volatile organic compounds react with various oxygen compounds and oxides of nitrogen, which are naturally present in the atmosphere. The POCP is reported in ethene (C_2H_4) equivalents, using the "High NO_x"-scenario, which is predominant in the EU.

Quantification of the following types of environmental impacts has been excluded from the calculations following discussions with ANEC:

- Nature occupation/land use
- Human toxicity
- Ecotoxicity
- Injuries

4.2.1 Normalisation of life cycle environmental impacts

Three ways of presenting normalised results were described in the study by 2.-0 Consultants, see 2.10.9.

In the current study, the environmental impacts calculated by the LCI/LCA-procedure have been normalised by relating them to the annual contribution form an average consumer in the EU, i.e. the option not employed by 2.-0 Consultants. This way of normalisation is one of the central elements in the Danish EDIP-methodology, allowing for a comparison of which type of environmental impacts is of largest concern. For all impact categories, the results are reported in the same basic unit, the Person Equivalent (PE). For convenience, we have chosen to present the results in milli Person Equivalents (mPE), where one PE is equal to 1000 mPE.

The Person Equivalent is an expression of the annual contribution of an average citizen to a given impact category, taking into consideration also the geographical scale of the impact. As an example, for Global Warming Potential the global emissions of greenhouse gases (measured in CO_2-equivalents) are distributed on the total amount of citizens on the earth. Detailed inventories, e.g. from IPCC, are available for this purpose, and the result is that the average World citizen emits greenhouse gases corresponding to 8700 kg CO_2-equivalents per year. For acidification, which is considered to be a regional impact, the amount of acidifying gases being emitted in the region of EU is calculated using the databases available in EMEP/CORINAIR emission inventories published by the European Environment Agency[1]. Being a regional impact, the total emission of acidifying gases (measured in CO_2-equivalents) in the EU are divided by the number of citizens in the same area, resulting in an average contribution of 74 kg SO_2 per person and year.

It is remarked that the concept of using Person Equivalents for comparison in all essence is similar to benchmark concept developed by Nissinen *et al*, 2004, using the average daily per capita environmental impacts of the whole Finnish economy as a basis for the benchmarking. Obviously, the background data differ (EU versus Finnish average impacts), and the background data have also been established in different ways. However, the basic information conveyed by the two approaches is the same if it is taken into consideration that10 milli person equivalents (mPE) is the same as one percent. In accordance with the EDIP-methodology we have chosen to report in mPE, but this unit is readily converted to percent by dividing with 10.

The average contributions (called the “normalisation references” or the “Person Equivalent”) for the selected impact categories are summed in Table 4. For more information, please refer to the original description of the methodology

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[1] See e.g. http://reports.eea.europa.eu/EMEPCORINAIR4/en/page002.html

(Hauschild & Wenzel, 1998) and the report on updating of the background data ((Stranddorf, Hoffmann & Schmidt, 2005).

Table 4. Normalisation references (Person Equivalents (PE)) for EU-15 for selected impact categories (Stranddorf, Hoffmann & Schmidt, 2005).

Impact category	Unit	Normalisation Reference for EU-15 citizens (equal to 1 Person Equivalent)
Global Warming Potential	Kg CO_2-equivalents	8,700
Acidification	Kg SO_2-equivalents	74
Nutrient enrichment/ Eutrophication	Kg NO_3^{2}-equivalents	119
Photochemical ozone formation	Kg C_2H_4-equivalents	25

The EDIP-methodology does in principle only allow for a normalisation of the scientifically established impacts, i.e. GWP, AP and EP. Being considered as environmental exchanges rather than impacts, energy consumption and waste generation do not belong to the categories included in the EDIP-methodology. However, as these types of environmental exchanges are relatively easy to comprehend, estimates of the annual contribution of an average European citizen has therefore been established by using readily available statistical information. In this way, results for energy consumption and waste generation can be presented in the same unit (mPE) as GWP, AP, and EP.

For energy consumption, information from Eurostat was used (Eurostat, 2006), stating that the *per capita* consumption of energy in the EU was 3.6 tonnes oil equivalents, corresponding to 150.7 GJ.

With respect to waste generation it is difficult to find high-quality figures. It was chosen to use the information from the EAA (2003) stating that the amount of waste generated per citizen in Western Europe was 3.8 tonnes, while for citizens in Central and Eastern Europe an average of 4.4 tonnes was reported. For simplicity, it was assumed that the EU25 average is 4.0 tonnes, including crudely estimated values for mining and construction work.

It is stressed that the normalisation references for energy consumption and waste generation are preliminary estimates, which should be detailed and/or verified before being used in a standardized framework. For the purpose of comparing the relative importance of different types of environmental interventions in the present context, the normalisation references are judged to be sufficiently precise.

4.2.2 Life cycle results

The cradle-to-grave environmental impacts of the nine product groups examined are presented in condensed format in Table 5.

Table 5. Normalised environmental impacts in milli Person Equivalents (mPE) per year for the examined product categories

	Gross Energy Requirements	Global warming	Acidifi-cation	Eutro-Phication	Ozone Depletion	Waste	POCP
Energy using products							
Dishwasher	20.6	15.9	10.9	29.9		1.7	
Television	9.7	7.6	5.0	0.0		0.6	
PC	23.1	19.3	13.2	0.2		4.7	
Fridge-freezer	22.9	18.0	12.2	0.2		2.7	
Mobile phone	0.9	0.8	0.7		0.0		0.2
Building products							
Sealant[1]	0.3	0.3	0.2	0.1		0.1	
Wood flooring[2]	12.2	2.9	6.0	5.7	0.0		39.2
Insulation[3]	0.7	0.9	0.9	0.5	0.0	1.7	1.0
Comparison product							
10 km in an average car	71.8	82.6	15.4	58.5		3.8	104.2

[1] Functional Unit: 20 containers of sealants, life time 15 years
[2] Functional Unit: 100 m^2 of flooring, life time 50 years
[3] Functional Unit: 40 m^2 of attic insulated with an U-value of 0.14 W/m^2K, life time 50 years

It is emphasized that the data presented in the table have not been established by a standardised approach, but by using readily available data sources, described in more detail in the subsequent sections. As an example, it can be seen from Table 5 that not all impact categories are included for all product groups. The reason for this is that the information is not available in the basic sources, and no efforts have been devoted to produce this additional information. If a common standard for LCA is used, e.g. ISO 14040/ISO 14044, a uniform way of data collection, manipulation and presentation will ensure that the results are fully comparable.

Table 5 gives a good indication of the differences in life cycle impacts, both between the selected product groups and between the selected impact categories. A prominent finding is that driving 10 km in an average per day causes environmental impacts which are 3-4 times higher than those caused by the use of energy-using products like refrigerators and dishwashers. Although not surprising, the finding stresses the importance of transportation in the overall picture of environmental impacts, and it is obvious that for many people this is one of the main possibilities of diminishing their environmental footprint.

It is also evident from Table 5 that energy consuming products like refrigerators, dishwashers and televisions have a significant impact in many categories. It is in this context worth noting that the magnitude of these impacts is determined by choices which are taken with long intervals. The life time of a refrigerator is thus assumed to be 15 years, during which it is not possible to decrease the environmental impacts by other means than buying a new device. It is therefore important that the consumer is made aware of his/hers possibilities of reducing the environmental impacts in the purchasing situation, e.g. through the use of the EU energy labelling scheme. As the other impact categories in general are closely related to the energy (electricity) consumption, an energy-efficient choice will also have a beneficial effect on other impact categories. One exception from this is the contribution to nutrient enrichment (eutrophication) from washing machines and dishwashers, caused by the use of detergents. In such cases, additional performance indicators like availability of dosage mechanisms are also of obvious interest.

Wood flooring as a building product also gives a significant contribution to many impact categories, the main reason being the lacquer used to produce the requested surface. It can be discussed whether the two products flooring and lacquer should be kept separate, but the consumer should as a minimum be aware that by choosing a given flooring product he has also determined a very large amount of the impacts related to its maintenance for the next 50 years.

Sealants and insulation both comes out with relatively low impacts, despite an up-scaling from a declared unit of one container and one kg, respectively, to more realistic consumption figures for the life time of a building. A fully precise picture cannot be established for building products until a "model house" has been defined, but the presented figures can be used for a first indication of the relative importance of building products. It should be noted that especially insulation, but also flooring and sealants to a lesser extent, serves the purpose of reducing the overall energy consumption in housing. This is not included in Table 5, but an example of the reduction possibilities through increased insulation is given in 5.10.

4.2.3 LCA rating of the selected product groups

The nine product groups addressed in the study only constitutes a minor fraction of our everyday consumption, but they nevertheless accounts for about 10-15% of the impacts caused by the average consumer. Some of the important products/services missing in the picture are heating appliances, shoes/textiles and food products, but our overall impacts are literally determined by every choice of product we make – and that is many.

The nine product groups have, despite their apparent lack of representativity, been used to rank the environmental impacts which can be attributed to the products. For this purpose, an arbitrary scale was established, reflecting seven different concern levels ranking from "Almost significant" to "Very high", Table 6

Table 6. Magnitude of environmental impacts and their associated concern level.

Environmental impact in mPE	Concern level
≤ 0.1	Almost insignificant
0.1-0.5	Very low
0.5-1	Low
1-5	Some
5-20	Significant
20-50	High
> 50	Very high

With this scoring system, an overview of the relative importance (or concern level) of the nine product groups with respect to selected environmental impacts can be created (Table 7). Please note that blank cells are caused by missing information.

Table 7. Normalised environmental impacts in milli Person Equivalents (mPE) per year associated concern levels as indicated by colour codes for the examined product categories.

	Gross Energy Requirements	Global warming	Acidifi-cation	Eutro-Phication	Ozone Depletion	Waste	POCP
Energy-using products							
Dishwasher	20.6	15.9	10.9	29.9		1.7	
Television	9.7	7.6	5.0	0.0		0.6	
PC	23.1	19.3	13.2	0.2		4.7	
Fridge-freezer	22.9	18.0	12.2	0.2		2.7	
Mobile phone	0.9	0.8	0.7		0.0		0.2
Building products							
Sealant[1]	0.3	0.3	0.2	0.1		0.1	
Wood flooring[2]	12.2	2.9	6.0	5.7	0.0		39.2
Insulation[3]	0.7	0.9	0.9	0.5	0.0	1.7	1.0
Comparison product							
10 km in an average car	71.8	82.6	15.4	58.5		3.8	104.2

1 Functional Unit: 20 containers of sealants, life time 15 years

2 Functional Unit: 100 m^2 of flooring, life time 50 years

3 Functional Unit: 40 m^2 of attic insulated with an U-value of 0.14 W/m^{2}K, life time 50 years

The colour codes allow for an easy identification of how the product groups perform in the selected impact categories. Being an arbitrary scale, however, it can always be discussed if the steps of the scale have been chosen in the best possible way. For a first indication the chosen scale seems to provide sensible results, but especially future inclusion of more product groups may create a need for adjustments of the scale.

Another argument against the use of a scale like this to describe the relative importance of product groups is that it addresses a more or less unknown sample of the product group in question. For energy-using products, the results for "average" products are presented, but the consumer will not be able to purchase a product with the same environmental properties. It is not unrealistic to assume that there is a factor 2 between best and worst performing products within most energy-consuming products. For wood-flooring, the impacts from a certain type lacquer have been included, but the picture may change significantly if a different lacquer is chosen. The results depicted in Table 7 therefore primarily indicate the relative importance of a product group.

The scaling system is therefore primarily seen as a way of providing the consumer with a quick overview of the relative importance of the product group in question. This knowledge can eventually be used by the consumer to decide which impacts on health and environment to focus on in the purchase situation, taking advantage of the product-specific information found on the front page of the EDS.

For energy-using products it can be claimed that the existing energy-labelling scheme in all essence provides the information needed for the common consumer to make an informed choice. In this case, there is no need to provide additional information about e.g. global warming and acidification, as these impacts are implicitly addressed by the energy label. The more sophisticated consumer may, however, be able to use the colour codes to determine the concern level, and the detailed life cycle calculations to choose the product with the least environmental impacts.

For building products, the colour codes can direct the attention of the consumer towards the most important environmental issues, e.g. that wood flooring is of high concern with respect to global warming potential and POCP because of the lacquer used. For sealants and insulation products, the main message conveyed is perhaps that they are of low concern with respect to the impact categories addressed, and the efforts in purchasing may be better used in choosing a product without content of hazardous substances and/or impact on indoor air quality. Tools for this purpose have therefore been developed.

4.3 The content of chemicals in consumer products

The EU Directive on classification, packaging and labelling of hazardous substances (67/548/EEC) provides a uniform framework for classification and labelling of chemical products. Furthermore, the Cosmetics Directive (76/768/EEC) sets the legal framework for cosmetic products, e.g. relating to the nature and amount of substances allowed. However, for both “common” chemical products (e.g. household chemicals, detergents and certain building products like sealants) and cosmetic products like for instance soap, shampoo and creams, the potential hazards related to human health and ecosystems may be difficult to judge for most consumers.

FORCE Technology was therefore asked by ANEC to develop a ranking system which could help consumers in choosing a product with a low potential for impact on health and environment.

The scoring and rating system outlined below is inspired by the Norwegian EcoProduct-project (Strand-Hansen, 2006). The purpose is to give a graphical presentation of the potential hazard (or health/environmental performance) of a (chemical) product in a way which is similar to that used in energy labelling.

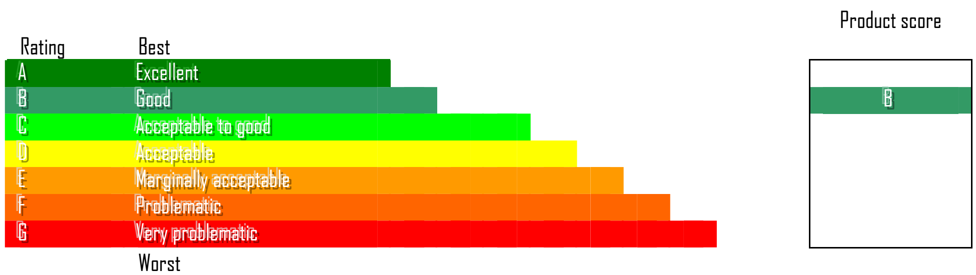
Any one product will only receive one classification through the system, namely the worst code applicable to any of the chemicals declared to be in the product.

The amount limits and the rating of seriousness is a first suggestion. Being a more or less arbitrary choice, the suggestions can and should be subject to discussion before a final implementation.

4.3.1 Scoring system

Labelling	Amount R-sentences	≤ 0.01% or not actively added	< 2 %	2-10 %	10-20 %	> 20 %
No labelling or "Explosive"/"Inflammable"	R1; R19	A	A	A	A	A
Harmful to health (Corrosive, Harmful, Irritating)	R20; R21; R22; R29; R31-32; R34-38; R67	B	C	D	E	F
Dangerous to the environment	R51-59	B	D	E	F	G
Sensitizing	R42; R43	B	D	E	F	G
Chronic effects	R33; R39; R41; R48; R65-66; R68	B	F	F	G	G
Acutely toxic (toxic and very toxic)	R23-28	B	G	G	G	G
Carcinogenic, mutagenic or toxic to reproduction	R40; R45; R46; R49; R60-64	B	G	G	G	G

4.3.2 Rating system



4.3.3 Discussion

As stated previously, the scoring and rating system is based on somewhat arbitrary choices. The choices lead directly to discussions regarding how the ratings should be interpreted and, perhaps more important, whether they are in accordance with both regulatory and consumer perception of potential impacts on health and environment. Some of the good questions which can be asked are:

- Is a product "Acceptable to good" if it contains harmful substances in a concentration which is just below 2%?
- Is a product "Marginally acceptable" if it contains sensitizing substances or substances which are dangerous to the environment in concentrations between 2-10%
- Is a product "Very problematic" if it contains substances with chronic effects in concentrations higher than 10% - or should it rather be termed "Unacceptable".

There are no unequivocal or science-based answers to these and similar questions. It is, however, obvious that the simple graphical presentation allows a quick assessment and comparison of products fulfilling the same service, as is the case for products with an energy label. It is therefore judged that common consumers without problems can use the rating system in the purchasing situation. The "green" consumers and professional purchasers can of course also use the rating system, but they may in some cases want to take supplementary information into consideration, e.g. relating to mandatory information to be given on the product or other types of information conveyed through detailed environmental product declarations.

It must, however, be acknowledged that allergic persons will not be given the information most important to them, i.e. whether the product contains substances which may be detrimental to their health. The well-known problem is mainly related to fragrances which are added in very low concentrations, and sensitized persons must therefore still use the legally required declaration of content to determine whether a given product is of concern.

4.4 Rating of indoor air quality of building products

The impact on Indoor Air Quality (IAQ) is an important issue for many consumer products, especially building products which may emit unwanted substances during a long period after their installation in a building. Other product types, e.g. consumer electronics, may also emit decomposition products during their use, but the extent and nature of this is far less investigated and regulated than building products.

The impact on IAQ is in many countries assessed by using an appropriate testing scheme. The most common approach is to measure the area-specific emission rate for a wide range of substances at predefined intervals (e.g. 3 and 28 days after installation). The measured emission rates can be converted to concentrations, taking into account the loading factor for a product (i.e. the relationship between the surface of the product and the test chamber volume) as well as the specific air change rate for the product, distinguishing between e.g. sealants, paints and floor coverings.

The emission rates or concentrations are compared to the Lowest Concentration of Interest (LCI) for single substances as well as pooled values for groups of substances. The LCI-values are determined through a toxicological evaluation of readily available information, e.g. air quality guidelines, toxicity values for chronic exposure and occupational exposure limits (applied with a safety factor of 100).

4.4.1 The German AgBB scheme

There are some differences between the existing national schemes with respect to which substances are determined – and when. In Table 8, the basic requirements in the German AgBB-scheme are outlined.

Table 8. . Pass criteria in the German AgBB scheme

Substance of substance group	After three days	After 28 days
Total Volatile Organic Compounds (TVOC)	≤ 10 mg/m3	≤ 1 mg/m3
Individual substances	All compounds with a concentration ≥ 1 µg/m3 are identified. For substances with a LCI and a concentration ≥ 5 µg/m3, the ration between Concentration and LCI is calculated and the sum of the ratios must not exceed 1. Particularly critical substances with LCI-values ≤ 10 µg/m3 are included in the calculation if their concentration equals or exceeds 1 µg/m3.	
Carcinogenic substances (Cat. 1 or Cat. 2)	Calculated individually. Sum of concentrations ≤ 0.01 mg/m3	Calculated individually. Sum of concentrations ≤ 0.001 mg/m3
Semivolatile Organic Compounds	Not measured	Sum of concentrations ≤ 0.1 mg/m3
VOC's without pre-defined LCI		The sum of such VOC determined at concentration ≥ 0.005 mg/m3 must not exceed 0.1 mg/m3.
Sensory testing	To be included when a test procedure has been agreed upon.	

Testing after the German AgBB-scheme (and the French NEHAP-scheme) results in either accept or rejection of a product. Thereby a very simple message can be conveyed to the consumer, e.g. in the form of a label and/or a short sentence like "Approved by AgBB".

In the context of an Environmental Data Sheet for common consumers, approval/non-approval may be indicated by using a colour code as appropriate:

Indoor Air Quality
Approved
Not Approved

For the sophisticated consumer, a summary table could be established, giving the results of the first and second tests:

Table 9. Summary table for a fictive building product with respect to Indoor Air Quality as tested and reported in the AgBB-scheme

Substance or Substance group	Unit	After day 3		After day 28	
		Criteria	Value	Criteria	Value
TVOC	$\mu g/m^3$	$\leq$ 10,000	58	$\leq$ 1000	35
SVOC	$\mu g/m^3$			$\leq$ 100	13
Carcinogenic substances	$\mu g/m^3$	$\leq$ 10	Nd	$\leq$ 1	Nd
Substances with LCI				$\leq$ 1	0.48
Substances without LCI	$\mu g/m^3$			$\leq$ 100	41

The level of detail in the summary table outlined above allows in principle for a rating of individual products. The value of such a rating is, however, judged to be limited because an approved product does not emit any substances in concentrations above the "Lowest concentration of Interest". In other words, the rating in the AgBB and similar schemes changes from "Green/Acceptable" to "Red/Non-acceptable" as soon as a product does not pass one of the criteria. Both common and sophisticated consumers should therefore in principle be satisfied with an approved product – and avoid choosing a product without approval.

Even more detail is of course available in the full test report, addressing about 200 specific substances. Conveying this amount of information is only interesting for the very sophisticated consumer, but the information could be made available via the web-site of the producer.

4.4.2 Other approaches for testing of Indoor Air Quality

The Finnish scheme for testing of IAQ (M1 or FiSIAQ) differs from most other schemes, e.g. by examining emission rates rather than concentrations and by having two different classifications.

The criteria in the Finnish scheme for emission classification of building materials relates to the basic measurement of emission rates rather than to the derived values for concentration. The criteria do not specifically include the semi-volatile organic compounds and with respect to carcinogens, they only address substances classified in IARC Category 1 (with the exception of formaldehyde). On the other hand, the criteria in the Finnish scheme include specific requirements with respect to formaldehyde and ammonia, two substances which are generally recognised as problematic with regard to indoor air quality. Furthermore, the scheme includes a panel testing of olfactory properties, resulting in an evaluation of whether the odour is acceptable or not. The Finnish scheme operates with two acceptance levels, M1 and M2, where the M1-criteria are most stringent. According to the web-site of the scheme (http://www.rts.fi/english.htm), there are currently no products with a M2-classification, only products with the best classification.

The Danish-Norwegian DICL (Danish Indoor Climate Label) also includes a sensory evaluation, taking into account both the acceptability of the odour as well as its intensity. As one of the only schemes it also includes a testing procedure and related criteria for release of particles and fibres.

When combining the Finnish criteria with the Danish DICL-criteria for release of fibres it is possible to establish a scoring and ranking system, which allows for a distinction between products of varying quality (see Table 10). This scoring system may be of value if and when consumers have the choice between approved/not-approved products on the shelves in building markets. Judged by the high availability of low-scoring (M1) products in the Finnish scheme the need for a scoring system may be low, but as the Finnish scheme also has demonstrated that non-classified products have significantly higher emission rates, a scoring system including all products may become of interest on the longer term. The basic requirement for this is that it is a regulatory obligation to have the products tested, however without legal requirements to their performance in the test.

Table 10. Scoring system for indoor air quality based on the Finnish and Danish schemes

Examined product qualities	Unit	M1 criteria	M2 criteria	M3 criteria	Score
Points		1	3	15	
Total organic volatile compounds (TVOC)	mg/m^2h	< 0.2	< 0.4	≥ 0.4 or no data	
Formaldehyde, HCOH	mg/m^2h	< 0.05	< 0.125	≥ 0.125 or no data	
Ammonia, NH_3	mg/m^2h	< 0.03	< 0.06	≥ 0.06 or no data	
Carcinogenic substances (IARC Category 1)	mg/m^2h	< 0.005	< 0.005	≥ 0.0005 or no data	
Fibers (DICL criteria)	mg/m^3	≤ 0.75	> 0.75	> 2 or no data	
Odour acceptability		≥ 0.1		≤ 0.1	
Total score					Sum of above

The scoring system can be converted into the following ranking, giving an easy identification of the performance of the product:

Table 11. Ranking system for Indoor Air Quality

Total score	Rating	Best	Product score
6	A	Excellent	
8	B	Good	
10	C	Acceptable to good	
12	D	Acceptable	D
14	E	Marginally acceptable	
16	F	Poor	
> 16	G	Unacceptable	
		Worst	

4.4.3 Discussion

The scoring/rating system based on the German AgBB-scheme (and similar schemes) is very simple, allowing all types of consumers to distinguish between approved and non-approved products at a glance. The testing results furthermore allow for communication of more details to the sophisticated consumer, however with limited possibility of a further distinction between product properties other than they are all acceptable from an indoor air quality perspective. The two levels of communicating product properties with respect to indoor air quality is the basic suggestion from FORCE Technology. Before a practical implementation it should, however, be considered if there is a need to complement the current criteria with additional criteria addressing emission of particles and fibres and/or olfactory properties, e.g. as found in the Danish or Finnish schemes.

The scoring and rating system based on Finnish/Danish criteria is judged to be in good accordance with regulatory and consumer perception of how products can be characterised with respect to their impacts on indoor air quality. The basic idea behind the large differences in scoring (best = 1; worst = 15) is that it allows for an easy identification of unacceptable products or products which have not been tested. Any product which does not fulfil M1 or M2 criteria in all sub-tests will thus be rated as “unacceptable”. A product is rated as “poor” if it only fulfils M2-criteria in all tests, while the remaining, more positive, ratings reflect a gradually increasing performance, ending with the rating “Excellent” being awarded to products which pass M1-criteria in all tests. A possible drawback of the scoring system is that it contrary to most other schemes is based on emission rates rather than concentrations. However, conversion from one unit to the other is probably not a practical problem. Another drawback is that the scoring system may be judged by all stakeholders (regulatory bodies, industry and consumers) to be a “not-so-good” idea to be able to rate products which are unacceptable in an indoor air quality perspective.

A determining factor in many schemes is how the Lowest Concentration of Interest (LCI) values are determined. Here, some differences between otherwise similar schemes are observed by a quick glance. It is outside the scope of the current report to make a closer examination of the background for the differences, but it is obvious that passing the test becomes more difficult with lower LCI-values. In this context it is remarked that many – or perhaps all - wood products cannot pass one or more criteria in some schemes because they emit substances like pinene, which has been awarded a very low LCI-value. This is obviously not very operational, leaving consumers and professional purchasers with no choice other than choosing an unacceptable product. On the other hand, setting very high quality standards for a product group where the product performance is diverse allows for awarding the rating “Excellent” in Table 11 to only the very best products, where more slack criteria perhaps would mean that also “good” products would be rated as “Excellent”.

Other test schemes and criteria – and combinations thereof – are available and are being used on the national level by the building industry. It is outside the scope of the present study to review them all and suggest the best practice in relation to communication to common and sophisticated consumers. Choosing one test method on the expense of (all) others is most probably a difficult process involving scientific as well as political considerations. The suggestions in the present project to establish two levels of information for common and sophisticated consumers, respectively, is however viable as the examples show. The acceptance limits are also realistic, distinguishing between acceptable and non-acceptable products, but they may of course be subjected to a discussion of whether they should be amended (more/less stringent) or differentiated with respect to appropriate values for different types of products.

4.5 Use of eco-labelling criteria

The three dominant eco-labels on the European market today, i.e. the EU Flower, the Nordic Swan and the German Blue Angel, all establish their award criteria based on the life cycle perspective. Without going into any detail it is evident from the available criteria that the major life cycle stages (raw material production, manufacturing, use and disposal) have been examined in order to pinpoint the areas, where it is possible to distinguish between "good" and "not-so-good" products from an environmental perspective. Dedicated LCA's may play a role in this process, e.g. by providing information about two different production routes, but in many cases it seems like qualitative aspects are included without any efforts being made to quantify their importance. An example of a qualitative aspect is the prohibited use of certain flame retardants, where the knowledge that the prohibited substances may have serious impacts on health and environment is sufficient argumentation for their ban in eco-labelled products. Another example is the requirement that all plastic parts above a certain weight (usually 25 g) shall be marked with the appropriate code in order to facilitate future disassembly and recycling. In this case, the requirement will no doubt cause less consumption of non-renewable resources in the life cycle perspective, but the actual decrease cannot be determined with any precision.

The basic function of the eco-label is to allow consumers to choose a product with a documented good environmental performance. Knowing the label and its logo, the choice is easy in the purchasing situation. At the same time, many producers of products without an eco-label claim that their products are equally good, but they will for varying reasons not apply for the label. By requiring producers to provide information on their products' performance in relation to eco-label criteria, the consumer may with a small additional effort be able to compare labelled and non-labelled products and make an informed decision. It can be argued that such an initiative may reduce the motivation for marketing eco-labelled products, simply because the environmental benefits will appear to be small. This may be true, but it is equally possible that such a requirement will cause producers to go "all the way", i.e. provide documentation that a product fulfils all criteria and apply for the eco-label.

The number and nature of eco-label criteria for some product groups can be seen as a barrier for communication of the requested information to consumers. Without a quantification it is not possible to determine in a scientific way which criteria actually provides the largest benefits for the environment if an eco-labelled product is chosen. Selecting specific indicators or key criteria amongst the full range is accordingly more or less arbitrary, unless the eco-labelling body has made such considerations as it is the case for some product groups in the EU eco-labelling scheme. It is therefore chosen in our proposal to include all criteria, well-knowing that both industry and consumers will appreciate a simpler solution, including only selected criteria. Creating consensus on which criteria to include may prove to be fairly straightforward, e.g. by using product panels with representation of all stakeholders, but such efforts have been outside the scope of the current project.

4.6 Conclusions

The rating system for life cycle environmental impacts is included in the EDS because it gives the consumer a quick overview of how important the impacts of the product group addressed in this way are, compared to other well-known product groups. It thus allows the consumer to direct the focus towards the most important issues, e.g. in the case of most energy-using products the energy consumption as well as the energy-related impacts such as global warming and acidification will appear as important issues. On the other hand, if the reported life cycle impacts appear to be small (green and yellow ratings) then the consumer may direct the attention to other issues of concern, e.g. the possible exposure to hazardous chemicals through direct contact or via emissions to the indoor environment.

In this context, the scoring and rating systems for “Chemical content” and “Indoor air quality” provides an operational way of presenting health and environmental information to consumers at a quick glance.

The suggested systems are readily implemented, being based on information which is available to most manufacturers and in many cases also 3rd-party verified. The systems therefore fulfil two of basic requirements often stated by consumers.

A drawback of the scoring and ranking systems is that there is as of yet no consensus about the criteria used. For the chemical scoring system, the choices are – as in any other system – arbitrary and will as such without doubt give rise to discussions about their appropriateness. For the scoring of Indoor air quality, a choice between acceptance limits as found in national schemes have been made. Also here discussions are foreseen on which limits are most appropriate in the current context.

It is our opinion that the benefits far outweigh the drawbacks, allowing consumers to make informed choices on a reasonable justified background. All suggestions for improvements are, however, welcomed, e.g. following a consensus process.

Using eco-label criteria to indicate the performance of a specific product allows especially the sophisticated consumer to make an informed decision. In general, a broad spectrum of environmental issues is covered by a set of criteria. They are not equally relevant in the overall picture but it has nevertheless been chosen to include them all.

It is envisioned that the colour codes (green or red) will attract the attention of the consumers, e.g. one or two red ratings among a majority of green ratings will make the consumer take a closer look at which properties are not in accordance with best environmental practice. The consumer may then decide whether this property is important for the decision and make the choice accordingly. In a producers’ perspective, the ideal situation is that all ratings are green, as is the case for products which are eligible for being awarded an eco-label. Red ratings – if any – can on the other hand be a motivating factor for improvements, because problematic properties are brought to the attention of the consumer through the EDS.

It is remarked that the examples given in the current project do not contain the exact wording of the eco-label criteria, but only excerpts indicating the scope of the criterion. Official criteria need to be technically correct, but including the full wording in all cases will most probably affect the perception and acceptance of the information in a negative way, without adding any real benefits. The approach and wording used in the current project is not fully consistent, but shall be seen as a first suggestion. Persons and organisations with core competence in communication can possibly find other and better ways to phrase the normative requirements associated with eco-label criteria.

5 Background information for the EDS

Establishing the EDS-examples requires that information on life cycle environmental impacts, chemical content, impacts on Indoor Air Quality and compliance with a broad range of eco-label criteria is available.

It has been outside the scope of the present study to establish precise information for the product groups addressed. Instead, a variety of data sources have been examined in order to find bits and pieces of information which, when combined, can demonstrate the elements and their usefulness in the suggested approach.

The product properties being reported in the Environmental Data Sheets do thus not belong to a real-life product, but are in general combined from a number of products within the product group. It is, however, assumed that most producers relatively easy can find and document the requested information and also that the information can be verified by a third party, if so desired. No efforts have been devoted to describing a documentation and verification system in any detail, but it is obvious that the core elements in such a system must be very similar to those in testing and eco-labelling schemes.

The following paragraphs presents an analysis and discussion of the most relevant environmental issues for the examined product groups as they appear through information on life cycle impacts, testing schemes and eco-label criteria, supplemented with an expert-based recommendation of inclusion of the content of chemicals as a relevant element. Based on the analysis, eight examples of EDS have been established. These are presented in the Annex to the report.

5.1 General background for energy-using products - The MEEUP study

Of the five selected energy-using products, four products (televisions, pc's, dishwashers and refrigerators/freezers) have been examined in detail in the product cases reports from the EU MEEUP-study (Kemna *et al*., 2005a). The methodology used is in many respects similar to that used in conventional LCA conforming to ISO 14040-series, although some simplifications have been made along with decisions about the system boundaries to be applied.

Without going into detail with the methodology developed it was judged that the results from the study are comparable to the life cycle environmental impacts reported in the current study for other product groups. It is underlined that the overall goal of the present study is not to present precise LCA-values, but rather to establish an overview of the order of magnitude of the annual environmental impacts induced by use of the selected products. In this context, the base-case calculations provided by the MEEUP-project are judged to give representative values for the four product groups, although it should be acknowledged that the variations within a given product group may be large, as is also the case for non energy-using products.

In brief, the results for the four product groups included through the MEEUP-study allows for a calculation of the annual impacts of using the product in question for the following environmental exchanges and impacts:

- Gross Energy Requirements (GER)
- Global Warming Potential
- Acidification Potential
- Eutrophication Potential
- Waste, non-hazardous/landfilled
- Waste, hazardous/incinerated

The contribution to depletion of the ozone layer is for all examined products described as "negligible", while the contribution to another commonly included impact category, "Photo-oxidant Creation Potential", cannot be calculated with the available information.

In the calculations in the present project it was decided not to distinguish between different types of waste, but include all types under one heading. The background for this decision is that the normalisation reference used does not distinguish between different types of waste and furthermore, it is our experience from review of many LCA-studies that waste as an impact category is not treated in a consistent way, allowing for comparison at a disaggregated level. It is therefore evident that the calculations for waste shall be interpreted with extreme caution.

For more information about the elements in the MEEUP methodology, the reader is referred to the methodology report (Kemna *et al*., 2005b). In the present report, only a short description of the four "average" products examined is given, together with the decisions taken for variables like product life and use pattern.

5.2 Comparison product: 10 km per day in an average car

Transportation by private car is perceived by most consumers as having a significant environmental impact – and quite rightly so. There are, however, vary large variations in the impacts caused by individuals in this context, the two main elements being the distance driven and the fuel efficiency of the vehicle used.

A daily driving distance of 10 km was suggested by ANEC for comparison purposes, and with respect to fuel efficiency and relevant environmental impacts it was chosen to use a LCI from VW, providing figures for the life cycle resource consumption, emissions and waste from driving a Golf A4 for 150,000 km (Schweimer & Levin, 2000).

No efforts were devoted to changing the system boundaries for the study, but it is obvious that increasing the service provided by the car from 150,000 to e.g.

300,000 km will decrease most impacts per driven kilometre significantly, estimated about 10-15%.

The basic figures in the LCI allowed for a straightforward calculation of the impacts per km, aggregating individual emissions under relevant headings by using the effect factors employed in the EDIP-methodology. As for the other selected products, the impact potentials were subsequently normalised by using the information given in 4.2.1, resulting in the environmental profile given below:

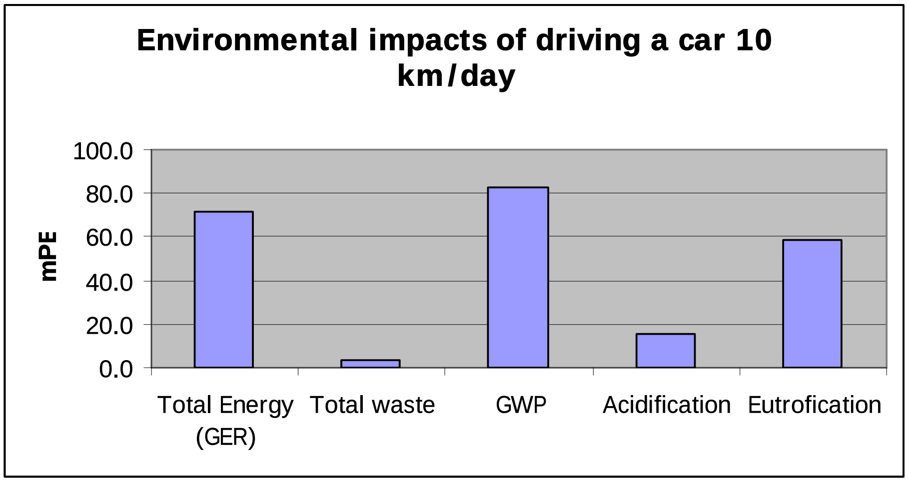


Figure 1. Environmental impacts from driving an "average" car 10 km/day

It is remarked that the distance of 10 km/day is significantly less than the average distance driven in person cars by EU citizens. In a recent publication from Eurostat (Eurostat, 2007) it is as an example stated that the number of passenger-kilometres driven in Sweden was 87,000 million, corresponding to an average of about 10,000 km per citizen per year or about 27 km/day. However, the functional unit of 10 km/day is most probably a figure which most consumers can relate to and therefore also use in a quick assessment of relative importance.

5.3 Dishwashers

5.3.1 LCA information

The base-case dishwasher being examined in the MEEUP-report is characterised by the following features:

- 12 place settings dishwasher
- Weight 59 kilo
- 220 dishwashes per year
- Energy consumption 1.118 kWh/wash
- Detergent consumption: 20 g/wash
- Salt consumption: 20 g/wash
- Rinse aid: 4 g/wash
- Product life: 15 years

It should be noticed that the dishwasher – contrary to other energy-using being examined in the present study – has a significant consumption of other resources than energy in the use stage. The energy consumption and waste generation related to this is included in the inventories, without possibility of disaggregating the information. The impacts induced by dishwashers alone are therefore smaller than reported here, especially the eutrophication potential which is judged to be mainly related to the use of detergents and rinse aid.

The results from the MEEUP-analysis of a dishwasher are shown in Figure 2.

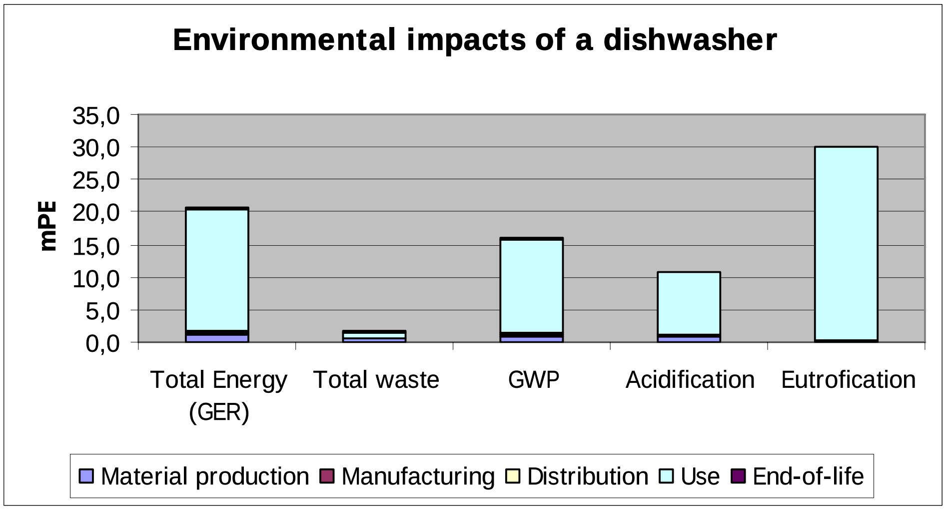


Figure 2. Environmental impacts in milli Person Equivalents (mPE) per year from using a dishwasher.

5.3.2 Additional environmental information

The use stage of dishwashers is clearly the most demanding with respect to environmental impacts. The main concerns are consumption of energy, consumption of water (not included in the LCA information presented in Figure 2) and consumption of detergent and rinse aid. The eco-labelling criteria in the EU-Flower scheme (CEC, 2001) include the following elements:

- Energy-efficiency
  - Energy consumption
  - Suitability for connection to a hot-fill water supply
- Water consumption
- Prevention of excessive use of detergents
- Noise
- Take-back and recycling, incl.
  - Free-of-charge take-back for recycling of the product
  - Permanent marking of plastic parts heavier than 50 grams
  - Restricted use of certain flame retardants
  - Verified possibility of disassembly
- Life time extension possibilities, e.g. replacement parts being available for 12 years
- Appliance design, allowing the user to select a program for washing a standard load using detergents that work best at temperatures lower than 65ºC

- Cleaning and drying performance
- User instruction, providing advice on the correct environmental use

An overview of the products' compliance with the eco-label requirements can be created fairly easily by establishing a simple checklist. In the EDS-example, compliance/non-compliance is emphasized by using green and red shading, respectively.

Table 12. Checklist for compliance with the EU ecolabel criteria for dishwashers.

Criteria	Clause in EU Flower scheme (2001/689/EC)	Criteria fulfilled (Yes/no)	Comment
Energy efficiency			
Energy class: A (10 or more settings) B (5-10 settings) C (less than 5 settings)	1 a		Number of settings, energy class and energy consumption to be declared
Suitable for connection to hot-water supply	1 b		
Water consumption			
Water consumption lower than defined threshold	2		Water consumption in defined test cycle to be declared
Prevention of excessive use of detergent			
Clear markings on detergent dispenser	3		
Noise			
Noise less than 53 dB(A) for free-standing and 50 dB(A) for build-in models	4		Noise level to be declared
Take-back and recycling			
Take-back for recycling, free of charge	5 a		
Plastic parts ≥ 50 g with permanent identification marking	5 b		
No hazardous flame retardants	5 c		
Disassembly report available	5 d		
Life-time extension			
12 years availability of replacement parts	6 b		
Appliance design			
Low-temperature (≤ 65 °C) program available as standard	7 a		
Clear markings identifying appropriate settings	7 b		
Adjustable dosing of salt	7 c		
Cleaning performance			
Cleaning performance class A or B	8		Cleaning performance class to be declared
Drying performance			
Drying performance Class A or B	9		Drying performance class to be declared
User instructions			
Instruction manual includes for correct environmental use	10		

5.4 Televisions

5.4.1 LCA information

The life cycle impacts from use of televisions have been calculated using a weighted average of CRT- (85%) and LCD-displays (15%). Obviously, the impacts from this television do not reflect those of actual products on the market, but the market conditions in 2004. Since then, LCD- and plasma displays have gained a much larger share of the market, and the LCA values calculated are therefore most probably overestimated. They are, however, still considered to give a good indication of the environmental impacts being related to watching TV.

The base-case television being examined is characterised by the following features:

- 22" monitor
- Weight: 30 kilo
- Product life: 12 years
- On-mode: 1460 hours per year; 0.085 kWh/hour
- Stand-by mode: 7300 hours/year; 0.001 kWh/hour

The results of the MEEUP-calculations are presented in Figure 3.

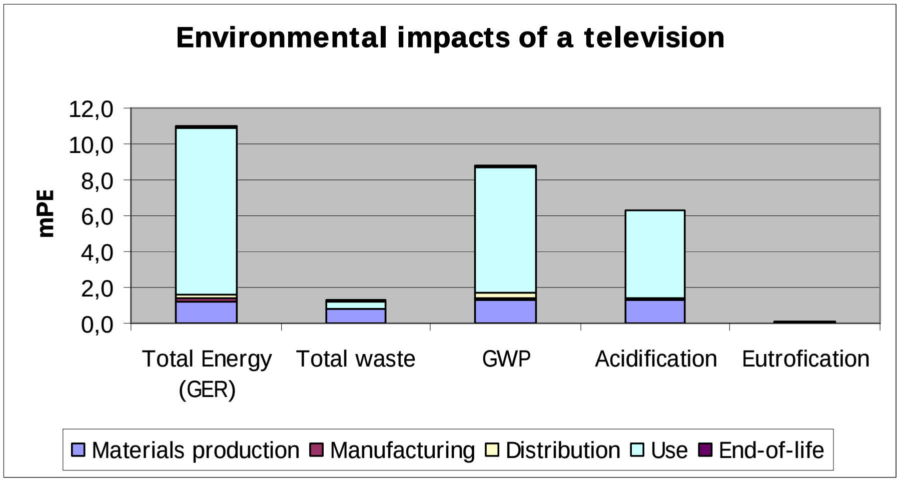


Figure 3. Environmental impacts in milli Person Equivalents (mPE) per year from using a television.

5.4.2 Additional environmental information

It is evident from Figure 3 that the main contribution to the impacts calculated comes in the use stage and being related primarily to the consumption of electricity. This finding is also reflected in the EU-Flower eco-labelling criteria for televisions (CEC, 2002), which include the following elements:

- Energy savings
  - Clearly visible off-switch
  - (Low) stand-by mode energy consumption
  - (Low) stand-by consumption of an integrated digital receiver/decoder, where applicable
  - (Low) on-mode energy-efficiency index
- Life-time extension, i.e. replacement parts being available for 7 years
- Take-back and recycling, incl.
  - Free-of-charge take-back for recycling of the product
  - Permanent marking of plastic parts heavier than 50 grams
  - Restricted use of certain flame retardants in plastic parts
  - Verified possibility of disassembly and subsequent recycling of plastics and glass
- User instructions providing advice on proper environmental use
- Environmental declaration available, based on ECMA's Technical Report 70, "Product-related environmental attributes". It is remarked that these

declarations contain information on the presence/absence of certain substances of concern in (selected) components.

An overview of the products' compliance with the eco-label requirements can be created fairly easily by establishing a simple checklist. In the EDS-example, compliance/non-compliance is emphasized by using green and red shading, respectively.

Table 13. Checklist for compliance with the EU ecolabel criteria for televisions.

Criteria	Clause in EU eco-label scheme	Criteria fulfilled	Comment
Energy savings			
Clearly visible off-switch	1 a		
Passive stand-by consumption ≤ 1.0 W	1 b		Energy consumption to be declared
Active stand-by consumption for receiver/decoder ≤ 9.0 W	1c		Energy consumption to be declared
Energy-efficient on-mode	1 d		Energy consumption to be declared
Life time extension			
Replacement parts available for seven years	2		
Take-back and recycling			
Take-back for recycling – free of charge	3		
Disassembly report available	3 a		
Recyclability	3 b-f		
No hazardous flame retardants	3 g		
User instructions			
Instructions for proper environmental use	4 a-g		

5.5 Pc's

5.5.1 LCA information

The life cycle impacts from use of personal computers have been calculated using a weighted average of work stations (80%) with either CRT-monitors (30%) or LCD-displays (70%). It is not evident from the study report whether the 20% fraction of laptop computers has been included in the calculations. Irrespective of whether laptop computers are included or not, it is evident that the average impacts as calculated are not representative of any actual product on the market, being a mixture of different technologies. There is little doubt that the market develops towards an increased share of laptop computers and/or LCD-displays, and the results are therefore judged to give a conservative estimate of the environmental impacts.

The base-case pc being examined is characterised by the following features:

- Product weight, incl. monitor: 21 kilo
- Product life: 6 years
- On-mode energy consumption: 266 kWh/year
- Stand-by and off-mode energy consumption: Not included (or integrated in the figure for on-mode consumption)

The results of the MEEUP-calculations for personal computers are presented in Figure 3.

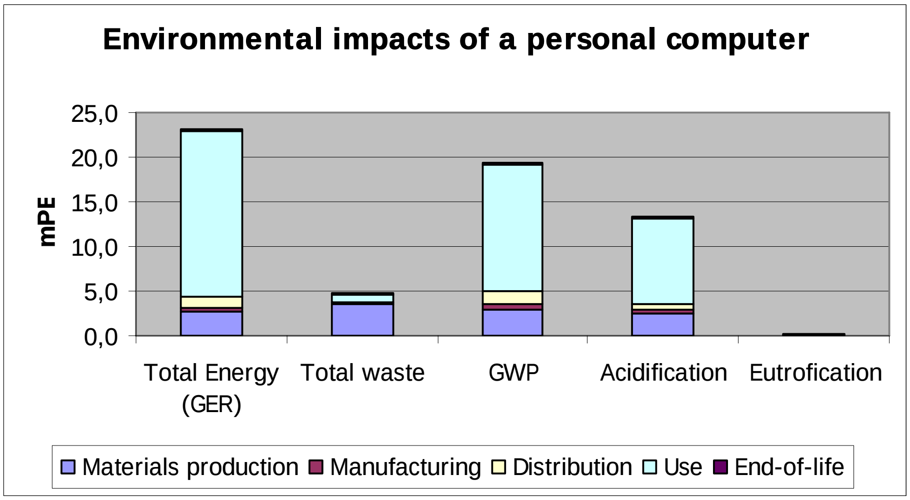


Figure 4. Environmental impacts in milli Person Equivalents (mPE) per year from using a personal computer.

5.5.2 Additional environmental information

It is obvious from Figure 4 that except for generation of waste the largest contribution to the examined environmental impacts occur during the use stage, being related to consumption of electricity. This finding is also reflected in the EU-Flower eco-labelling criteria for personal computers (CEC, 2005), which include the following elements:

- Energy savings
  - Easily accessible off-switch on system unit and monitor
  - (Low) off-mode power consumption for system unit and monitor
  - (Low) sleep-state energy consumption, being activated automatically
  - (Low) active power consumption for monitors
- Life-time extension, allowing change of memory, harddisk, CD/DVD-drive and graphic card
- Mercury content of lamps in LCD monitors
- Noise
- Electromagnetic emissions
- Take-back, recycling and hazardous substances, incl. among other things
  - Free-of-charge take-back for recycling of the product
  - Restricted or prohibited use of certain flame retardants in plastic parts
  - Verified possibility of disassembly and subsequent recycling of plastics and metals in the housing and chassis
  - Marking of plastics
  - (Very low) content of mercury, cadmium and lead in batteries
- User instructions providing advice on proper environmental use
- Packaging

An overview of the products' compliance with the eco-label requirements can be created fairly easily by establishing a simple checklist. In the EDS-example, compliance/non-compliance is emphasized by using green and red shading, respectively.

Table 14. Checklist for compliance with the EU ecolabel criteria for computers.

Criteria	Criteria No.	Compliance	Comment
Energy savings – system unit			
Easily accessible on-off switch on system unit	a		
Energy requirements for system unit fulfilled	b, c, d		Energy consumption in Standby (off mode), sleep mode and idle state to be declared
Energy savings - monitor			
Easily accessible on-off switch on monitor	A		
Energy requirements for monitor fulfilled	B, c, d		Energy consumption in sleep-mode, off-mode and maximum active power consumption to be declared
Lifetime extension	2		
Memory is readily accessible and can be changed	A		
Hard disk, CD drive and DVD drive can be changed	B		
Graphic card are easily accessible and can be changed	C		
Mercury content of LCD monitor	3		
The background lighting of the LCD monitor shall not contain more than 3 mg of mercury on average per lamp			
Noise	4		
Noise does not exceed 40 dB(A) in idle mode and 45 dB(A) when accessing the hard disk			Noise level to be declared
Electromagnetic emissions	5		
The requirements in the standard EN50279, category A, are met	5		
Take back, recycling and hazardous materials	6		
One qualified person alone shall be able to dismantle it	A		
Disassembly report available	B		
Hazardous materials are separable	C		
90% (w/w) of plastics and metals in housing and chassis are technically recyclable	D		
Plastic parts fulfil requirements regarding content of hazardous substances, etc. as appropriate	f, g, h, i		
Batteries contain less than 0,0001% mercury, 0.001% cadmium or 0.01% lead	J		
User instructions			
Product is sold with relevant user information on the proper environmental use	7		
Packaging	8		
Requirements on recycled content and recyclability of packaging fulfilled			

5.6 Refrigerators and freezers

Refrigerators and freezers is not a clearly defined product group, but rather 5-10 different product groups being defined as a function of their function and capability for cooling and freezing. The EU Energy Label distinguishes between the following products:

- Refrigerator without low-temperature compartment
- Refrigerator/chiller (5º and/or 12 ºC)
- Refrigerator with 0 star compartment (< 0 ºC)
- Refrigerator with 1 star compartment (< -6 ºC)
- Refrigerator with 2 star compartment (< -12 ºC)

- Refrigerator with 3 star compartment (< -18 ºC)
- Refrigerator with 4 star compartment (< -18 ºC)
- Upright freezer
- Chest freezer
- Refrigerator/freezer > 2 doors or "other"

A simpler characterisation is used in the MEEUP-project, distinguishing between only to categories: Refrigerators (incl. Fridge-freezers) and Freezers.

5.6.1 LCA information

When developing LCA information for single products, the actual classification model is not important. For the conscious consumer, however, it is important to realise that the need for cooling and freezing can be covered in many ways, e.g. by buying a refrigerator/freezer or by buying refrigerator and freezer as separate products.

The base-case refrigerator/freezer being examined is characterised by the following features:

- Product weight: 50 kilo
- Product life: 15 years
- Energy consumption: 295 kWh/year
- Hydrocarbon refrigerant and blowing agent

No information is available with respect to the volume of the compartments in the refrigerator/freezer, but it is assumed that the chosen values represent average figures for products on the European market in 2004.

The results of the MEEUP-calculations for refrigerators/freezers are presented in Figure 3.

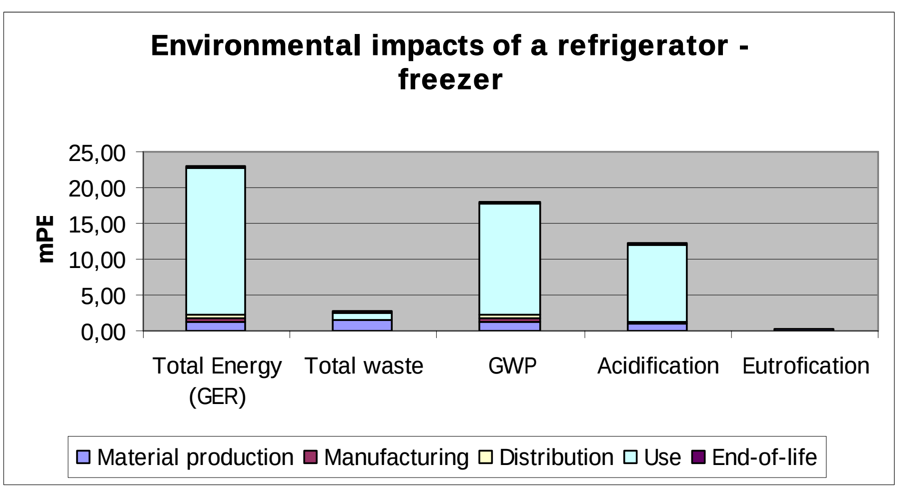


Figure 5. Environmental impacts in milli Person Equivalents (mPE) per year from using a refrigerator/freezer.

5.6.2 Additional environmental information

It is obvious from Figure 5 that the largest contribution to the examined environmental impacts comes from the use stage, being related to consumption of electricity. This finding is also reflected in the EU-Flower eco-labelling criteria for refrigerators and freezers (CEC, 2004), which include the following elements:

- Energy savings
- Reduction of ozone depleting potential (ODP) of refrigerants and foaming agents
- Reduction of global warming potential (GWP) of refrigerants and foaming agents
- Life time extension, i.e. replacement parts and service being available for 12 years
- Take-back and recycling
    - Free-of-charge take-back for recycling of the product
    - Permanent marking of plastic parts > 50 grams
    - Restricted or prohibited use of certain flame retardants in plastic parts
    - Verified possibility of disassembly and subsequent recycling of plastics and metals in the housing and chassis
    - Easy identification of the type of refrigerant and foaming agent
- User instructions providing advice on the correct environmental use
- Noise
- Packaging

It is remarked that the current eco-label criteria includes the criterion that the ozone depleting potential of refrigerants and foaming agents must be zero. As the use of such substances for the given purpose is not permitted under Regulation 2037/2000/EC, the criterion is regarded as unnecessary for products being marketed today.

An overview of the products' compliance with the eco-label requirements can be created fairly easily by establishing a simple checklist. In the EDS-example, compliance/non-compliance is emphasized by using green and red shading, respectively.

Table 15. Checklist for compliance with the EU ecolabel criteria for refrigerators and freezers

Criteria	Clause in EU Flower scheme (2000/40/EC)	Criteria fulfilled	Comment
Key criteria			
Energy efficiency class A+ or A++	1		Energy efficiency class shall be declared, together with the energy consumption
No ozone depleting substances	2		
Low Global Warming Potential	3		GWP of refrigerants and foaming agents shall be declared
Additional criteria			
Life time extension guaranteed	4		
Free take-back for recycling	5		
Disassembly report available	5.1		
Plastic parts $\geq$ 50 g have a permanent mark	5.2		
Plastic parts without specified	5.3 & 5.4		

flame retardants			
Type of refrigerant and foaming agent indicated	5.5		
Instruction manual includes advice on the correct environmental use	6		
Noise emissions ≤ 40 dB(A)	7		Noise level shall be declared
Packaging materials separable	8.1		
Cardboard consist of at least 80% recycled material	8.2		

5.7 Mobile phones

5.7.1 LCA information

For mobile phones, a LCA of a third generation mobile phone from Nokia (Mclaren & Pukkula, 2005) as reported in the Integrated Product Policy Pilot Project was used to establish the information presented.

The LCA does not include the End-of-life stage, and does therefore not report quantitatively on waste issues to any significant extent. It is also noted that the LCA was made in 2003 and therefore not reflects the latest technological developments. It is, however, judged that it gives a fair picture of modern mobile phones, indicating at least the right order of magnitude of the environmental impacts. The results are presented in Figure 6.

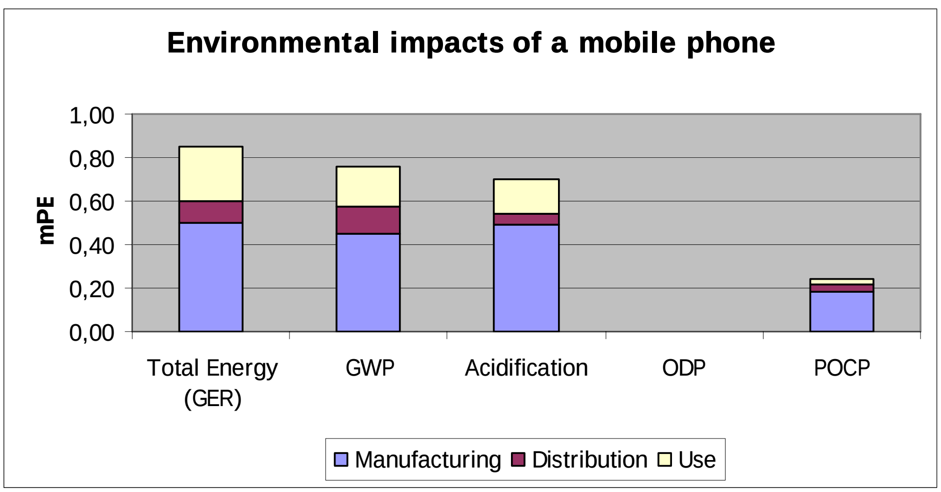


Figure 6. Environmental impacts in milli Person Equivalents (mPE) per year from using a mobile phone.

5.7.2 Additional environmental information

In the context of mobile phones, two issues not addressed by the LCA results may be of importance. One is the use (and waste management) of the plastics in the casing and the rare elements used for the advanced electronics, drawing on resources which must be considered as scarce, although precise information on their availability and total consumption is difficult to find. The other is the electromagnetic radiation generated during use, with unknown effects on the user of the phone. Here, it should be considered to include information on SAR-values (Specific Absorption Rate), an indicator for the exposure to electromagnetic fields which is well-known by all producers of mobile phones.

These issues are in focus in the German Blue Angel criteria for mobile phones (RAL-UZ 106 (RAL, 2006b)), including criteria which calls for the lowest possible SAR-levels as well as criteria which aims at ensuring best possible recycling, similar to that of other electric and electronic products.

An overview of the products' compliance with the eco-label requirements can be created fairly easily by establishing a simple checklist, based on RAL-UZ 106. In the EDS-example, compliance/non-compliance is emphasized by using green and red shading, respectively.

Table 16. Checklist for compliance with the German Blue Angel criteria for mobile phones (RAL-UZ 106).

Criteria regarding	Clause in RAL-UZ 106	Criteria fulfilled	Comment
Emissions			
SAR-value < 0.60 W/kg	3.1.1		Declare SAR-value
Product papers inform consumers about SAR-values and how to minimize exposure	3.1.2		
Product take-back			
The manufacturer accepts to take-back the product, free of charge, for utilization/recycling according to applicable law	3.2		
Recyclable design			
Product is designed for easy dismantling for recycling purposes	3.3		
Materials requirements			
Polymers and flame retardants do not contain chlorine or bromine	3.4.1		
Lead and cadmium must not be added to plastics and coatings used	3.4.1		
Plastic case parts > 10 g are marked according to DIN ISO 11469	3.4.1		
Printed circuit boards must not contain PBB, PBDE or chlorinated paraffins	3.4.2		
Cadmium, mercury as well as beryllium and their compounds are not used	3.4.3		
Batteries and accumulators does not contain any lead, cadmium or mercury	3.5		
Accessories			
The scope of supply includes an external earpiece and a speaker (a headset)	3.6		
Packaging			
The plastics used for packaging do not contain halogen			

5.8 Sealants

5.8.1 LCA information

For Sealants, an EPD from the Norwegian EPD scheme (NEPD, without year) was available.

The EPD is based on a cradle-to-gate LCA, with the environmental exchanges being reported for the life cycle stages "Raw materials", "Transportation" and "Own production" while the calculated environmental impacts only are reported as totals for the whole life cycle.

It should be noted that in the recalculations needed for fitting the information to the general concept used in the present study, some differences with respect to the results for Global Warming Potential and Eutrophication Potential emerged. No obvious explanation was found for this, but as the differences were only 10-50%, the recalculated values were used to indicate the right order of magnitude. It is also mentioned that the amount of sealant was included as waste (hazardous/energy recovery) at the end-of-life stage.

The functional unit –or perhaps rather the declared unit - used is one 300 ml container of sealant. This is an obvious choice, allowing consumers to compare different sealants as long as the volume compared is the same, as is the case for most sealants being sold to private and professional consumers. It is, however, difficult to judge the overall importance of using sealants, the question being how many functional units are being used in a given application.

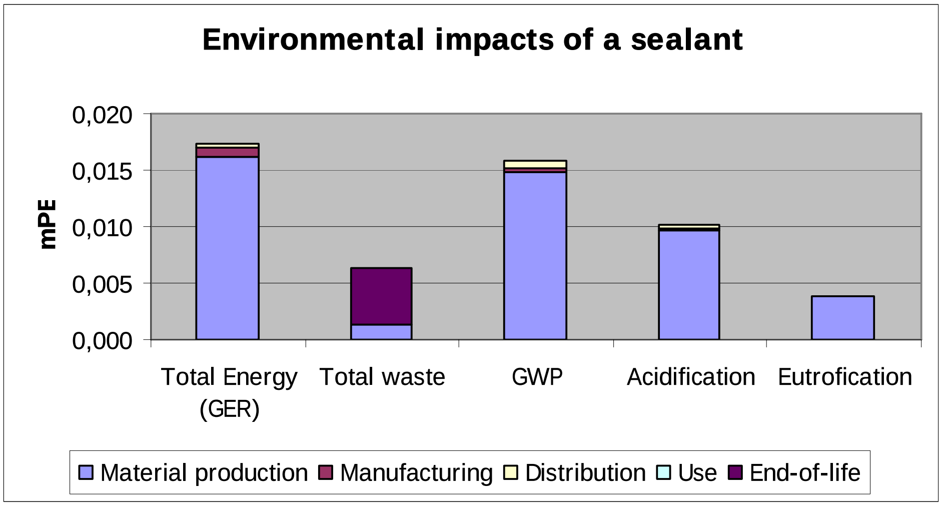


Figure 7. Environmental impacts in milli Person Equivalents (mPE) per year from using one container (300 ml) of sealant.

The results presented in Figure 7 indicate that sealants have a low environmental importance in all examined impact categories, the contribution being less than 0.02 mPE per functional unit in all cases. This picture is not likely to change significantly as the amount of sealant used in construction of a building or refurbishing of a room is assumed to be limited, e.g. a few containers is used in refurbishing of a room.

5.8.2 Additional environmental information

Even though the reported life cycle impacts are judged to be of low importance, sealants may pose significant health and environmental problems related to the materials and substances used.

The German Blue Angel eco-labelling scheme has established criteria for sealants for interior use (RAL-UZ 123 (RAL, 2006a)), including the following elements:

- General substance requirements, addressing among other things the non-use of substances or preparations which are listed as very toxic, toxic, carcinogenic, mutagenic, reprotoxic and teratogenic
- Restrictions on the use of biocides
- Prohibited use of pigments containing lead, cadmium and chromium(VI) beyond natural or process-related impurities
- Prohibited use of phthalates
- Restrictions on the use of organotin compounds
- Indoor air quality

    - Low emissions of TVOC, TSVOC, formaldehyde and other aldehydes
- Prohibited use of fungicides, insecticides, flame retardants and halogenated organic compounds (with some exceptions)

An overview of the products' compliance with the Blue Angel eco-label requirements can be created fairly easily by establishing a simple checklist. In the EDS-example, compliance/non-compliance is emphasized by using green and red shading, respectively.

Table 17. Checklist for compliance with the German ecolabel for low-emission sealants (RAL-uz 123).

Criteria regarding	Clause in RAL-UZ 123	Criteria fulfilled	Comment
Manufacture			
General substance requirements fulfilled	3.1.1		Declare name and concentration of classified substances
Requirements on preservation agents fulfilled	3.1.2		Declare preservation agents
Pigments without lead, camium and mercury	3.1.3		
No phthalate-based plasticizers are used	3.1.4		
Content of organotin compunds < 0.1%	3.1.5		
Use			
Indoor Air Quality	3.2.1		Provide test results obtained in relevant schemes
Serviceability	3.2.2		Specify relevant standards for which the product comply
Recycling and disposal			
No fungicides, insecticides, flame retardants or halogenated compounds	3.3		
Declaration and consumer information			
Container text and Technical Data Sheet	3.4		

The eco-label criteria have a strong focus on the content of hazardous substances and the possibility of exposure to these from emissions to the indoor climate. Obviously, a product which complies with all criteria should be regarded as safe for the consumer, and accordingly also recommendable. For products, which do not fully comply with the criteria, using the rating system for the content of (hazardous) chemical (see section 4.3) can provide the consumer with a good indication of the performance of a given product, and it is therefore suggested to include this rating in the Environmental Data Sheet for sealants.

The significant differences between different types of sealants have been demonstrated by rating them with respect to Indoor Air Quality and content of chemicals. The EDS for a silicone-based sealant thus signals that the product can be regarded as acceptable, whereas the EDS for a polyurethane-based sealant shows that both its content of chemicals and its possible impact on indoor air quality is problematic. It is, however, emphasized that the two products not necessarily are interchangeable, i.e. they may fulfil different functions in a building. The two examples are thus primarily a demonstration of how the rating systems are able to distinguish between environmental and health properties of products.

5.9 Wood floorings

5.9.1 LCA information

For Wood floorings, a German LCA as reported in Int J LCA was used (Nebel *et al*., 2006), giving cradle-to-grave LCA results for different wood floorings.

The study is fairly rich in detail, but does unfortunately not allow for a division into life cycle stages which is operational in an EPD context. The main problem in this is that it is not possible to distinguish the impacts from the installation and maintenance stages. It has therefore been chosen only to show the total values in the present report. It is, however, remarked, that the manufacturers commissioning the study most probably will be able to present the results in an un-aggregated form corresponding to the requirements in existing and future EPD-schemes.

The functional unit is 1 m^2 of laid wood floor covering assuming average wear and tear in a home that is completely refurbished after 50 years. For normalisation purposes all results have therefore been divided with 50, giving the environmental impacts per year over the expected life time of a building. Knowing the area to be covered it is thus fairly easy to calculate the impacts from covering the floor with the desired material. The results of the calculations are shown in

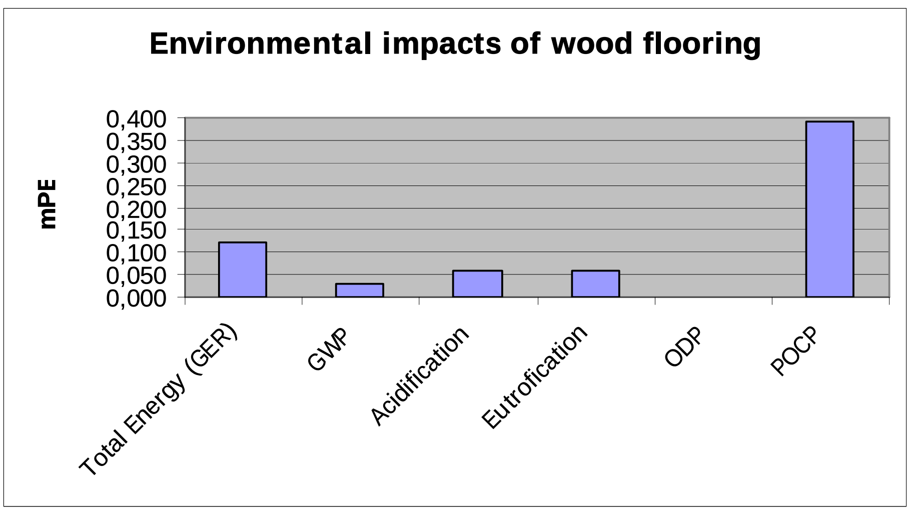


Figure 8. Environmental impacts in milli Person Equivalents (mPE) per year from using one square meter of wood flooring.

Except for the contribution to Photo-oxidant Creation (POCP), the results presented indicate that wood floorings have a relative low environmental impact per m^2. The contribution to POCP is very high, about 0.4 mPE per m^2, the energy requirements amount to about 0.12 mPE, while the contribution to the other impact categories examined is less than 0.02 mPE per functional unit. It is, however, evident that if an area of 100 m^2 is covered with wood flooring then the environmental impacts per year becomes of the same order of magnitude as energy-using products like personal computers and televisions.

The significant impact on creation of photo-oxidants is primarily caused by the surface finishing, where 140 g UV-curing lacquers is used per square meter. It is an open question whether the surface treatment should be included in the life cycle of the floor as such, but from a consumers' point of view the total impacts from the chosen floor solution seem to be the most appropriate information, reflecting the life cycle perspective.

5.9.2 Additional environmental information

What is not apparent from the figures is that both the wood, the glue used in the manufacturing and the surface treatment may be significant sources of pollutants affecting indoor climate and human health, primarily in the form of volatile organic compounds. It therefore seems appropriate to declare hazardous substances used in the production as well as results of tests of which substances are emitted to the indoor environment in the use stage – and in which concentrations.

These issues are considered in the German Blue Angel ecolabel criteria for wood-products and wood-base product (RAL-UZ 38 (RAL, 2002)), which additionally considers the sustainability of the wood used in the production. The criteria in RAL-UZ 38 are used to derive a checklist for wooden floor products, addressing the most important environmental aspects (Table xx). It is remarked that some test methods and criteria are based on German legislation and guidelines, which are suggested to be used until international agreements eventually can be reached, e.g. in the EU ecolabel scheme, the Flower.

Criteria regarding	Clause in RAL-UZ 38	Criteria fulfilled	Comment
Manufacture			
Wood from sustainable forestry is used	3.1.1		
For wood-based materials, formaldehyde steady state concentration of 0.1 ppm in test chamber is not exceeded	3.1.2		Wood-based materials marked with RAL-UZ 76 need not be tested
Substances in coating systems are not classified as very toxic, toxic, carcinogenic, mutagenic or teratogenic	3.1.3.1		Declare classified substances
The amount of VOC in coating materials does not exceed 250 g/l for two-dimensional and 420 g/l for three-dimensional products	3.1.3.2		
The liquid coating system comply with the VdL Directive on Wood Paint Systems			
Use			
Emissions of formaldehyde, organic compounds and CMT substances are below specified limits	3.2.1		Declare test results
Packaging allows post-manufacture outgasing of volatile compounds	3.2.2		
Relevant replacement parts are available for five years	3.2.2		
Recycling and disposal			
Fungicides, insecticides, flame retardants and non- halogenated organic compounds are not added to the product	3.3		

The eco-label criteria have a strong focus on the content of hazardous substances and the possibility of exposure to these from emissions to the indoor climate. Obviously, a product which complies with all criteria should be regarded as safe for the consumer, and accordingly also recommendable. For products, which do not fully comply with the criteria, using the rating system for the content of (hazardous) chemical (see section 4.3) can provide the consumer with a good indication of the performance of a given product, and it is therefore suggested to include this rating in the Environmental Data Sheet for wood flooring.

The rating system developed for assessment of indoor air quality (see section 4.4) is not directly applicable to wood flooring systems because some of the criteria differ. It is thus not possible to use the detailed rating, but the simplified rating system ("Approved"/"Not Approved") can be applied if the assessment is based on the actual criteria for wood flooring.

It should be noted that for obvious reasons, the German ecolabel criteria do not address future surface treatment of the flooring, only the initial treatment performed by the manufacturing company. In order to ensure that also future maintenance can be handled with environmental concerns, analogous criteria and a corresponding checklist can be established by using either German ecolabel criteria (RAL-UZ 12a) or EU Flower criteria for paints and varnishes. This is, however, outside the scope of the present study.

5.10 Insulation

5.10.1 LCA information

For insulation, a LCA by Schmidt *et al.* (2003) was used, reporting cradle-to-grave data for three insulation materials, however with little or no possibility of distinguishing between the impacts from different life cycle stages. For reporting in the present context, stone wool was chosen.

The functional unit is a thermal resistance (R-value) of 1 m^2K/W over a 50 year period, being fulfilled by using 1.182 kg of stone wool. This functional unit is conventionally used by manufacturers of insulation materials and it was also suggested for use in the context of the EU Eco-labelling scheme when criteria were developed in 1995. The results of the calculations are presented in Figure 9.

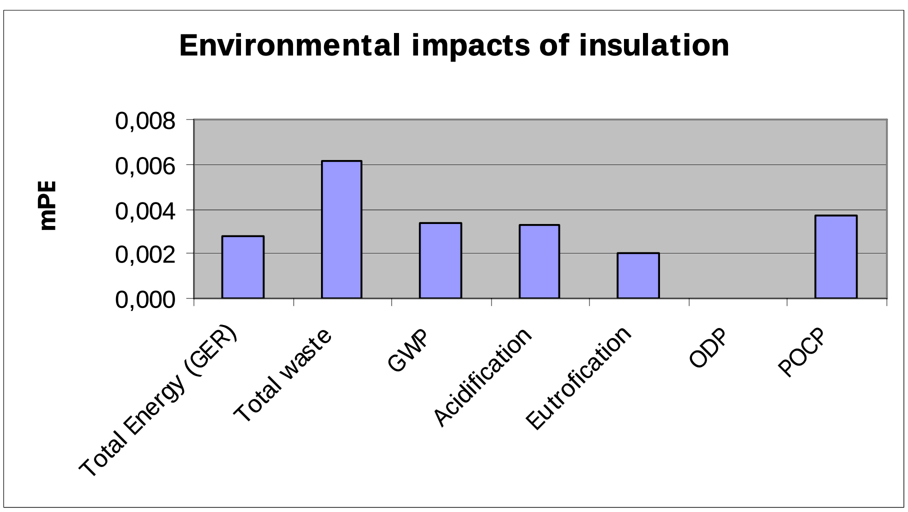


Figure 9. Environmental impacts in milli Person Equivalents (mPE) per year from using one square meter of insulation with a R-value of 1 m^2K/W.

For the consumer, a more suitable functional would probably be (national) building regulation requirements, e.g. the Danish Building Regulations from 1995 stating that the required heat resistance (R-value) in attics is 6.76 m^2K/W, corresponding to an U-value of 0.14 W/m^2K. To achieve this insulation capacity, a thickness of 250 mm is required, corresponding to a weight of stone wool insulation of 8.0 kg/m^2.

When using the more consumer-relevant functional unit and considering that more than one square meter needs to be insulated, the environmental impacts related to the activity “insulation of attics” obviously increases significantly. For an attic of 40 m^2, the impacts increase about a factor 270. In the larger context, however, the impacts measured as mPE/year are still modest, being in the order of magnitude of 1 mPE/year, a little larger than the annual impacts induced by the use of a cellular phone.

The impacts from production of insulation materials appear to be even more insignificant when their energy saving potential is considered. Clausen (2007) has calculated the heat loss over 50 years as a function the U-values.

Table 18. Life cycle energy cost and energy saving potential as a function of desired heat resistance.

Insulation layer thickness Mm	Construction U- value W/m^2K	Heat loss 50 years (MJ)	Life cycle energy cost for stone wool (MJ)	Energy saved 50 years (MJ)	Energy payback rate 50 years
0	1.54	19958	0	0	-
80 mm	0.42	5594	44.8	14319	319
250 mm	0.14	1865	140	17953	128
350 mm	0.10	1332	196	18430	94
500 mm	0.071	944	280	18734	67

The calculations clearly show the benefits of insulating houses up to – and beyond – legal requirements. At some point the extra construction materials necessary and the dimensions will make the energy payback rate reach zero, but the very straightforward message from the calculations is to insulate as much as practically possible. As an operational example of this, the additional energy savings from increasing the insulation thickness from 80 to 250 mm is 3634 MJ/m^2, or more than 220,000 MJ for a 60 m^2 attic. In this perspective, the difference between insulation materials with respect to production energy requirements is of less importance, being crudely estimated to 1-10% of the savings potential.

5.10.2 Additional environmental information

The LCA results presented do not address other issues of concern for consumers, e.g. the potential impacts on indoor climate and human health. These aspects are addressed to a limited extent in Schmidt *et al.*, 2003, focusing on exposure levels during installation of insulation materials and the potential effects of fibres and additives. Indoor Air Quality is, however, mentioned, stating that emissions of hazardous substances to the indoor climate will only occur if a proper vapour barrier is not present in the building envelope.

As for other building products, consumers should be able to make an informed choice integrating environmental and health concerns. Criteria for insulation materials have not been established in the EU Flower, the Nordic Swan and the German Blue Angel eco-labelling schemes, and the criteria suggested have therefore been established using criteria for comparable product groups as well as the following considerations, pinpointing the environmental and health aspects being assumed to be in focus, if and when official criteria are developed.

The aspects judged in the current project to be of main interest are:

- Fitness for use of the product, especially dimensional stability. If a product is not fit for use during its entire life time, e.g. as a consequence of settling of loose fill fibres, the energy savings may be reduced significantly. This aspect is recognized as being very important, being subject to specific requirements in national building regulations along with requirements regarding other fitness-for-use aspects like fire properties, resistance to biological attack and moisture stability.
- Emission/Indoor concentration of fibres. This aspect is considered to be especially important when the insulation is in direct contact with indoor air as is primarily the case when mineral wool is used for noise insulation. When installed behind a vapour barrier or cladding material the risk of increased fibre concentration is generally negligible. The concentration can be determined by using the Danish Indoor labelling scheme.
- Emissions of hazardous substances. Also here the potential risk primarily pertains to applications in direct contact with indoor air, while in other cases the concentration will in general be low the detection limit. Applicable test methods and acceptance levels are found in many countries. For the example EDS, the German AgBB test scheme has been used, but other national testing schemes may be equally applicable and relevant.
- Content of hazardous substances. Although the common consumer is not exposed directly to insulation materials in everyday life, absence of potentially hazardous substances in the insulation product is often regarded as important.
- Radioactivity. With natural stones and sand being the main raw materials in mineral wool production, there is a risk of the product emitting naturally occurring radioactive elements like radon, radium and thorium. Also here are suitable test methods and acceptance levels available.

It is outside the scope of the project to define very precise criteria with associated procedures for measurement and verification. This should be the subject of a dedicated working group with members from industry, government bodies, academia, etc., as it is generally the case when eco-label criteria are developed. For illustrative purposes, the following head-line criteria are suggested, together with potentially useful reference criteria from other product groups.

Table 1 Environmental specifications for insulation products			
Criteria regarding	Example clause	Criteria fulfilled	Comment
Manufacture			
General substance requirements, relating to the absence of Toxic, Very toxic, carcinogenic and reprotoxic substances	RAL-UZ 123, clause 3.1.1		Declare classified substances and their concentrations
Preservation agents	RAL-UZ 123, clause 3.1.2		Declare preservation agents and their concentrations
Use			
Fitness for use meets building regulation criteria			To be documented and verified on the national level, until a harmonized standard is developed
Indoor Air Quality	RAL-UZ 123, clause 3.2.1		Declare test results
Emission of radioactive substances			To be declared – acceptance levels have not been established
Recycling and disposal			
No fungicides, insecticides, brominated flame retardants or halogenated compounds	RAL-UZ 123, clause 3.3		Overlapping to some extent the first criteria
Declaration and consumer information			
Technical Data Sheet including information on proper installation procedure	RAL-UZ 123, clause 3.4		Information regarding use of adequate personal protection equipment to be included

The suggested criteria have a strong focus on the content of hazardous substances and the possibility of exposure to these from emissions to the indoor climate. Obviously, a product which complies with all criteria should be regarded as safe for the consumer, and accordingly also recommendable. For products, which do not fully comply with the criteria, using the rating system for the content of (hazardous) chemical (see section 4.3) can provide the consumer with a good indication of the performance of a given product, and it is therefore suggested to include this rating in the Environmental Data Sheet for insulation materials.

5.11 Discussion

5.11.1 LCA-based results

The results presented in the report have been established using readily available information about the selected product groups. It must be acknowledged that there are significant differences between the background studies used owing primarily to the context in which they have their intended use. All of the referred studies are alleged to be based on ISO 14040 and ISO 14042, but these standards allow for a large flexibility in their interpretation.

Given the limitations, the LCA-information derived from the studies is judged to allow for a comparison of the relative importance of the product groups with respect to global and regional environmental impacts.

The LCA-based results are summarized in Table 19, taking into consideration that the impacts per declared unit as reported in the previous sections must be up-scaled in order to reflect the actual impacts caused by a consumer when fulfilling his needs in a practical building situation.

Table 19. Normalised environmental impacts in milli Person Equivalents (mPE) per year for the examined product categories

	Gross Energy Requirements	Global warming	Acidifi-cation	Eutro-Phication	Ozone Depletion	Waste	POCP
Dishwasher	20.6	15.9	10.9	29.9		1.7	
Television	9.7	7.6	5.0	0.0		0.6	
PC	23.1	19.3	13.2	0.2		4.7	
Fridge-refrigerator	22.9	18.0	12.2	0.2		2.7	
Mobile phone	0.9	0.8	0.7		0.0		0.2
Sealant[1]	0.3	0.3	0.2	0.1		0.1	
Wood flooring[2]	12.2	2.9	6.0	5.7	0.0	1.7	39.2
Insulation[3]	0.7	0.9	0.9	0.5	0.0		1.0

[1] Functional Unit: 20 containers of sealants, life time 15 years
[2] Functional Unit: 100 m^2 of flooring, life time 50 years
[3] Functional Unit: 40 m^2 of attic insulated with an U-value of 0.14 W/m^2K, life time 50 years

The results give a good indication of the relative importance. For energy-using products, dishwashers, refrigerators and personals computer are clearly more demanding on the environment than televisions and mobile phones, whereas for building products, (wood) flooring is clearly more demanding than sealant and insulation.

When comparing energy-using products to building products it can be seen that the environmental impacts from using (wood) flooring (100 m^2) are of the same order of magnitude as that for "large" energy-using products, while the impacts from sealant and insulation is significantly lower.

Being only example calculations it is not possible to make strong conclusions. It would for example be of large interest to know the actual differences within the single product group - differences which for some energy-using products like televisions and refrigerators may amount to a factor 2 between best and worst performing product.

5.11.2 Additional environmental information

The report presents an approach to how the issue of additional environmental information to be included in an EPD can be handled. The elements of the approach have been developed with a minimum of resources available, and they should neither be regarded as final nor as fully consistent.

Some examples are given, showing how eco-label criteria can be used to show the environmental performance of products in a simple graphical presentation. The graphical presentation can to a large extent only present the results on a limited scale, e.g. reflecting compliance/non-compliance with eco-label criteria and "missing information". Establishing a larger scale similar to that used in EU energy labelling scheme requires quantitative information (and appropriate testing methods), which are only available to a very limited extent, if at all.

Certification schemes for building products, e.g. addressing indoor air pollution is an important source for quantitative or semi-quantitative data, and these are therefore included where relevant. For the examples developed, the German AgBB-scheme has been used, but other national testing schemes are probably of similar quality. A quick screening of some (national) schemes showed that there are differences with respect to the approach as well as the strictness of “pass criteria”, and the criteria used in the EDS should when possible reflect a harmonized European approach. For the purpose of demonstrating the benefits of including Indoor Air Quality, the German AgBB-scheme is however believed to provide a good basis.

6 Final remarks

The concept for and examples of Environmental Data Sheets presented in the report differs significantly from Environmental Product Declarations as they are found in existing schemes and the format suggested by 2.-0 Consultants.

A main difference is that an EDS provides less information than most EPD's being published in the existing schemes, at least as measured by the number of words and figures. The detailed information on life cycle environmental impacts has been significantly reduced along with information about environmental management systems in function, technical details about production methods and product properties, recommendations on proper environmental use of the product, etc. Instead, producers are requested to present more focused information on product performance in relation to a broad range of environmental issues as reflected by core life cycle information, eco-label criteria, testing schemes and a newly developed scoring system for the content of chemicals in a product. Producers are also invited to present product characteristics as they see fit, thereby allowing the consumer to make an informed choice based on knowledge about technical and environmental performance presented side by side.

The concept for Environmental Data Sheets is in its present form basically a suggestion of how environmental information other than that derived from life cycle assessments can be communicated to the consumer. Information from life cycle assessments should not be neglected, but the common consumer will most probably make the same choice when purchasing an energy-using product with and without the results from a life cycle assessment, as long as the information from an energy labelling scheme is available. The sophisticated consumer may include other elements than energy labelling in his decision process, e.g. by judging the product performance as related to eco-label criteria which covers a wide range of issues. The sophisticated consumer may also find some of the information elements in traditional EPD's useful, but more research on consumer perception of environmental information is needed before the best approach can be decided.

A main drawback in excluding the detailed life cycle information is that the consumer will not necessarily know whether he has chosen the "best" product, only that he has chosen a product with known properties, e.g. the energy class of the purchased refrigerator. However, the requested information for energy-using products also includes information on the actual energy consumption, and by using this figure, the consumer can make an even better choice between two or more products with the same properties. Not knowing the exact life cycle impacts related to electricity consumption is in this context of minor importance, but the average life cycle information can of course be replaced by product-specific information in those cases where this is judged to be useful.

As outlined, the suggested two-page format for an EDS covers the environmental aspects believed to be most important. The format can however be changed as needed or desired in order to accommodate desires from relevant stakeholders, e.g. producers, consumers or legislators. Some may perhaps wish to include more information, others to reduce the amount of information. The format and content of the EDS has not been discussed with relevant stakeholders during the project, but the findings in consumer perception studies strongly indicate that there is a need to simplify and focus environmental information, if it is to be used in the purchasing situation. It is therefore suggested that the concept should be presented for relevant consumer groups, e.g. as one of several ways of communicating environmental information. After all, it is the individual consumer who purchases the majority of the products included in the present study, and the individual consumer is therefore also the primary target group for the Environmental Data Sheets.

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Annex 1. Rating of the chemical content in consumer products

It was a wish from ANEC that the Environmental Data Sheets included an explanation directed towards consumers of how the score for chemical content is derived. The suggestion from FORCE Technology is to make the explanation available to interested consumers on a website with unrestricted access. The following text is believed to give the desired knowledge.

The potential impacts on human health and the environment from chemicals in consumer products depends in short on how humans or the environment is exposed on the one hand, and the effects the chemicals may cause on the other. A very precise indication of the potential impacts can be obtained by using the EU Technical Guidance Document on risk assessment of chemicals, but since it requires significant resources to make an assessment of a single product or substance, a more simplified approach is needed if an indication of the potential hazards should be given for the multitude of consumer products available today.

The simple approach suggested by FORCE Technology makes it possible to assign one of seven ratings to chemical-containing building products like sealants, insulation materials and paints/lacquers, and also to common consumer products like household detergents, all-purpose cleaners, etc.

In the rating system, exposure potential is judged by the amount (in percent) of the constituents of the product. The system divides the amount into five groups, the lowest possible amount being “less than 0.01% or not actively added” and the highest possible amount being “more than 20%”. Having the very low limit of less than 0.01 % ensures that a content of very hazardous chemicals is not overlooked. It must, however, be recognized that allergic reactions may occur at even lower concentrations. Allergic individuals are therefore encouraged always to read the full declaration of content to ensure that a product does not contain substances which the person is allergic to.

The effect potential of each of the chemical components is assessed by using the risk sentences (R-sentences) assigned to them according to the EU system for labelling and classification of chemicals. It is obvious from their wording that the R-sentences indicate very different effect potentials. It is common sense to most consumers to consider irritating properties far less serious than carcinogenic properties, but it cannot be expected that all individuals agree that a content of 2-10% of irritating substances equals a content of less than 2% of environmentally hazardous substances in seriousness.

A ranking system like the one presented here can therefore only be established using more or less arbitrary choices, however being based on common sense perception of how serious the potential effects in general are considered to be.

In practice, the rating system combines the exposure and effect potentials of the individual chemicals in a product as presented in Tables 1 and 2. The information provided to the consumer is, however, restricted to the highest score assigned to an individual chemical. The scores are thus not added, only the most serious combination is communicated. It is acknowledged that this is a significant simplification of the official classification systems, but it nevertheless allows for a verifiable message being sent to consumers, however without the possibility of identifying exactly which effect potential is addressed by the assigned rating.

7.1 Scoring system

Labelling	Amount R-sentences	≤ 0.01% or not actively added	< 2 %	2-10 %	10-20 %	> 20 %
No labelling or "Explosive"/"Inflammable"	R1; R19	A	A	A	A	A
Harmful to health (Corrosive, Harmful, Irritating)	R20; R21; R22; R29; R31-32; R34-38; R67	B	C	D	E	F
Dangerous to the environment	R51-59	B	D	E	F	G
Sensitizing	R42; R43	B	D	E	F	G
Chronic effects	R33; R39; R41; R48; R65-66; R68	B	F	F	G	G
Acutely toxic (toxic and very toxic)	R23-28	B	G	G	G	G
Carcinogenic, mutagenic or toxic to reproduction	R40; R45; R46; R49; R60-64	B	G	G	G	G

7.2 Rating system

Rating	Best
A	Excellent
B	Good
C	Acceptable to good
D	Acceptable
E	Marginally acceptable
F	Problematic
G	Very problematic
	Worst

Product score
B

Annex 2. Example Environmental Data Sheets for eight product groups

The EDS concept has been exemplified for eight product group. The examples are demonstrated on the following pages. The products in the examples are more or less fictive, the information being related to different products within the product group. Photos are deliberately of a bad quality, their function being primarily to indicate the possibility of combining technical and environmental information in one sheet, the EDS.