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Assessment of Criteria Development within the EU Eco-labelling Scheme

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The reports are, however, published because the Danish EPA finds that the studies represent a valuable contribution to the debate on environmental policy in Denmark.

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Preface

The Department of Environmental Impact Assessment at dk-TEKNIK ENERGY & ENVIRONMENT has elaborated this environmental project for the Council for recycling and cleaner technology, the Danish Environmental Protection Agency.

The project has been carried out throughout the period 1993 - 2000.

The steering committee was limited to representatives from the Danish Environmental Protection Agency and dk-TEKNIK ENERGY & ENVIRONMENT.

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Sammenfatning og konklusioner

EU's Forordning om miljømærker blev indført i 1992 med ikrafttrædelse den 23. marts 1993. De første miljømærkestudier blev igangsat i 1992.

Den praktiske forberedelse af det kommende EU miljømærke skema blev således påbegyndt før indførelsen af Forordningen. Til trods for den tidlige forberedelse har EU ordningen dog mødt mange forhindringer på sin vej. Udvikling af kriterier er bare én måde at fokusere på implikaitonen af ordningen på. I dag er der stadig ubesvarede spørgsmål tilbage, men ordningen - og vigtigheden af den (i en produktorienteret, miljømæssig strategi) vokser støt.

Dette projekt sammenligner tolv studier om udvikling af EU's miljømærke kriterier. Der er flere studier, der sammenligner fastlæggelsen af kriterier inden for samme produktgrupper indenfor forskellige miljømærkeordninger. Såvidt vi ved, er dette det eneste projekt, der sammenligner miljø mærke undersøgelser med hensyn til (LCA-) metodiske emner på tværs af produktgrupper.

Projektet er udført over en lang periode (1993-2000). De discipliner, der har været mest fokus på - LCA og kriteriefastlæggelse - har begge undergået en enorm udvikling i samme periode. Dette har skabet en unik mulighed for at undersøge inddragelse af LCA i kriteriefastlæggelsen, mens begge værktøjer har været under udvikling. Man kan sige, at projektet er udviklet på dets lange vej, og målet med projektet har til en vis grad flyttet sig. Målet er flyttet fra oprindeligt kun at give et overblik til også at inddrage vedtagne kriterier.

På baggrund af den lange periode i projektet har det været muligt at medtage de første forslag til kriterier i de miljømærke undersøgelser, der blev foretaget, hovedpunkterne fra forhandlingerne og i mange tilfælde også de endeligt vedtagne kriterier.

En detaljeret beskrivelse af undersøgelsen findes i afsnittet "Introduction". Den overordnede struktur i rapporten er delt i to.

Den første del af rapporten giver et overblik over, hvad der er sket i tolv miljømærke studier. Specielt inddragelse af LCA i arbejdet med kriteriefastlæggelse er fremhævet. Men også andre emner såsom håndtering af energi og spildevand samt data kilder er medtaget. Ved denne sammenligning bliver mange ligheder og uligheder afsløret.

Anden del af rapporten tager sit udgangspunkt i de vedtagne kriterier, og der skabes et overblik over generelle træk ved studierne.

Ved at kombinere de to metoder har det været muligt at skabe grundlag for en diskussion. Udfaldet af denne diskussion vil bidrage til fremtidige kriteriefastlæggelser og ved revision af Forordningen.

Det er vanskeligt at konkludere skarpt på basis af diskussionen. Nogle af de konklusioner, der kan drages er:

- Der er en indbygget konflikt mellem det at have præcise og veldefinerede produkt-gruppe definitioner og på samme tid udvide produkt-grup-

perne, så de omfatter flest mulige produkter. Den sidstnævnte er en konsekvens af ønsket om at få dækket så mange produkt-grupper - og dermed så stor en del af markedet - som muligt.

- De vedtagne ISO LCA standarder anbefaler en iterativ proces, når LCA studier gennemføres. Den samme anbefaling er relevant når man balancerer mellem definitioner af ”functional unit”, ”fitness for use” og design af kriterier. Medlemslandene og EU Komissionen må arbejde med disse specifikke problemstillinger fordi, den iterative proces let kan kollidere med international forhandlinger. Under internationale forhandlinger kan det ofte være svært at genoptage allerede lukkede diskussioner.

- Det ville være en fordel, hvis medlemslandene og EU Komissionen kunne enes om dele af ”impact assessment”, f.eks. normalisering af globale og regionale miljøpåvirkninger. Dette ville sikre en mindre debat af relativt ukomplicerede emner og dermed hurtigere forløb og samtidig give en større gennemsigtighed til ordningen som sådan.

Summary and conclusions

The EU Regulation of eco-labelling was adopted in 1992 and it came into force on 23. March 1993. The first EU eco-labelling studies were initiated in 1992. Thus, a practical preparation of the-coming-to-be EU eco-labelling scheme was initiated before the adoption of the Regulation itself. However, early preparation of the EU schemes met many obstacles on its way.

The development of criteria is just one way of focusing on the implications of the scheme. Today, unresolved issues still remain but the scheme and the importance of it (in a product oriented environmental strategy) is growing steadily.

This study compares twelve EU eco-labelling criteria development studies. There are more projects in which different eco-labelling criteria establishment studies within the same product group are compared. However, to our knowledge this is the only project that compares eco-labelling studies with respect to (LCA-) methodological matters and including different product groups.

The project has been carried out over a long interval of time (1993-2000). The disciplin most in focus - LCA and criteria establishment - have both undergone an enormous development within that period of time. This has created a unique possibility to investigate the involvement of LCA in establishing of criteria while both tools have been under development. One can say that the project has evolved on its long way and the target of the project has to some extent been moving as well. The target has changed from originally only performing a survey to including adopted criteria also.

Due to this lengthy time span of the project it has been possible to include the original criteria proposals with the eco-labelling studies that were carried out, highlights from the negotiations and in many cases the final adopted criteria.

A detailed description of the study is placed in the Introduction. The overall structure in the report is divided in two parts.

The first part of the report monitors what has been done in twelve eco-labelling studies. Special emphasise has been put to the inclusion of LCA in the work of establishing criteria. But also other matters like handling of energy, waste water treatment and data sources were considered. By this comparison many similarities and dissimilarities are revealed.

The second part of the report takes its starting point from the adopted criteria. An overview of general features is given.

By combining the two approaches it has been possible to make room for a discussion. The outcome of this discussion will provide input to future establishing of criteria and revision of the Regulation.

It is not possible to provide clear-cut conclusions on the basis of the discussion. Some of the conclusions that can be drawn are:

- There is a built-in conflict between having precise, well-defined product group definitions and at the same time enlarging the product groups. The

latter is a consequence of the wish to cover as many product groups as possible and thereby also to cover as large a part of the market as possible.

- The adopted ISO LCA standards recommend an iterative process while performing LCA studies, the same recommendation is relevant when balancing between definition of functional unit, fitness for use and design of criteria. The member states and the EU Commission have to work on these specific topics because the iterative process easily may conflict with international negotiations. In international negotiations it may often be difficult to reopen already decided discussions.

- It will be advantageously if the member states and the EU Commission could agree upon some parts of impact assessment, e.g. normalisation of global and regional environmental impacts. That would ensure less debate of relatively non-complicated matters and also provide more transparency to the scheme as such.

1 Introduction

In 1992, the European Commission adopted a regulation on a Community eco-label award scheme, (1). This Regulation established a voluntary eco-label scheme intending to:

- promote the design, production, marketing and use of products which have a reduced environmental impact during their entire life cycle;
- provide consumers with better information on the environmental impact of products.

This scheme is part of a more market oriented policy approach consistent with the principles and objectives of the fifth EC environmental action programme.

Under the Community eco-label scheme, an eco-label may be awarded to products which are in compliance with specific ecological criteria for the corresponding product groups (1), (2).

This study was initiated in 1993 following the introduction of this EU-Scheme for eco-labelling of products. The goal of the study was to provide a survey of the different methodologies for development of criteria for 12 product groups. The 12 selected product groups were the first studies of the start of the scheme.

Within the last 6 years several attempts have been done to develop general guidelines for establishing criteria for eco-labelling. Thus, the Groupe des Sages has in 1997 published a second edition of "Guidelines for the application of life cycle assessment in the EU eco-label award scheme" (2). However, those attempts are still not to be regarded as the final methodological approach.

The present work is not meant as a general guideline on how to set up criteria for eco-labelling. It is meant to be a presentation of the great variety in methodologies, form of presentation, use of databases etc. performed in the 12 different studies on setting up criteria. All studies are among the first that were performed. Thereby it might contribute to the work which takes place now on establishing of criteria as well as generel guidelines for establishing of criteria. Further, the work may contribute to the revision of the EU-labelling regulation.

1.1 **Background**

A survey of some methods and data used is elaborated for the product groups of which criteria has been adopted. These studies[1] are:

Washing machines (UK)(3)[2], dish washers (UK)(4)[1], soil improvers (UK)(5), light bulbs (UK)(6), hairspray (UK)(7), paints and varnishes (F)(8), refrigerators (I)(9)[3], freezers (I)(10)[2)], detergents (D)(11), kitchen rolls

[1] The letters after each product group refers to the country being responsible for the development of criteria for the specific product group.
[2] The studies on washing machines and dish washers will be elaborated togther.
[3] The studies on freezers and refrigerators will be elaborated together.

(DK)(12)[4], toilet paper (DK)(13)[3], copying paper (DK)(14)[3], T-shirts and bed linen (DK)(15)[5].

The subject of this study has been a moving target. When the study was initiated (1993) one of the intensions was to map what has been done in the eco-labelling studies. A group of experts, the Groupe des Sages, first developed one set of guidelines on how to establish eco-labelling criteria for product groups. These guidelines also included considerations of the matter of how to apply LCA methodology to eco-labelling. Later (1997) the guidelines (2) were further developed. More projects aiming at establishing of eco-labelling criteria were initiated (long) before the guidelines of the Groupe des Sages were established. To some extend one can argue, that the initiation of the work of the Groupe des Sages was because of the different eco-labelling studies or rather because it was evident, that each study - most of them claiming to use the same set of (SETAC) guidelines, that later became the "Code of Practise" (16) - developed different methodologies.

While it presumably never will be totally solved if these differences were because of cultural differences or general uncertainty on what to do, there is no doubt that the combination of a rather new and at that moment not fully developed LCA methodology and a new EU eco-labelling scheme gave rise to different interpretations. This was just further underlined because the "establishing-of-criteria"-studies also have specific needs, e.g. inclusion of market survey, definition of product group that are not dealt with in traditional LCA methodology. In addition to this it has taken - and still takes - some time to decide which scientific degree that is actually sufficient to decide on good and relevant eco-labelling criteria.

Just to add to this complexity, the comprehensive studies of Inventory reports and Life cycle screening and the proposals for criteria which were presumed to be the basis for the final adopted criteria for each product group were for many products modified, and criteria proposed as a part of the research work were often revised before the final adoption.

Because of the changing and developing situation over a period from 1993 to 1999 the concept of this present study has been revised several times. From the aim of mapping what has been done to critical discussion of specific eco-labelling studies to an overall survey of the first seven years with EU eco-labelling scheme in the perspective of LCA methodology. A survey performing a little of each of the (critical) directions ending in a fruitful discussion and recommendations for future eco-labelling work.

Thus, in the beginning the aim of the study was to perform a quick review of the background material for all 12 product groups in order to perform a survey. The survey should examine similarities and differences concerning the basis provided for design of criteria from these studies. Especially the survey should focus on the LCA methodological aspects e.g. inclusion or exclusion of different life cycle phases, system boundaries, data quality and inclusion of impact assessment. In order to identify relevant aspects detailed reviews were performed for three studies: Soil improvers, Light bulbs and Refrigerators. In the following the survey of these 3 studies will be titled "*The Prestudy*".

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[4] The studies on kitchen rolls, toilet paper, copying paper and writing paper will be elaborated on at the same time.

[5] The studies on T-shirts and bed linen are elaborated on at the same time.

The idea performing the Prestudy was to obtain information on a number of issues within 3 general areas (LCA methodological aspects, horizontal aspects and data aspects) and this information would appear useful when identifying aspects to be investigated for the remaining 9 studies. In fact the Prestudy did reveal a number of important aspects. These are dealt with in the survey of the remaining studies.

1.2 **Further analysis on the basis of the Prestudy**

The experience of the Prestudy proved that the methodology used for the survey of the 3 studies (Soil improvers, Refrigerators and Light bulbs) was not one adequate method to examine eco-labelling studies of the remaining product groups. There were several reasons for this point. Firstly, the background reports did not necessarily have the presumed linkage to the final criteria as anticipated. For several product groups the final criteria were developed on the basis of extended studies. Thus, the analysis of the first published LC-screening reports did only contain parts of the relation to the criteria adopted later. Secondly, the effort to standardise studies linked to a well-defined schedule turned out to be very difficult without being able to state any of the methods used as being right or wrong and at the same time without being able to identify strong similarities. Thirdly, however useful the very detailed survey of the different reports showed to be extremely time consuming compared to the factual output.

In order to do a short cut in the project without losing the hard earned experiences, the opposite approach has been taken for the remaining studies:

The criteria adopted for the scheme have been used as a starting point. The reason is that the criteria are the result of the entire work and the criteria are the basis for environmental improvements caused by the labelling system. The quality of the criteria conducts the environmental benefits. Therefore, the study has to focus on the kind of facts (environmental data and linkages between functional unit, environmental impact, fitness for use) which creates the best basis for development of criteria or in other words: the aim with the analysis of the remaining product groups is to uncover links between the background studies and the design of criteria. An optimal situation will be if the identified limits, short cuts etc. provide an easier development of future criteria.

The succes or quality of a set of criteria can be described as the possibility of the criteria to promote cleaner technology or/and cleaner products within the scheme of eco-labelling. However, the effect of a set of criteria does not start before the criteria are adopted to the scheme. In fact the effect does not start before adopted criteria are used and manufactures apply for the label. In few cases this last act actually has never happened. The criteria shall be acceptable for the interested parties (industries, NGO's, competent bodies) and at the same time promote cleaner technology and cleaner products. The property of criteria to cover these sometimes conflicting demands at the same time has not been an easy spot in all cases. This is one reason why the adopted criteria in some cases are far from the criteria proposed in the draft reports.

1.3 **Guidance for the reader**

In the following the contents of the report is presented. The presentation is at the same time a guide for how to read the report.

Chapter 2 ”Methodological aspects - Vocabulary” is a short introduction to the conceptions, activities and routines linked to the cradle to grave analysis as a basis for design of criteria for eco-labelling of products. The chapter forms a basis for understanding of the wording in the rest of the report. In the chapter an explanation is presented about the vocabulary used. The horizontal aspects are divided in items like energy, transportation, cleaning procedures (in manufacturing systems), packaging, waste handling, recovery and use, emission, connection to public plants, semi-products, and control methods. The data aspects are divided in several subgroups. These are the identification of the use of different data bases, the different ways of using these sources, input on raw materials, energy, on to some extent the assessment of environmental loadings and the use of environmental and health data.

Chapter 3 ”Methodological aspects from the Prestudy” is a summary of the Prestudy presenting the methodological key issues considered in the background studies of freezers, soil improvers and light bulbs. The focus is set on the central concepts linked to LCA methodology (fitness for use, functional unit, goal definition and scoping, inventory methodology etc.). The main conclusions from the Prestudy are identified and discussed. This is followed by a short presentation of the handling of central aspect in the other 9 reports. Thereafter there is a discussion of advantages or disadvantages of different approaches.

The main aspects in the Prestudy is the methodological aspects. Also horizontal and data aspects are considered.

These 3 types of aspects are not totally separated; this is the case when assessing the impacts of energy consumption including selection of data on emission factors from energy production. In the description of the individual aspects it is therefore noted when an aspect overlaps with other aspects.

Chapter 4 ”Comparison with other selected studies” summarises the remaining 9 studies. Special efforts of comparison are done with respect to the goal and scoping issues (fitness for use, functional unit, purpose of the study and product definition) while less efforts are done with respect to impact assessment. For the goal and scoping aspects it is described if and how the specific issue is raised under each specific ecolabelling study. For the impact assessment methods for identification of environmental key features are considered for the most relevant studies. All the way through the chapter the influence of the discussed aspects to the later criteria establishment are considered.

Chapter 5 ”Methodological aspects analysed on the basis of the adopted criteria ” discusses the results of chapter 4 across the different product groups. Criteria design, the relation between criteria and life cycle screening, the life cycle phase that the criteria are related to, cleaner technology aspects linked to the criteria, source basis for criteria and the basis for levels are discussed. Specific and general patterns are identified.

Chapter 6 ”Features of criteria of the established product groups” discuss the items given in chapter 5 ”Methodological aspects analysed on the basis of the adopted criteria ”. Thus, the aspects in question are criteria design, relation between design of criteria and the LS-screening, identification of Life cycle phases, cleaner technology and cleaner products aspects, source basis for criteria and the basis level for the criteria. To some extent chapter 6 ”Features of criteria of the established product groups” appoints how the patterns identified in chapter 5 can be applied in future development of

criteria and to what degree a revision of the EU eco-labelling scheme can improve the work of eco-labelling.

Chapter 7 ”Discussion and future development of criteria ” is the concluding chapter. In the chapter the overall conclusions and discussions are outline. This outline is followed by detailed discussions on special relevant aspects, like:

- demands of transparancy
- identification of key features
- demands for standardisation of environmental elements
- links between product group definition and functional unit
- fitness for use and environmental key features
- links between product group definition and functional unit
- standardisation of horizontal elements
- the role of consensus oriented discussions
- the range of eco-labelling as an environmental regulation tool
- products’ suitability for eco-labelling

The chapter conclude with som final views of future development of criteria.

2 Methodological aspects - Vocabulary

The procedure for eco-labelling of products under the labelling scheme managed by the European Commission, includes 6 phases:

Table 2.1

Phase	*Task*	*Subtask*
Phase 1	Preliminary phase (incl. product group selection)	
Phase 2	Market survey	
Phase 3	Inventory	Goal Definition and Scoping Inventory Analysis
Phase 4	Environmental Impact Assessment	Impact Assessment Proposals for Criteria Setting
Phase 5	Setting of Criteria	
Phase 6	Presentation of Draft Proposal for a Commission Decision	

(17)

Just like LCA, criteria development can be characterised as an iterative process. New knowledge in one phase has an impact on conclusions in other phases. The phases are therefore not necessarily finished in succession.

The aspects considered here are related to the method of applying LCA screening for establishing of criteria for eco-labelling, i.e. how to establish key features without a comprehensive inventory and a complete assessment of the impacts related to emissions and consumption of resources. Even if methods vary in different studies it is clear, that the elements described somewhat detailed below do form a part of each of the studies in one way or the other.

The studies are usually performed by national consultants from the member countries. The reports containing inventory and proposals for design of criteria are discussed by an Ad Hoc Working Group (AHWG). An AHWG consists of representatives of industrial organisations commerce, NGO's (consumer and environmentalists), competent bodies from the member countries and officials from the Commission. This AHWG has for some product groups been rather powerful and reflects the potential conflicts between different groups of the society.

Later in this chapter concepts which are frequently used in this study are shortly explained and their relevance briefly described.

2.1 **Inventory**

2.1.1 **Goal definition and scoping**

The description of the different approaches in the Prestudy is made by going through of a number of specific items:

2.1.2 **Product group definition**

The idea of the eco-labelling scheme is to compare different products within the same product group to each other with respect to environmental loading. Therefore the definition of a product group is very important. Many products have more functions or a function can be fulfilled by different product groups. The inclusion or exclusion of specific products has to be adressed.

In several studies the product groups are defined but there are some variation concerning how narrow the definitions are.

2.1.3 **System boundaries**

The setting of the system boundaries may have great impact on the results of a LCA. Therefore, it has been relevant to survey how these boundaries have been set up in different studies and the reasons for the choices.

The setting up of system boundaries includes a definition of what part of the life cycle that are taken into account in the study. Examples of life cycle steps that are included in some cases and not in others are production of auxiliary chemicals, manufacturing of the machinery used for the production, or extraction and processing of crude oil subsequently used for the production of synthetic polymers.

Another important parameter that is included in the choice of system boundaries is the scale of environmental parameters which is included, i.e. whether transport, sewage treatment and wastehandling issues are included.

2.1.4 **Environmental fields**

One part of the discussions about the system boundaries is whether local, regional and/or global environmental issues are included.

The environmental fields that have to be taken into account are broadly defined in the matrix in Annex I of the Council Regulation (1).

There are, however, differences as to which effects on environment and health (e.g. destruction of the ozone layer or human cancer caused by substances emitted to the air) different studies are dealing with. This might be due to the fact that the effects caused by different products are not alike, but also due to the fact that the judging of the relative importance of different effects are not alike. Similarly, some studies include occupational health whereas this aspect is not included in other studies. A survey of the impacts that the different studies are dealing with, including a discussion of where and why differences occur, was therefore performed in the Prestudy.

2.1.5 **Functional unit**

The data obtained in the inventory usually should be compared through a functional unit. The methods and arguments for choosing or not choosing a functional unit in the studies is presented and discussed.

2.1.6 **Establishment of key features**

When an inventory has given data for input and output in the life cycle of a product the next step in the process normally is to point out the features that are most important from an environmental and health point of view. The establishment of such key features (i.e. a number of consumption and emission parameters) is the first step in selecting which parameters the criteria will deal with. Therefore it is essential to survey the methods used for establishing key features.

2.1.7 **Inventory data**

In the inventory part of the LCA as *in- and output* data are collected. This means consumption of energy and raw materials and emissions of pollutants and waste. The collected data appears to be both qualitative, semi-quantitative as well as quantitative, and the degree of specification of the input and output varies. The methods for choosing the level of data of the inventory has been surveyed in the Prestudy.

2.1.8 **Process flow-charts**

One of the best way to present the components of a system is to develop a flow-chart showing how the sub-systems are interlinked. Some care is needed in the construction of the flow-charts. Sometimes a general form of the system is presented. This might very well be an over-simplification of the reality which makes it difficult to use (i.e. too many flows or points are missing). Another, most likely possibility is that the flow-chart gets too detailed. A too detailed flow chart does not necessesarily reveal the relevant information since it makes it difficult to distinguish important issues from less important. Therefore the use of flow-charts and how they are used is described in the Prestudy.

2.1.9 **Allocation procedures**

Establishing of eco-labelling criteria is a very practical matter. This is also true when it comes to the application procedures. In many eco-labelling studies it has been revealed to be an important matter to consider to which extent a parameter is influenced by connection to public plants, recycling etc. It is also an important matter when a factory e.g. produces both products that are eco-labelled and products that are not or produces co-products.

Therefore part of the present study has been to reveal what kind of allocation procedures have been used when allocation rules have been needed.

2.1.10 **Impact assessment**

In general, LCA-impact assessment contains 3 steps:

- *Classification* - the process of assignment and initial aggregation of inventory data to relatively homogenous problem types (e.g. greenhouse gases or ozone depletion compounds) within the larger impact categories (i.e. human and ecological health and resource depletion).
- *Characterisation* of system input and output according to their relevant *impact factors*, e.g. global warming potential (GWP). Impact factors are coefficients which can be used to translate a particular entry into a quantitative contribution to an impact category. Multiple impacts can be aggregated and converted into common units (*impact descriptors*) based on a common mechanism of action or other common features. The units are impact *equivalents* related to a standard substance, e.g. CO_2-equivalents. An impact score and profile can be compiled from the quantified contributions to the impact categories. The different entries of the impact profile may also contain qualitative entries ("flags") denoting aspects which could not be quantified into an *impact score.* Sometimes these impact equivalents are brought in perspective by *normalisation*. In this way, effect scores of the environmental profile are related to the total magnitude of the impact category in a given area and time period. Normalised effect scores may constitute a better basis for comparison.
- *Valuation* - the assignment of relative values or weights to different impacts to allow decision makers to assimilate and consider the full range of relevant impacts.

Differences in approaches applied in the studies have occured both in each of the three steps and in the way the steps are combined. There have also

been differences in the way the selection of key features has been combined with impact assessment. All approaches have been reviewed.

Differences in classification appeared due to the use of different data sources when the effects are described. This aspect is related to the survey of data mentioned below.

2.1.11 **Terminology and criteria**

Differences in the studies may occur due to the different methodological approaches described above, but there may also be variations in the terms used to describe the methods applied in the study. It is registered whether there are differences in the terminology in the 3 studies examined in the Prestudy.

Among other things the Prestudy resulted in some reflections upon the practical use of the indicative matrix in the regulation on eco-labelling. These reflections lead to the conclusions that it was preferable to use the nomenclature used in the latest SETAC publications within the framework of LCA[6)7)].

The setting up of the final criteria on the basis of the established key features implies considerations of a number of practical aspects (e.g. assessment of the possibilities of achieving an actual environmental benefit when choosing a certain parameter, or the availability of appropriate test methods for controlling the parameters). This certainly allows a great variety of approaches, and furthermore it is possible to choose between hurdles and scoring systems. These aspects are surveyed and to some extent discussed.

2.2 **Horizontal aspects**

Studies have to deal with matters that are general for all product groups under consideration, so called horizontal problems. Therefore it is important to survey how different studies have dealt with these problems.

2.2.1 **Energy consumption**

When energy consumption is looked at, different approaches are possible and these may lead to variable results. One approach is to deal only with the apparent energy used in e.g. the production plant whereas another is to deal with primary energy. Also, the emissions from energy production may be included in some studies and not in others. It is therefore important to survey the different approaches used in the studies and the argumentation for using the methods.

2.2.2 **Transportation**

When transportation is looked at, different approaches are possible and these may lead to variable results. One approach is to deal with the energy consumption when the transportation takes place. Another approach is that transportation is not a part of the assessment procedure because of the idea of the single european market, and again another is to screen the actual transportation needs and upon the results of that, judge whether the transportation is the determining factor for the product group. If so criteria for that product group should not be established, or the criteria should be transportation specific. The different approaches and the argumentation used in the studies are surveyed.

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6) Guidelines for Life-cycle Asessment: A "Code of Practise".

7) A Conceptual Framework for Life-Cycle Impact Assessment.

2.2.3 **Emissions**

It is registered how emissions are registered, i.e. whether the actual emission from a plant is used as inventory data (black box principle) or whether the potential emissions (not including reduction in the amount of the emitted substance due to cleaning equipment) are the data used.

2.2.4 **Connection to public plants**

In a number of cases, production sites are connected to a public plant instead of establishing their own facility (e.g. energy production, waste water treatment). This raises the problem of how to allocate the input and output of the public plant to the users of the facility. Allocation to public plant and the method used for allocation is included.

2.2.5 **Semi-products**

Semi-products may for some kind of products be almost exclusively bought from suppliers and this raises the question of the way to handle such semi-products. If the production of semi-product is found as one of the key impacts, criteria may be applied to that phase of the life cycle. It may also be judged that it is not possible to change the environmental impacts from manufacturing the semi-products by setting criteria for these. In other cases it may be judged that the manufacturing of semi-products contributes only very little to the overall environmental impact of the product and thus is not a key feature. A conclusion like this is related to the setting up of system boundaries. Therefore, it is essential to establish how different studies have handled semi-products when criteria are set up. The different approaches and the argumentation used in the studies are surveyed.

2.2.6 **Control methods**

When applying for an eco-label a manufacturer or retailer has to inform on the parameters described in the criteria for the product group. When the EU scheme was new there were very few (if any) decisions on a general EU level on how this information should be supplied (format etc.). Further, there were few decisions on how the information should be controlled.

This has been developed over time, e.g. development of application formats connected to the specific criteria. The chosen formats and control methods are registered.

2.2.7 **Packaging**

The handling of packaging - like in the case of transportation - varies, too. It is registered whether packaging has been regarded as an integrated part of the product subject to the same environmental demands as the product itself, if it has not been included at all or if any other approach has been chosen. The arguments for the choices are discussed.

2.2.8 **Data aspects**

Even when studies are using the same methodology different results may occur if different sets of data are used. Different types of data sets appear at different levels of an eco-label study. The handling of e.g. the case of missing data is crucial. Data sources and types are registered and it is noted in the study whether or not data quality indicators have been developed.

2.2.9 **Raw materials**

Raw materials used in the production of a product may be common products on the market and in this case it could be chosen in some studies not to get information from the suppliers on emissions and consumption of resources, but instead use generic data (i.e. data concerning oil-/plast products deriving

from standardised european data sources (18)). The use of generic or specific data is mapped in the survey.

It is also important to survey if assessments made in one eco-label study is taken into account into other studies. If for example paper is part of a product, and an assessment of this material is part of the key features, it is essential that this assessment is consistent with the assessment performed in the eco-label studies on paper products in stead of introducing totally different key features. The arguments for the choices are discussed.

2.2.10 **Energy**

As described in connection with the "horizontal aspects" data concerning energy production (e.g. emissions from power plants, efficiency of power production) may be included in some cases, and therefore it has been necessary to survey which data are used for the three product groups analysed in the Prestudy.

2.2.11 **Assessment of environmental loadings**

In the process of assessing the environmental impact of the environmental loadings that have been found in the inventory phase, it will often occur that these loadings are compared with the total emission of the same substance. It is therefore essential to register whether the emission data used as reference are national, regional, EEC or global and the reasons for choosing the reference.

2.2.12 **Environmental and health data**

In the cases where "official" judgments are used in the impact assessment it is registered which sources (i.e. type of list, country, year of issue) are used.

3 Methodological aspects from the Prestudy

3.1 The LCA approach

In this chapter the results from the investigated studies in the Prestudy (light bulbs, refrigerators, soil improvers) is presented with respect to methodological aspects. The focus has been put on some general aspects in the LCA approach like the goal definition, the inventory and the impact assessment. For each of these aspects the approaches used in the investigated studies in the Prestudy will be highlighted. Individual characteristics of the studies will in relevant instances be stressed out. All the considered studies are 1. generation studies. For many of the product groups there have been at least one revision since the present study was done.

Following the three separate presentations a comparison of the three studies from the Prestudy is presented and similarities and differences are highlighted and the most significant features are drawn out.

3.2 Light bulbs

3.2.1 Goal definition and scoping

In this section an introduction to the goal definition and scoping in the light bulbs study will be presented.

Purpose of the study

As it is stated in the study itself the purpose of the LCA study was to catalogue and sum up potential adverse effects on the environment of the light bulbs in order to:

- provide an objective appraisal of the environmental impact of the light bulbs,
- facilitate comparison between the different light bulbs within the same product category (corresponding to the product group).

Product group definition

Two separate product categories were defined in the report. These were single-ended and double-ended light bulbs.

The categories were defined taking the following points into account:

- Double-ended light bulbs are easily distinguished by the consumers from the single-ended bulbs both with regard to appearance and function.
- Double-ended light bulbs constitute a homogenous group in terms of energy efficiency, technology used (mostly fluorescent) and design purpose (mostly non-domestic).
- By defining the product categories as above direct comparison between compact fluorescent bulbs and standard incandescent bulbs is allowed within the category of single-ended bulbs.

Product categories based upon the function for which the light bulbs are purchased might appear more relevant for the consumers. Thus, the light bulbs could with advantage be divided into product groups of domestic and non-domestic light bulbs.

Criteria setting

Criteria were in the first case only proposed for single-ended light bulbs on the basis of following arguments:

- Relevant criteria - in terms of energy use - for double-ended bulbs will exclude double-ended bulbs for domestic use, since they are less energy efficient than the non domestic bulbs.
- If separate criteria for the two product categories were made the consumers could be mislead to buy eco-labelled single-ended bulbs in preference to non-labelled double-ended bulbs which actually are more energy efficient.
- If the same set of criteria were used for the two categories, all double-ended bulbs would meet the criteria and the eco-label would then fail to achieve its aim.

The purpose of the Eco-Labelling Scheme is to encourage manufacturers to introduce cleaner and sustainable technology in the manufacturing of products from all of the product groups encountered in the scheme. Therefore, criteria for each product group should be proposed but the stringency of the criteria for a specific product group should of course be adjusted to the environmental performance in general within the product group. At an interim stage criteria were also proposed for double-ended bulbs

Fitness for use criteria

Some fitness for use criteria were proposed. These were:

- The bulbs should comply with three European standards concerning electromagnetic interference developed by the European Committee for Electrotechnical Standardisation (CENELEC - Comité Européan de Normalisation Electrotechnique).
- The packaging of the light bulbs should contain information about any special characteristic of the bulbs.

The fitness for use criteria did not cover the most straight forward demand on light bulbs; to provide light for the purpose of use throughout a minimum time period. This could be ensured by proposing a minimum number of lumen hours for the bulbs.

Scope and system boundaries

The LCA included the environmental interventions directly associated with the light bulbs, namely the phases of pre-production, production, distribution including packaging, use and disposal. Effects arising from the construction of plant and tools, the development of infrastructure or the needs of workers were excluded, since it was considered very difficult to determine and allocate them objectively.

Only few aspects of the different life stages in light bulbs' life cycle were actually included in the report and this was only done to a limited extent. It implies that for instance in and output of auxiliary products were for the most part excluded.

Environmental fields

No aspects of occupational health or risk of accidents were considered in the LCA.

In the study of light bulbs it was argued that the experience has shown that the potential impacts arising from construction of plant and tools, the development of infrastructure and the needs of workers only to a minor extent contribute to the total potential impact of a product and therefore these factors were excluded from the study.

Functional unit

For the purpose of comparisons, a functional unit was selected. The selected functional unit was equal to 1.5 times the light output of a standard incande-

scent bulb (60W) and 0.3 times that of a compact fluorescent bulb (11W). The functional unit was not used when discussing scarcity of the elements identified in compact fluorescent bulbs nor was it used or considered in many of the proposed eco-label criteria. For some of the figures it is not clear whether they are related to the functional unit, since it was not specified in the legends to the figures. Since consumption of energy appears to be of crucial importance in connection with environmental performance of the light bulbs throughout their life cycle, it would have been more transparent directly to include an aspect of energy consumption in the functional unit. Thus, a functional unit of a fixed number of lumens per watt would somehow have been a better standard of reference for the environmental performance of the light bulbs.

Key features

No real LCA was performed in the light bulb study. Instead a very limited sort of screening LCA was performed. The so-called "environmental indicators" were selected.

The "environmental indicators" were selected very early in the study - before the inventory - to include the fields that could be of environmental relevance in connection with the light bulbs' life cycle. Thus, the environmental indicators were used as parameters for the analysis and indicated the direction of focus for the analysis. In this matter, the environmental indicators can be interpreted as being equivalent to "key features" - the term commonly used in other studies - with the reservation that key features often are selected after the inventory.

The following environmental indicators were selected:

- Emissions to air: particulate matter
  greenhouse gases
  acid forming gases
  critical volume.
- Emissions to water: chemical oxygen demand (COD)
  suspended matter
  critical volume.
- Solid waste: mass generated.
- Natural resources: energy used
  mass used
  scarcity index of elements used.

The critical volumes of water and air were employed as indicators of toxicity to man and were mentioned to be based on emission loadings to air and water normalised after the toxicity standard of "MAK[8].

3.2.2 **Inventory analysis**

The inventory contains in- and output data on five of the most typical bulb models within the four different technologies (standard incandescent, tungsten halogen, compact fluorescent with variable control gear and tubular fluorescent) used for domestic lighting in the EC. Compact fluorescent bulbs with both magnetic and electronic gear were included. Thus, data for one type of double-ended light bulbs, namely tubular fluorescent bulbs, were included in the inventory, although no criteria were in the first place proposed for these bulbs. The data were included for the purpose of comparisons with the figures from the four different single-ended light bulbs. Little attention

[8] The right abbreviation is "MAK" and not "MAC" as used in the report; "MAK" stands for "Maximale Arbeitsplatz-Konzentration" = "maximum concentration at the workplace") which are Swiss occupational standards.

was paid and little information was given about the control gear of the compact fluorescent bulbs and the transformer necessary to use some of the tungsten halogen bulbs.

Process flow chart

An illustration of the environmental interventions of the light bulbs' life cycle was included in the report. The illustration outlined in a schematic way the interventions related to the phases of pre-production, production, distribution, use and disposal. The flow chart illustration is very simplified and does not add any extra information to the life cycle stages of light bulbs compared to what could be expected. The flow charts serve as an general illustration for the reader. Therefore, the flow charts are not elaborated in respect of input/output.

Allocation procedures

In the study on light bulbs, allocation procedures were not paid much attention. There might be several reasons for that. Two of them deserve some thoughts in this presentation.

The study of light bulbs was in some way carried out in a general way, e.g. the used flow charts did not include connection to public plants, neither did it mention that several production chains could take place at the same factory.

While developing criteria the specific application procedures were not considered. A guidance document or maunal was not developed or considered. Because of this, procedures including allocation matters were not considered.

Inventory data

Most of the information concerning the inventory data was presented in the section dealing with the inventory and in Annex B of the report which was added to the second edition. Within the annex the various background data and methods used both in connection with the inventory and the impact assessment were discussed, and assumptions were identified and explained. A lot of the data selected for the inventory was already aggregated, such as SO_2 emissions and VOC emissions.

The inventory data were mixed with the aggregated data normally presented in the impact assessment. To some extent data that are not used were also presented and also a number of non-explained abbreviations. These things may lead to confusion.

The majority of the data used in the LCA was selected as being the "most suitable" for the study and was taken from the European manufacturers and associations, mainly the European Lighting Council (ELC), BUWAL-/FOEFL (Swiss Federal Office of Environment, Forests and Landscape) (19), TEMIS, A Computerised Tool for Energy and Environmental Fuel and LCA and Energy in Europe, Annual Energy Review CEC DG XVII (22).

The inventory data obtained from the European manufacturers and their associations were presented in one inventory table. The remaining inventory data were presented in Annex B of the report.

In the inventory table the data representing tubular fluorescent bulbs were presented mixed together with the data concerning the single-ended light bulbs. No specific data on solid waste were presented whereas data on performance in use were included. The presentation of the data on double-ended light bulbs among the single-ended light bulbs can be confusing since it veils the previously defined product categories. Few inventory data were actually presented in the table and the data were mostly related to input, whereas out-

put data were more scarce. Output data for the life phases of pre-production, distribution and use were omitted. On the other hand, data on the lifetime of the bulbs were included which - strictly spoken - have nothing to do with in- and output. Some of the data in the table were actually aggregated data (like VOCs) and should therefore rather be presented in the section of characterisation under the impact assessment. The term "VOCs" was not defined in the report. Also, terms as "electronics" and "others" were used without a describtion of, what they stand for but mentioning that it was unspecified by manufacturers.

3.2.3 **Impact assessment**

Classification

No real process of classification of impacts was performed in the report but the selected "environmental indicators" constituted a form of classification of the supposed input and output. Thus, the impacts of the light bulbs' life cycle were indirectly classified in the following categories:

- global warming,
- acid deposition,
- dust nuisance,
- water quality,
- air quality,
- depletion of natural resources and
- generation of solid waste.

No potential damage to the ozone layer, terrestical ecology or noise impacts has been included in the assessment since - according to the report - no aspect of the light bulbs' life cycle would cause specific effects in these fields. Any potential impact on occupational health or aspects of accidental risks was excluded as well.

The statement that light bulbs do not have any potential impact on terrestical ecology or noise impact is not further discussed or documented in the report.

Characterisation

The identified environmental impacts were aggregated into impact categories as follows and were all calculated per functional unit. The impact categories were global warming, acid deposition, toxicity to man and resource consumption.

The *Global warming* expressed as CO_2-equivalents per Mlm.hr. (Mega Lumen hours), include figures for emissions of CO_2, CO, CH_4, N_2O and non-methane volatile organic compounds. Global Warming Potentials (GWPs) were taken from the International Panel on Global Warming (IPCC, 1992) reflecting a 100 year timescale.

According to IPCC, non-methane volatile organic compounds (NMHCs) are categorised as indirect greenhouse gases meaning that they only indirectly - via formation of ozone, water and CO_2 - have a greenhouse effect. The GWPs for indirect greenhouse gases (mainly NMHC, CO, NO_x and CH_4) are connected with large uncertainties and therefore, IPCC does not recommend using them. If the indirect GWPs are used they should be distinguished from the direct GWPs and all of the indirect GWPs should be considered or the reasoning for only including NMHCs and not the other indirect greenhouse gases should be mentioned.

The *Acid Deposition* expressed as SO_2-equivalents per Mlm.hr., include figures for emissions of SO_2, NO_x, NH_3 and HCl. Conversion factors were taken from the French Eco-Labelling Study of Paints and varnishes which used the data from VROM Bestrijdingsplan Verzuring 2000 (1990).

In addition to the above mentioned gases, hydrogen fluoride - as proposed by the Dutch Centre of Environmental Science in Leiden (CML) - is also often included as a gas which contributes to the acid deposition. The study does not mention whether HF initially was considered for light bulbs.

The *Toxicity to Man* was divided in one part concerning air and one part concerning water. Concerning air, the toxicity to man was expressed as critical volumes of air per functional unit. The emissions to air were mentioned to be related to the Swiss MAK standards. In connection with energy consumption, the data of critical volumes were taken from the BUWAL database and included the following emissions:

Air: particles, SO_2, HC, NO_x, N_2O, CO, aldehydes, other organic compounds, NH_3 and fluorides.

As for air, toxicity to man was considered and was expressed as critical volumes of water per functional unit. The emissions to water were mentioned to be related to the German MAK standards. With regard to energy consumption the critical volumes were taken from the BUWAL database and included the following emissions:

Water: suspended solids, BOD, oils, phenols, NH_3, fluorides, chlorides and Fe-ions.

For the *Consumption of resources* the figures of electrical energy consumption have been aggregated and are expressed in primary energy using a conversion factor of 38% for electrical energy in the EC. It is not clear what kind of fuel was considered in the case of consumption of thermal energy.

Valuation

No quantitative valuation was performed in the study but the various impact categories were compared in an implicit way since some of the potential impacts were highlighted on the behalf of the other impacts.

The majority of the emissions connected to light bulbs' life cycle was shown to arise from the consumption of electrical energy during use, and therefore the energy efficiency of the bulbs was regarded as the most important environmental characteristic of the bulbs.

Depletion of natural resources was discussed in connection with the use of different elements as raw material for light bulbs. The use of raw material per functional unit was shown to be largest for compact fluorescent light bulbs with magnetic control gear. Therefore, a table showing the different elements identified in compact fluorescent light bulbs was presented together with a scarcity index (reserves/production ratio). In that table, tin (from the EC Directive on pollution caused by certain dangerous substances discharged into the aquatic environment (76/319/EEC)) was shown to be the most scarce resource with an existing world supply of no more than twenty years.

Other potential impacts that were highlighted were as follows:

- Emission of dust particles to the air during the phase of pre-production due to mining activities.
- A relatively high Chemical Oxygen Demand (COD) due to release of organic matter to water during production of packaging material used in the distribution phase.
- Relatively high critical volumes of air and water emissions during the phases of pre-production and distribution due to releases during mining,

particularly of metals and releases during production of packaging materials.

A scarcity index of the various elements used in the bulbs is a good help for evaluating the potential depletion of natural resources but it should be combined with figures of consumption before being of any use. A high annual consumption of a less scarce element can easily be of higher environmental concern than a minimal consumption of a more scarce element.

This could have been expressed by a very simple formular like e.g.:

$$\text{Scarcity Index} = \frac{\text{exploitable reserves}}{\text{annual world consumption}}$$

3.3 Refrigerators and freezers

In this part the eco-labelling study of refrigerators and freezers is presented in detail.

3.3.1 Goal definition and scoping

Purpose of the study

In the report, the purpose of the study was described as developing criteria that might help to promote the development and employment of cooling appliances which, while complying with safety and performance requirements, have a reduced environmental impact. It was mentioned that the promotion of the criteria should be achieved by giving a clear and complete picture of the interactions that refrigerators and freezers have with the environment throughout their life cycle.

Product group definition

The product category of cooling appliances was initially defined as "refrigerators, refrigerators/freezers and freezers sold on the market". Subsequently, on the basis of a market analysis, the product category was redefined as: Refrigerators, refrigerators/freezers and freezers having the following characteristics:

- household applications,
- electrically powered,
- compressor refrigerating circuit,
- total net capacity ranging from 50 to 1,000 litres,

where the appliances either may be:

- upright or chest models,
- free-standing or built-in models,
- with one or more doors,
- with or without low temperature compartment,
- with or without Frost Free system.

It was emphasised that the following types of cooling appliances were excluded from the product category:

- Appliances for industrial, commercial and vehicle applications because of:
  - The great variety of types of appliances with respect to specific use.
  - The relatively low number of units sold.
  - The complexity involved in undertaking LCA.
  - The relatively little importance of the environmental issues directly connected to the particular performance requirements.

- Absorption-type appliances since they imply a different technology compared to the traditional compressor-type technology and therefore, cause different environmental effects.
- Appliances for special applications because of the relatively limited number of appliances within this group and since such appliances are often only used in short time periods (e.g. camping refrigerators).

It was mentioned that the excluded types of cooling appliances could be examined in separate ad hoc studies.

The defined product group was further divided into appliance classes where several appliance classes were introduced for various purposes.

With respect to the final eco-label criteria the following 12 appliance classes were defined:

01 Refrigerators without low temperature compartments.
02 Refrigerators with 1 star compartment.
03 Refrigerators with 2 stars compartment.
04 Refrigerators with 3 stars compartment.
05[9)] Regrigerators/freezers with double doors, 4 stars.
06 Refrigerators/freezers with double doors, 4 stars, No-Frost.
07 Refrigerators/freezers with more than two doors, 4 stars.
08 Regrigerators/freezers with more than two doors, 4 stars, No-Frost.
09 Upright freezers.
10 Upright freezers, No-Frost.
11 Chest freezers.
12 Chest freezers, No-Frost.

The "**star system**" was mentioned to be a conventional system indicating which temperatures can be reached and which cooling performances can be obtained by the cooling appliances.

The "No-Frost" system was mentioned to consist of a special design of the cooling appliance where the evaporator is positioned in a separate part of the cooling compartment(s) allowing cold air to recirculate inside the compartment(s). This permit a better temperature control and distribution in the compartment(s) as well as a lower humidity level. Moreover, it was stated that no defrosting operations are necessary during use of cooling appliances with No-Frost system. Therefore, No-Frost appliances were mentioned to be particularly useful for cooling appliances under:

- Intense use with frequent door opening rate.
- Climatic zones characterised by high temperature and/or high humidity level.

Originally, a slightly different classification was used, where the refrigerators with 1 and 2 star(s) compartment(s) were grouped in one class and the refrigerators with low temperature compartment and those with 0 star compartment were divided in separate groups. After the second peer review this classification was changed to the above shown classification. However, No-Frost appliances were still kept in separate classes, since their specific characters otherwise easily could be hidden by non-No-Frost appliances in the same class.

[9)] This class did also include those (very few) appliances with one door and an inner, separate, 4 stars compartment.

For the purpose of determining the material composition of the cooling appliances another sub-classification was used.

While performing the quantitative LCA, a grouping system based on "standard models" was in order to consider different "cases" in connection with the "standard models".

The many different classification groups or classes is confusing. This confusion was further emphasised since the structure of the report did not reflect or explain the many subgroups.

The reasoning for grouping No-Frost appliances in separate sub-categories appears reasonable while considering the expected increase in No-Frost appliances but this distinction between No-Frost and normal appliances is not kept up in the quantitative analysis, where the appliances are considered together just with the inclusion of a correction factor.

The term *"fitness for use"* was not used directly in the report. However it was used indirectly since a set of *preliminary conditions* (that were a number of EEC norms and regulations) was required.

The content of the above mentioned norms and regulations should have been described. It might also have been a good idea to include some more stringent requirements - not necessarily standardised norms - in order to profile the eco-label in a better way.

Scope and system boundaries

The following stages of production were considered: Extraction of raw materials, transformation of the raw materials into basic materials (steel, plastic etc.), transportation of the materials, processing of the basic materials to form appliance components and finally the assembling of the components. The CFC substitutes present merits and disadvantages from the point of view of appliances manufacturing process, functional performance and environmental behaviour. Therefore, the working group avoided to set specific criteria on them.

The distribution phase comprised transportation of the appliances from the manufacturer to the retailer and further on to the consumer as well as transportation of discarded appliances to waste disposal plants. Also, contributions from the packaging materials throughout the stages of production, distribution and use was included in the distribution phase.

During the use phase of the appliances, the following aspects were considered: Consumption of electrical energy, accidental loss of CFCs, CFC loss during maintenance operations and noise.

For the stage of disposal, the volume of solid waste, the amount of water and air pollutants as well as the consumption of energy and water (if any) were considered. There are some uncertainties as to which aspects are actually included in this item, e.g. it is not clear whether CFC and/or HCFC is included. In the cases of recycling of materials and heat energy produced by incineration, the obtained resources were subtracted from the respective figures of consumption. The impact of 3 different disposal methods of the discarded appliances including packaging were examined, namely straight dumping, dumping after removal of refrigerating fluid, dumping after removal of refrigerating fluid and recovery of recyclable parts. Furthermore, a 25%'s incineration of the waste otherwise ready for dumping was probably also included but this aspect was not quite clear.

Environmental fields

In the analysis the stages of production, distribution, use and disposal were considered. For each of these stages, the following aspects were mentioned to contribute to the environmental impact of cooling appliances:

- energy consumption,
- consumption of raw materials,
- water consumption,
- air emissions,
- water discharges,
- solid waste production and
- noise.

Considering the relatively high content of iron and sheet steel in cooling appliances impacts in connection with the preparation of these materials could have been considered relevant. Soil pollution/degradation and effects on eco systems have not been considered either.

Furthermore, no aspects of occupational health were considered despite the fact that many hazardous chemicals (lubricating oils, paints etc.) are used in the production phase of cooling appliances. The risks of accidents were considered in connection with some of the alternative refrigerating and foaming fluids.

Functional unit

No functional unit was directly defined in the study. Instead the various types of cooling appliances were compared on the basis of different cases of two defined "standard models". The standard models consisted of two defined cooling appliance models of different sizes (with or without freezer) but with fixed characteristics in terms of material percentage composition, weight and consumption of auxiliary resources (water, energy for production, methane for production).

Considering the many different models of cooling appliances existing on the market it appears like a quite significant simplification only to consider 2 standard models of cooling appliances. Significant differences exist in for instance the characteristics of chest freezers and upright freezers which may be overlooked when only using two standard models as a starting point for the analysis. A minimum of 4 standard models namely refrigerators, refrigerators/freezers, upright freezers and chest freezers, would have given a better picture of the very diversified market of cooling appliances.

Otherwise, a reduced number of the twelve appliance classes could have been used as standard models.

Also, the cooling capacity of the appliances could with advantage have been included.

Key features

A screening LCA or qualitative LCA was performed in order to reveal the various environmental characteristics of the different types of cooling appliances. Throughout the stages of production, distribution, use and disposal the various environmental aspects were discussed and the current state of the aspects was mentioned.

Especially the environmental problems connected to the use of CFCs and to a minor extent alternative refrigerating and foaming fluids were discussed with respect to the different life stages, and the production of CFCs was examined in details.

In connection with the phase of production a "mean percentage composition" was introduced. On the basis of the collected data, it was stated that little dif-

ference occurred in the minimum and maximum percentage compositions of the appliances (the biggest difference occurred for iron materials/cast with a minimum composition of 46.2% and a maximum of 66.5%) across the subcategories and therefore, a general mean percentage composition was calculated in order to represent all of the appliances. The mean percentage composition was used subsequently in the quantitative LCA.

Also, an average weight for two standard models was identified in the qualitative analysis. For the standard model with freezer compartment an average weight of 56.0 kg was calculated whereas for the smaller standard model without a freezer compartment a weight of 31.7 kg was used based on the average weight of the appliances in the category of "refrigerators with 2 doors and 1 compressor", see ***Table 3.1***.

In order to outline the "environmental features" of the various cooling appliance models the following parameters - or key features with the reservation that the parameters were selected *before* the inventory - were selected:

- Natural resources: consumption of virgin raw materials[10)]
  consumption of recycled materials,
  water consumption,
  energy consumption.
- Emissions to air: direct green house gases,
  indirect greenhouse gases,
  uncertain greenhouse gases,
  ozone depleting gases,
  acid equivalents,
  toxicity (critical volume).
- Emissions to water: chemical oxygen demand (COD),
  biological oxygen demand (BOD),
  toxicity (critical volume).
- Solid waste: mass generated.

In any case it is still a quite marked simplification to apply the same material composition percentage to the mentioned categories. More specific material composition values relating to for instance the 4 standard models as previously proposed would have been preferable.

The selection of environmental parameters before the inventory cannot be recommended since important aspects easily can be overlooked in the initial phase.

3.3.2 **Inventory analysis**

The inventory analysis was based on 11 different scenarios of the two standard models of cooling appliances. It was emphasised that the 11 scenarios of the standard models not necessarily were models existing on the market but that they were defined in order to represent the various types of cooling appliances on the market. The eleven scenarios of the two standard models (with or without freezer) of cooling appliances were defined combining 2 possible levels of energy consumption, 3 different refrigerating fluids, 4 different foaming agents and 3 alternative disposal methods.

It was mentioned that the final results of the analysis on the 11 scenarios were to be transferred to the 12 product categories for which the eco-label criteria were proposed.

[10)] A division between virgin and recycled materials was made beforehand.

By performing the quantitative analysis on scenarios and defining the scenarios the way they are, the analysis will automatically be focused on - or limited to - the aspects outlined in the case models. These are the aspects related to the refrigerants and the foaming fluids, the disposal method and to a certain degree to energy consumption.

Fixation

However, the fixation of some of the minor aspects, like for instance water consumption during production, exclude the possibilities of establishing criteria on these aspects which are of minor - but still measurable - importance.

All the other parameters of the scenarios such as material composition and consumption of auxiliary resources during production (water, methane, energy etc.) were kept constant having the values as defined for the standard models. The specific data on the material percentage composition and the weights of the two standard models (with or without freezer) are shown in ***Table 3.2***.

As for what is mentioned in the report, the mean percentage composition of the two defined standard models should fit with the weight-based values of the materials as given in ***Table 3.2***. This is obviously not the case but why the figures do not fit with each other and on which basis the weight-based figures then are derived is not clear.

Table 3.1
Case models for which the quantitative life cycle was performed.

	Standard size 1				*Standard size 2*				*size 2 "Green Frz."*
Dumping, total losses as follows:[1] *Refrig. fld.: 100% loss Foam. fld.: 100% loss*	A1		-	-	-	-	-	-	-
Dumping, total losses as follows:[1] *Refrig. fld.: 10% loss Foam. fld.: 100% loss*	A2	B1	B2	B3	C1	C2a	C2b	C2c	C3[2]
Dumping, recovery of materials, total losses as follows:[1] *Refrig. fld.: 10% loss Foam. fld.: 25% loss*	A3	-	-	-	-	-	-	-	-
Weight/kg	56.0181	56.0181			31.7124	31.7124			35.552
Volume/l	320	320			127	127			127
Refrigerator	yes	yes	yes	yes	yes	yes	yes	yes	yes
Freezer	yes	yes	yes	yes	no	no	no	no	no
Refrig. fluid	CFC-12	HFC-134a			CFC-12	HFC-134a			Propane / Butane
Foam. fluid	CFC-11	HFC	HFC	HCFC-mix[3]	CFC-11	HFC	HFC	HCFC-mix[3]	Pentane
Energy con.(total)/kWh	5677	6250	5677	5677	2810	3090	2810	2810	3300

1) The values of total losses were calculated on the basis of the raw data sheets in the back.
2) For the "Green Freezer" (9%) of the refrigerating fluid butane were assumed lost during the use phase and the remaining butane was assumed removed without any loss in the disposal phase. For the foaming fluid pentane 4% loss of pentane was assumed during the production phase and 0.5% of the pentane in the foamwaste was assumed lost during the phase of disposal.
3) The HCFC-mix consists of a mixture of HCFC-142 and HCFC-22 (the exact composition was not mentioned).

Table 3.2
Material and weight composition of the two defined standard models.

	Mean composition in %*	*Standard size 1 (320 l, + freezer) in kg*	*Standard size 2 (127 l, no freezer) in kg*
Thermo plastic	1	0.9	0.5
Expanded polyurethane	10	7	2.1
Polycarbonate (ABS)	2.4	3.5	0.3
Expanded polystyrene	12.9	6.3	5.8
Polyvinylchloride	1.7	0.54	0.5
Copper	2.5	0.1	1.1
Iron and sheet steel (60% recyc.)	60.5	35	17.8
Aluminium (virgin)	3	-	0.6
Aluminium (100% recyc.)			0.7
Glass (56% recyc.)	1.6	1.4	1.4
Oil	0.6	0.22	0.3
Paint	0.9	0.5	0.33
Total (exc. refrig./foam. fluid)	97.3	55.46	31.43
Mat. consumption - relative/%	-	100	100
Refrig. fluid (alternating)	0.3	CFC: 0.1561 HFC: 0.1561	CFC: 0.1115 HFC: 0.1115 But./(Prop.): 0.022
Foam. fluid (alternating)	0.5	CFC: 0.402 HFC: 0.402 HCFC-mix: 0.402	CFC: 0.1709 HFC: 0.1709 HCFC-mix: 0.1709 Pentane: ?
Total	98.1	56.0181	31.7124

* Somehow the percentages for material composition do not fit with the weight-based values for the standard models as indicated in the table. No explanation can be given for this discrepancy.

Process flow-chart

Three process flow-charts were included in the report, depicting the production of CFC-12, the production of a specific cooling appliance model and the stage of disposal of discarded appliances. None of the included flow charts were commented in the report.

Allocation procedures

In the present study on cooling appliances not much attention was paid to allocation procedures. There are several reasons for that. The study of cooling appliances was general, therefore the use of scenarios evolved on the basis of aggregated and standardised data can not reveal information concerning allocation procedures. When the data are aggregated there should have been aggregated data that deal with allocation procedures as well. However, that sort of information may be difficult to obtain as general information. Further, the proposed criteria did not cover the appliance procedure and thereby difficulties in the assessment procedure including allocation procedures were not revealed.

Inventory data

In general, little information was given about the used data and the below mentioned information is for the most part derived from the raw data tables in the back of the first part of the report.

The data background for many of the used data is not clear and in general, the data are not very transparent. Furthermore, it might be of significant importance that the data used for the inventory analysis are not taken from the same source (or at least not directly from the same source) as the data on which the threshold levels for the criteria are based. Differences in for instance the age of the data, measuring methods, data collection procedures etc. might result in selection of biased data and thereby in the establishment of biased threshold levels.

The data sources are among others the European manufacturers (mainly Italian manufacturers), BUWAL/FOEFL (Swiss Federal Office of Environment, Forests and Landscape) (19), Life-Cycle Analysis of selected Packaging Materials - Quantification of Environmental Loadings, Chalmers Industriteknik (20) and "European Eco-label - Project for Application to Paints and varnishes" (8).

In order to establish specific threshold levels for the proposed eco-label criteria, data from various existing databases on cooling appliances were used while forming a new mixed reference database.

The comments related to the quality of the selected data will be discussed in the section dealing with the data quality aspects.

3.3.3 **Impact assessment**

Classification

No real classification was performed but a form of impact classification was already made via the various parameters selected in order to outline the "environmental features" of the cooling models. Accordingly, the impacts of cooling appliances throughout their life cycle were indirectly classified in the following categories:

- ozone depletion,
- global warming,
- acid deposition,
- water quality,
- air quality,
- depletion of natural resources and
- generation of solid waste.

As previously mentioned, few impact categories are actually included in the study. Especially the impact categories of soil pollution/degradation and effects on eco-systems could with advantage have been included.

Characterisation

The various impacts were aggregated and quantified within each of the identified impact categories. The identified categories were ozone depletion, global warming, acid deposition, toxicity to man and resource consumption.

The ozone depletion was expressed in Ozone Depletion Potentials (ODP) relative to CFC-11 per life cycle of the case model, included figures for CFC-11, CFC-12, CFC-113, CFC-114, CFC-115, Halon-1211, Halon-1301, Halon 2401, HFCs (=0), HCFC-22, HCFC-123, HCFC-124, HCFC-124b, HCFC-142b, CCl_4 (tetrachloromethane) and $C_2H_3Cl_3$ (1,1,1-tri-chloro-ethane)[11].

The global warming was expressed in CO_2-equivalents per life cycle of the case model as direct Global Warming Potential (direct GWP, included figures for emissions of CO_2, CH_4, N_2O, CFC-11, CFC-12, HCFC-22 and HCFC-134a), indirect GWP and uncertain GWP (included CO, NO_x, HCFC-

[11]) It was not mentioned which source the ODP values were taken from.

123, HCFC-124, HCFC-124b, and HCFC-142b) and summed up as Total Equivalent Warming Impact (TEWI)[12)13)].

The indirect GWPs - as well as the uncertain GWPs - are connected with large uncertanties and therefore, IPCC does not recommend using them. Furthermore, negative indirect GWPs also exist and if the "positive" indirect GWPs are included in the analysis, the negative indirect GWPs ought to be included as well.

The acid deposition was expressed as Acid Equivalent factors (AE factors grams of H^+-ions divided by the equivalent molecular weight per life cycle of the case model, figures NH_3, NO_2, SO_2 and HCl were included[14)].

Toxicity to man was divided in one part dealing with air and another dealing with water. Concerning air, the toxicity to man was expressed as critical volumes of air per life cycle of the case model (1 scenario). The emissions were related to Swiss and German MIK standards and, when no MIK standards existed, they were estimated on the basis of MAK standards. The standards were taken from the BUWAL database and included figures for the same components as in the BUWAL database.

Concerning water, the toxicity to man was expressed as critical volume of water per life cycle of the case model (1 scenario). The emissions to water were related to Swiss threshold limit values for discharges to recipients and included figures for the components as in the BUWAL database.

The consumption resources was focusing on the consumption of electrical energy. This was aggregated while assuming a conversion factor of 33%. The electricity conversion factors were taken from the BUWAL database.

Valuation

No quantitative valuation was performed. Instead the identified environmental impacts were qualitatively evaluated. The various impacts were assigned a rating where the ratings of "moderate" or "important" were used. Only two of the identified impacts were assigned the rating "important", namely the impact of air emissions - caused by electrical energy consumption - and the impact of CFC discharges during the life stage of disposal, see ***Table 3.3***.

In connection with energy consumption, it was emphasised that about 80% of the total air impact during the use phase were attributed to emissions related to production of electrical energy. Especially with respect to the total potential of global warming (TEWI) and acid deposition, the consumption of electrical energy was the main contributor to these impacts.

The discharges of CFCs used as refrigerating and foaming fluids were also pointed out as being of great importance in connection with the total en-

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12) The direct and the indirect GWPs were taken from the Intemational Panel on Global Warming (IPCC, 1992) reflecting a 100 year scale. The uncertain GWPs were taken from *(RIVM, 1991)*.

13) It is not clear which gases - nor which potentials - that are considered to be the indirect GWPs. A list is included in the report but it only indicates whether the different gases show sign of indirect GWP without presenting any values.

14) It was not mentioned where the concept of AEs was taken from. Normally, it is NO_X that is considered while quantifying the potential of acid deposition. It is not clear whether NO - assuming previous oxidation - actually was included in the figures for NO_2. Hydrogen flouride is often considered as contributing to acid deposition, too.

vironmental impact of cooling appliances. By substituting CFCs with alternative fluids having lower ODPs or ODPs of 0, marked reductions of up to 96% of the ozone depletion potential and 30% of the global warming potential could be obtained. Furthermore, removal of CFCs from the discarded appliances would reduce the potential for ozone depletion with 25% and the total potential of global warming with 18% during the phase of disposal.

As regards the use of alternative refrigerating and foaming fluids, little differences occurred in the analysis among the case models and considering the many open questions on some of the fluids, it was stated that none of the fluids could be said to have a distinct better environmental performance than the others.

Table 3.3
Relative importance attributed to the various environmental impacts identified in the life cycle of the case models of cooling appliances.

Stage of life cycle	*Impact*	*Degree*
Production	water discharges	moderate
	air emissions	moderate
	solid waste	moderate
	discharges of CFCs	moderate
Distribution	transport associated emissions	moderate
	packaging associated emissions	moderate
Use	air emissions measured as consumption of electrical energy	important
	discharges of CFCs	moderate
	noise	moderate
Disposal	solid waste	moderate
	discharges of CFCs	important

3.4 **Soil improvers**

In this part of the eco-labelling study soil improvers are presented in detail.

3.4.1 **Goal definition and scoping**

In this section a discussion of the goal definition and scoping in the soil improver study is presented.

Purpose of the study

The purpose of the LCA study was to identify which features of the soil improvers have a significant effect on the environment and to determine at which stages in the life cycle they occur and by that establish proposals for criteria for the award of an eco-label to soil improver material offered for sale as branded products.

A number of specific issues are encountered with other product groups. The most specific of these is to take into consideration the specific provisions of the Community waste management strategy.

Fitness for use

No accepted measures of the performance of soil improvers exist. It was therefore mentioned, that the performance of soil improvers can only be

judged in the context of the ground they are used upon and the skill of the gardener.

However, it was stated that the ability of soil improvers to better the physical structure of the soil generally is associated with a number of effects. These are soil crumb formation, structural stability, buffering capacity, storage capacity, textural modifiers and bulking agents. These effects were all mentioned to be related to a minimum content of bulky organic matter in the soil improvers.

In the case of prolonged application or over-application of some soil improvers it was mentioned that they may have an adverse impact on health, safety and environment rendering the soil improver unfit for the purpose of use. This is due to the fact that some soil improvers are based on waste-derived materials potentially containing components like toxic elements (e.g. heavy metals), organic chemicals (e.g. pesticide residues), non-putrescible elements (e.g. plastic contaminants), nutrients in abundance and nuisance dust.

Thus, inexpedient application of some soil improvers may lead to (soil) contamination of the above mentioned components and it was therefore emphasised that the fitness for use aspect of soil improvers was closely interwound with the environmental performance of the soil improvers during use.

Because of this coherence between the fitness for use and the environmental performance of soil improvers, the aspect of fitness for use was considered as being an integrated part of the eco-label criteria and as such dealt with in the eco-label criteria. The fitness for use criteria were dealing with aspects like general labelling requirements, product performance, soil degradation and water pollution, health and safety and nuisance.

It can be argued that the presence of heavy metals or other undesired components in some waste-based soil improvers do rarely influence the immediate performance of the soil improvers; such components do rather have an impact on the long term perspective. Instead, the immediate performance of soil improvers is directly dependent on the content of bulky organic matter as stated in the report. Therefore, it could have been advanta-geous only to consider the content of bulky organic matter in the fitness for use criteria and to deal with the other aspects under the eco-label criteria.

Environmental fields

As already outlined in the definition of the soil improver product group, the study was only dealing with branded soil improvers which for the most part excluded soil improvers used in the professional sector since they are rather purchased in bulk than as branded products.

In the report emphasise was put on processing routes of the major constituents - mainly organic bulk matter - in the soil improvers whereas potential impacts of the minor constituents like synthetic and/or inorganic materials were not considered. Two major processing routes of the organic matter in the soil improvers were identified and the study was limited to examine potential impacts connected to these two major routes. The two major processing routes were the processing route of natural deposit-based materials and the processing route of waste-based materials, where the latter was further sub-divided in three distinct waste-based processing routes.

The life stages of production, distribution and use were considered in connection to the major processing routes. For the included life stages potential impacts were examined in the areas prescribed in the EC Eco-Labelling Directive. These impacts are waste, soil pollution and degradation, water con-

tamination, air contamination, noise, consumption of energy, consumption of natural resources and effects on eco-systems.

The remaining two life stages - namely pre-production and disposal - were excluded on the basis of a number of considerations:

Pre-production:
Natural deposit-based materials:
The processes were considered as being the natural processes in which the deposits were created and laid down and as such, out of the scope of environmental impacts related to mans activities.

Waste-based materials:
The processes considered were the upstream processes generating the waste. These processes were excluded since:

- It would arise insurmountable practical difficulties to describe all the processes that potentially could be actual and therefore, to operate the eco-label scheme.
- Many of the potential environmental problems associated with these upstream waste processes arise primarily from the waste itself. By using the waste as raw material for soil improvers, these problems are eliminated or diminished.

Disposal:
For materials processed by either of the two major processing routes the phase of disposal was judged to be without relevance since the soil improvers are being consumed during the use phase.

The above mentioned areas are only indicative since all of the environmental fields were mentioned in the report but often just stated as being without relevance or significance with respect to soil improvers without presenting any arguments.

In other studies the pre-production phase is normally regarded as being the phase in which the raw materials are extracted and processed i.e. including all the processes until the actual production of the product. Thus, for the processing route of natural deposit-based materials the phase of pre-production could with advantage have been included.

For the waste-based processing routes the arguments for exclusion of the pre-production phase appear reasonable as long as transportation of the waste to the production site and potential waste segregation are considered, which is the case.

The exclusion of the waste aspect in connection to the use phase is questionable since any potential residues (heavy metals, resistant compounds etc.) of the soil improvers in the soil can be considered as being a waste product of the soil improvers. In that case, the residues should be regarded as any other in- and output in connection to the soil improvers life cycle and not only dealt with as a fitness for use aspect.

Few aspects of occupational health and no aspects of potential risks of major accidents were considered.

Functional unit

No functional unit was defined in the report and the concept was not discussed. However, in the impact assessment the consumption of energy was calculated per tonne produced soil improver meaning that the mass of produced

soil improver for each processing route was used as a basis of comparison and therefore, implicitly as a functional unit.

It is questionable whether the mass of produced soil improver constitutes an equal basis of comparisons since - as mentioned in the report - the performance of a soil improver during use rather is dependent on the content of bulky organic matter than on the total mass of soil improver. The degree of putrefaction of the organic matter used in the soil improver or the ratio between the organic matter and the bulky matter content could determine whether the mass is an equal basis of comparison.

Key features

A screening LCA was performed using the term "life cycle overview". No key features were selected, instead the life stages of relevance for the environmental performance of soil improvers were selected for the detailed LCA. Thus, the various life stages were looked over and the reasoning for excluding the phases of pre-production and disposal was mentioned. Furthermore, the coherence between the fitness for use aspect and the environmental performance of soil improvers were discussed.

The screening LCA was based on processing routes of the soil improver constituents rather than on the constituents themselves. There were a number of reasons for this. Some of the reasons were:

- An almost infinite range of materials of organic origin can potentially be used as raw materials for soil improvers raising practical problems in order to operate the eco-label.
- Common processes may have common impacts regardless of the type of organic material processed for the soil improvers.
- All soil improvers can easily be separated into two major processing or production routes, namely a processing route of natural deposit-based soil improvers and a processing route of waste-based soil improvers.

The waste-based processing route was further divided into two broad process routes, on which the analysis was based.

Process route of natural deposit-based soil improvers:

1: Products based on constituents extracted from natural deposits with minimum processing, e.g. peat.

Process routes of waste-based soil improvers:

2. Products based on waste which has been anaerobically digested followed by aerobic composting e.g. animal manure.
3: Products based on waste from gardens, e.g. leaves.
4: Products based on wastes which is graded only e.g. coir.

Furthermore, a qualitative description of the processing routes was given summarising the various processes connected to each route throughout the different life stages. Parallel to the summary a list of key words was included highlighting the various processes within the processing routes.

It was emphasised that many of the branded soil improvers are composed of mixtures of the above mentioned processing routes, but in most cases a single material, processed following a single processing route, makes it up as a dominant constituent.

The idea of using processing routes seems good considering the almost infinite diverse range of materials of organic origin that potentially can be used in the production of soil improvers though it might cause some operational problems in terms of how to allocate the identified emissions of the process-

ing routes to the final soil improver products. The majority of the soil improvers is composed of mixtures of materials from the different processing routes and can therefore not directly be related to the emissions of the separate processing routes.

3.5 Comparison of three different life cycles analysis

It has been shown that many differences between the studies occur when we get into details. In this part some of the main differences within special selected areas will be discussed. The structure of this part will be the same as in the parts concerning specific studies.

3.5.1 Goal definition and scoping

Purpose of the studies

While being aware that it is a very difficult task to compare the purpose of different studies, it is, however, very important that the same sort of thoughts are made in the initial phases.

Concerning the purposes of the studies it has been revealed that there are some variations. In the study of light bulbs it was explained that the purpose of the study was to catalogue and sum potential adverse effects on the environment of the light bulbs in order to provide an objective appraisal of the environmental impact of the light bulbs and to facilitate comparison between the different light bulbs within the same product category. In the study of cooling appliances it was mentioned that the purpose of the study was to promote the development and employment of cooling appliances which, while complying with safety and performance requirements, have a reduced environmental impact. Further, it was mentioned that the promotion of the criteria should be achieved by giving a clear and complete picture of the interactions that refrigerators and freezers have with the environment throughout their life cycle. Finally, in the study of soil improvers it was mentioned, that the purpose of the LCA study was to identify which features of the soil improvers that have a significant effect on the environment and to determine at which stages in the life cycle they occur.

On this basis it seems obvious that besides the common purpose of establishing proposals for eco-labelling criteria for the specific product group there is a great level of variation in the details and also in what seems to be the most important aspect in the selection and establishing of criteria. E.g. in some studies it is mentioned that the purpose is to promote the production of cleaner products while the focus in other studies is placed on how the comparison of different products within the same product group can be done.

Product group definition

The way the definition of the product groups is handled in the studies is very different. In the study of light bulbs, the definition of the product is specified very much with respect to the outfit of the product while aspects concerning the identity of the consumers is toned down. In fact, this procedure leads to a very narrow rank of products which exclude many types of products. In the study of refrigerators and freezers a number of divisions leading to a very large rank of specified product types is introduced. This approach does not seem to be very visionairy since it illustrates the status quo of the products very well but it does not reveal specific advantages or disadvantages of the products. In fact, except in a very few special cases this does not lead to exclusions of a number of product types. It rather leads to generalisations that simplifies the work on criteria. In the study of soil improvers the starting point is a mixture between a general definition based on the technical performance of the products and at the same time a demand saying that the products shall be branded. This approach is at the same time broad because of

the definition based on the function of the product and narrow because of the demand on branded products.

In the regulation it is a prerequisite that the criteria deal with existing products. In practise this demand leads to some exclusion of new not very settled products at the market. This is especially obvious in the case of refrigerators/freezers and in the case of soil improvers, while it seems to be less limiting in the case of light bulbs.

Scope and system boundaries

The investigation on how the scope and system boundaries have been set, revealed some variations, too.

In this part, the three different approaches to life cycle studies will be compared in order to illustrate which parts of the life cycle phases that have been included in the considerations.

As can be seen from the overview matrix, ***Table 3.4*** three of the fields from the indicative matrix have not been considered at all or only to a very limited extent in the three studies investigated in the Prestudy. These are a) soil pollution and degradation, b) noise and c) effects on eco-systems. Waste relevance has only been considered to a minor extent. In the study on light bulbs, most emphasis is put on consumption of resources and energy, and emissions related to energy consumption, all other environmental matters are considered of minor importance.

On the basis of the first three studies it can be observed that the LCA centres the work on certain contributions to the environment no matter what the product group is. Cooling appliances, soil improvers and light bulbs are very different groups of products and therefore one would have expected a more varying picture of which part of the life cycle that is contributing mostly to the environmental impact than what this screening of the studies has shown. In the next part this shall be further investigated.

Table 3.4
A matrix showing the areas considered in the LCA of the light bulbs, refrigerators and freezers and soil improvers.

phases / *fields*	*Pre-prod.*	*Prod.*	*Distri. includ. Pack.*	*Use*	*Disposal*
Waste relevance	(a), (b)	(a), (b), (c)	(a), (b), (c)	(a), (b)	(a), (b)
Soil pollution and degradation					
Water contamination	a, b	a, b, c	a, b, (c)	a, b	a, b
Air contamination	a, b	a, b, (c)	a, b, (c)	a, b	a, b
Noise		(c)	(c)	(b)	
Consumption of energy	a, b	a, b, c	a, b, c	a, b	a, b
Consumption of resources	a, b	a, b, c	a, b	a, b	a, b
Effects on eco-systems		c			

Pre-Prod. = Pre-Production
Prod. = Production
Distri. includ. Pack. = Distribution including Packaging
a = Considered in the LCA of light bulbs
(a) = Only briefly considered in the LCA of light bulbs
b = Considered in the LCA of cooling appliances
(b) = Only briefly considered in the LCA of cooling appliances
c = Considered in the LCA of soil improvers
(c) = Only briefly considered in the LCA of soil improvers

Environmental fields

In principle, non of the studies exclude themselves from any specific fields. Some of these aspects are already discussed in the section above dealing with scope and system boundaries. In this section only the main issues will be drawn out. Especially, the focus will be put on issues that are horizontally orientated.

In short, the consumption of resources and energy (ressources), the waste relevance and the contamination of air and water which to some extent are derivates of the consumption of ressources are the most investigated parts of the studies. In fact, in one of the studies only the consumption of energy and ressources has been considered thoroughly. The soil pollution and degradation, noise and effects on eco-systems do not seem to be investigated at all in any of the studies.

The aspect of packaging is not dealt with in any of the LCA approaches. In stead, criteria for packaging materials are set up on different basis. E.g. in the light bulb study criteria for packaging are suggested, but no life-cycle analysis on packaging[15)] is carried out. While in the two other studies the aspects on packaging are ignored.

In one of the studies, the study of light bulb, it is argued, that experience has shown that the potential impacts arising from construction of plants and tools, the development of infrastructure and needs of the workers only to a minor extent contribute to the total potential impact of a product and therefore these factors are excluded from the study. In the other studies no attention is paid to these aspects.

Generally, aspects relating to occupational health or risk of accidents are not considered in the LCA. This is especially conspicuous in the study on cooling appliances since many hazardous chemicals (lubricating oils, paints etc.) are used in the production phase. The risks of accidents were considered in connection with some of the alternative refrigerating and foaming fluids.

Functional unit

In any international contexts it is generally recognised that the definition of a functional unit is necessary when it comes to the comparison of different products. Therefore, it is interesting to note that in two of three studies, no functional unit has been defined.

In the study of light bulbs, a functional unit, although this can be criticised, was defined. In the study of soil improvers no functional unit was defined and the concept was not discussed. However, in the impact assessment some comparisons were made on the basis of one tonne produced soil improver. In the study of cooling appliances no functional unit was defined either. The matter was briefly touched and the comparison between different products was done by comparing two defined standard models. By defining standard models, the analysis in the study is very limited since most of the in- and output is kept constant while only a few key features, which are selected beforehand, differ from one product to another.

Establishing of key features

The way of handling the establishing of key features is similar in the studies of light bulbs and cooling appliances, while the approach is different in the study of soil improvers.

[15)] At the time (1992) there was an Italian study on eco-labelling of packaging (21) going on. The criteria are preliminary and that the results of the Italian study are awaited.

In the study of light bulbs and the study of cooling appliances environmental indicators and environmental features were selected. In both cases, however, this was done before the inventory. This is a very prejudiced way of handling an LCA whether it is meant as a *screening* or not. In the study of soil improver more care was taken to the screening LCA. However the screening LCA was carried out on the basis of qualitative process routes.

In the LCA of light bulbs and refrigerators/freezers, not only the approach but also the appointed key features are similar. In the light bulb study the environmental indicators were used as parameters for the analysis and indicated the direction of focus for the analysis. In this matter, the environmental indicators can be interpreted as being equivalent to "key features".

In the light bulb study the following environmental indicators were selected:

- Natural resources: energy used,
  mass used,
  scarcity index of elements used.
- Emissions to air: particulate matter ,
  greenhouse gases,
  acid forming gases,
  critical volume.
- Emissions to water: chemical oxygen demand (COD) ,
  suspended matter,
  critical volume.
- Solid waste: mass generated.

The critical volumes of water and air were employed as indicators of toxicity to man and were mentioned to be based on emission loadings to air and water normalised after the toxicity standard of ”MAK”.

In the study of cooling appliances the ”environmental features” were selected:

- Natural resources: consumption of virgin raw materials,
  consumption of recycled materials,
  water consumption,
  energy consumption.
- Emissions to air: direct green house gases,
  indirect greenhouse gases,
  uncertain greenhouse gases,
  ozone depleting gases,
  acid equivalents,
  toxicity (critical volume).
- Emissions to water: chemical oxygen demand (COD),
  biological oxygen demand (BOD),
  toxicity (critical volume).
- Solid waste: mass generated.

The critical volume approach was used in the case of cooling appliances as well.

Process flow charts

In all three studies, process flow charts were included and in all three studies the information that could be obtained from the flow charts were either very limited or it was not used. In one of the cases, cooling appliances, the flow charts were not made on the product but on the auxilary products. Anyway, the most common experience obtained from the studies is that the information that could have been obtained from flow charts is not revealed.

Allocation procedures

In the present studies much attention was not paid to allocation procedures. The studies were in some way general, e.g. the used flow charts did not include connection to public plants neither did they mention that several production chains could take place at the same factory. When those aspects are not considered carefully they can not be incorporated as a natural part of the study.

The comments of the general approach that has been used in the three studies also applies for the proposed criteria. In all three cases the criteria did not cover the appliance procedure, and thereby difficulties in the assessment procedure including allocation procedures were not revealed.

Inventory data

Concerning the inventory data it seems to be common but unfortunate that the data are mixed with aggregated data that could have been presented in the classification in the impact assessment. That has been the case in the study of light bulbs, soil improvers and cooling appliances. The data that have been depicted are in most cases presented as data that are most suitable for the purpose. Since specific data for the investigated products has not been collected. The data come from more or less common data bases. That may be the reason why the data sometimes seem very untransparent and in general too many tables have just been tranferred from other reports without having been given much thought. It is understandable and acceptable to include data depicted from different sources. However, when this is done it must be discussed and justified.

Classification

No real classification was made in any of the studies. In two of the three studies, the light bulb study and the cooling appliances study, some classifications were made although indirectly since the "environmental indicators" and the "environmental features" constitute a form of classification. However, some areas were without reasoning left out of the classification, e.g. ozone depletion, terrestical ecology. In the study of soil improvers neither classification nor characterisation was done.

Characterisation

As already mentioned characterisation was not made at all in the study of soil improvers. In the study of light bulbs special attention was given to global warming, acid deposition and toxicity to man (air and water). In the study of soil improvers special attention was given to global warming, ozone depletion and toxicity to man (air and water). Further, in the light bulbs and cooling appliances studies some focus was also put on resource consumption. The global warming was in both studies expressed in terms of CO_2-equivalents, ozone depletion was expressed as ODP relative to CFC-11, acid depletion was expressed in SO_2-equivalents. In both studies toxicity to man is expressed in terms of a critical volume approach. In both cases the BUWAL study and a mixture of German and Swiss MAK (and sometimes MIK) values was used. In generel, consumption of resources was not paid much attention in any of the studies.

Valuation

The valuation was performed differently in each of the studies. In the light bulb study the valuation was performed primarily on the basis of a scarcity index. There was, as mentioned in the section concerning the impact assessment on light bulbs, not paid any attention to the actual consumption per year of a certain resource but only to how scarce the resource is considered to be. In the soil improver study some ranking systems based on qualitative thougths were made. The ranking categories were: no-, low-, medium- or high significance and were based on the qualitative data collected on soil improvers. In the study of cooling appliances some rating was used, too. Only two aspects were identified as important, the rest of the aspects were identified as moderate.

3.6 **Conclusion of the Prestudy**

The Prestudy shows a wide range of methodological approaches for what is seen as equal starting points for solving parallel tasks at first sight. The different outcome cannot just be seen as different ways of handling the problems concerned. It is also a matter of different product groups which requires different methodological solutions. However, in order to ensure a harmonised proces of criteria development it is advantageous to use same methodlogy. In the following chapters the remaining product groups will be analysed differently in order to be able to identify the links between criteria and background reports.

4 Comparison with other selected studies

In this chapter the choices taken in other 9 studies will be described shortly in order to reveal similarities and dissimilarities in the chosen LCA approach.

In chapter 3 ”Methodological aspects from the Prestudy” many LCA methodological aspects were highligted. Since the studies were prepared in the early 1990´ies the impact assessment methodology within LCA were not very developed. This has not necessarily led to wrong conclusions but the impact assessment framework at that time (medio ’90) is not comparable with todays impact assessment framework. However, the goal and scoping was much more developed within LCA. In chapter 4 ”Comparison with other selected studies” the focus naturally will be on the most eco-labelling relevant part of goal and scoping. In chapter 5 ”Methodological aspects analysed on the basis of the adopted criteria ” the studies are analysed though the criteria and thereby the result of the impact assessment will be emphasised.

On the basis of chapter 3 ”Methodological aspects from the Prestudy” and in order to structure the reporting 5 areas are depicted. These are:

- fitness for use,
- functional unit,
- purpose of study,
- product group definition,
- methods for identification of environmental key features.

4.1 **Fitness for use**

The handling of fitness for use varies from study to study. However, even though it has not been mentioned by name in the three studies of the Prestudy it has not been neglected in any of the studies. On the basis of the Prestudy it seems to be very common to identify allready existing standards which, if they are met, can be a measure for the fitness for use of the products in question.

In the Prestudy it has been looked upon how the fitness for use has been handled. In the text to follow the handling of fitness for use in other investigated studies is presented.

In the study of *detergents* it is stated that "Detergents are highly competitive products on the market. The dosage recommendation is one of the key criteria and weighted strongly by a weighting factor....."[16]. Furthermore a washing performance test is proposed as a measure for how fit the product is for its purpose.

In the study of *hairsprays* (December 1992, p. VI-15) many considerations concerning fitness for use of hairsprays are presented. The overall goal of these thoughts can be illustrated by the following text "All products qualifying for eco-labels must be fit for use. Unfit eco-labelled products, however

[16] This has later proved to be true.

environmentally benign, would not be particularly useful and would damage the credibility of the programme". However, this subject is further elaborated and it is stated, that a standard does not exist to be used with respect to the performance of hairsprays at present. The authors to the report therefore propose some kind of test that includes testing for "holding power, duration of hold, drying time, ease of brushout and degree of removal by shampooing" (proposed by French experts). It is further mentioned that the testing should be performed by two experts nominated by the manufacturers of hairsprays in each member state and that no two experts of a member state should come from the same company.

In the study of *packaging* (June 1992) aspects concerning fitness for use is not considered nor mentioned. The study is still to be finished.

As a result of the study of *paints and varnishes* a set of criteria of fitness for use is placed. The fitness for use criteria for paints deal with the hiding power of the paint in question. The fulfilment of the criteria is proved by compliance with an ISO standard. The fulfilment of the criteria is proved by compliance with another ISO standard. As in the study of hairsprays many considerations were made in the light of correlation between environment and performance. In this case it is obvious that if the paints do not hide or if the varnishes are not resistant it implies a larger consumption of the product and this could imply a larger burden to the environment.

In the study of *paper products* the issue of fitness for use is dealt with only in an indirect manner. However done in an indirect way, the subject of fitness for use is touched upon in more parts of the report (Miljøprojekt nr. 179, 1991, p. 15, 29, 40-41), and later in the progress of the development of criteria it was decided that the weight and the quality of the product is correlated positively. This means the higher content of fibres pr. ton product the higher quality. In the first study the fitness for use issue is discussed in connection with matters like "the grammage effect" (p. 15), "the quality aspect" (p. 15) and "paper in comparison with other materials" and "paper in combination with other materials". However, mentioned several times, it is not done in a proper way in the first report but considerations were made later. Later research in the study of paper upon fitness for use showed, that the subject happened to be treated in a correct way, firstly. Further, for the tissue products a sort of correction factor for the absorption of liquid was added in order to take into account the fitness for use. The factor was developed by the industry.

In the study of *thermal insulation* fitness for use was, however not exhaustive, considered carefully (23, p. 18). The considerations are primarily centered on the thermal performance respectively the thermal properties and the thermal conductivity. As a consequence of this fact a criterion is settled with the purpose of a minimum requirement on the thermal performance. This has to be proved by compliance with an ISO standard. No criteria are settled with respect to the applicability of the different thermal insulation products placed at the marketplace.

In the study of *textiles* (March 1994, p.55) the aspect of fitness for use is taken care of in the setting of criteria. In the criteria a number ISO standards which the product has to meet are mentioned. These standards deal in general with matters like mechanical and physical properties, colour fastness and for T-shirts a spirality test as well.

In the study of *washing machines* (August 1992) fitness for use is touched several times. As a conclusion to these discussions it was decided to set a

performance criteria. The performance criteria deal with the machines' ability to wash. The criteria are to meet the requirements of a certain test method in order to prove that the machines are able to wash. The standard is a national standard since an international standard does not exist.

4.1.1 **Discussion of fitness for use**

The discussion presented below is divided into four main areas. These areas are if the fitness for use is defined at all (and how) in the studies: if the proposed demand of fitness for use is relevant, if there is a correllation between the defined fitness for use and the environmental performance of the products and if the fitness for use demand is based on the results obtained from the LCA study.

In all the investigated studies but packaging fitness for use is considered. This does not only mean, that the subject has been considered but also that demands are proposed in all studies except packaging. In many of the studies the criteria concerning fitness for use is based on some sort of (international) standard. This is the case for light bulbs, refrigerators and freezers, detergents, paints and varnishes, thermal insulation, textiles and washing machines. The proposed standards are international recognised in all studies but the study of washing machines. The standard proposed for washing machines is national. In the study of light bulbs criteria that are not based on standardisation are proposed as well. For soil improvers, hairsprays and paper no standards are mentioned, but the matter is handled in different ways. For soil improvers a number of fitness for use demands have to be met, for hairsprays an expert panel is proposed and in the case of paper the problem is solved by the use of the functional unit and if relevant a correction factor.

The considerations concerning fitness for use is on the one hand manyfold while on the other hand not always brought into effect in a useful way. In many cases this is because it is a difficult task. In the case of light bulbs it would have been useful to propose a criterion concerning the provision of light for the purpose of use throughout a minimum time period. In the case of soil improvers it would have been useful to propose a fitness for use criterion concerning the content of bulky material. For thermal insulation the life time of the product would have been relevant. The life time of the product was considered thoroughly but an international recognised standard did not exist.

In more of the studies it is identified that there is a positive correlation between the reduced environmental burdens and the (quality of) fitness for use performance of the products. This is the case of light bulbs, refrigerators and freezers, detergents, packaging, paints and varnishes, thermal insulation and washing machines.

The correlation between the environmental aspects and fitness for use is only identified through the use of LCA in very few studies. Even though this aspect is mentioned in more reports this is then caused by the imagination of the authors. In fact the correlation is only identified through figures in the study of detergents, hairsprays (partly) and paints and varnishes. In the study of soil improvers the exclusion of the waste aspect in connection to the use phase is questionable since any potential residues (heavy metals, resistant compounds etc.) of the soil improvers can be considered as being a waste product, e.g. contributing to soil pollution one of the impacts not dealt with in the LCA. In that case, the residues should be regarded as any other in- and output in connection to the soil improvers life cycle and not only dealt with as a fitness for use aspect.

The limited use of LCA means that even though the results are reliable, they are not actually proved in the studies. This is really a pitty since one of the very basic ideas of the LCA is to challenge dogmas and thereby verify these or the reject them. Thus, the reason for focusing on fitness for use is the credibility of the label, e.g. a bad functioning eco-labelled product could lead to credibility problems to the label in general.

4.2 **The functional unit**

The functional unit is the key measure of environmental performance which the system that is investigated delivers. It has to be clearly defined, measurable and relevant to input and output data. Examples of a functional unit is "the amount of detergents necessary for a standard household wash" or "the packaging used to deliver a given volume of beverage" (16).

In this section it is described if a functional unit is defined in the studies and whether the defined (or non-defined) functional unit is used in the studies. In the situations when a functional unit is not defined, the way the comparison among different products has been handled is described. Limitations of the defined functional unit, inclusion of other functions in the definition of the functional unit and the workability of the functional unit is discussed.

The picture obtained from the Prestudy of the definition and use of the functional unit is very inhomogenous. The results from the other investigated studies will be presented in the following text. Like it was shown in the Prestudy it is varying to which extent attention is paid to the definition of the functional unit and like the generel trend from the Prestudy, many difficulties and inaccuracies were introduced when the functional unit was defined.

In the study of *detergents* no functional unit was defined. (11). In the criteria document of March 1993 "the criteria are related to Gramm (g) per Wash respectively Gramm per kg dry textile and the critical dilution volume in liters per wash (l/wash). Provisionally g/wash is used but it has to be converted to g/kg textile as the heavy duty detergents are related to: dosage per 4,5 kg load (dry textiles) and the low duty detergents to dosage per 2,5 kg load in the washing machine".

Thus, some sort of unit for comparison was established by the g, g/wash, g/l and g/kg units. The matter of the ability to wash and clean clothes - the washing performance - was discussed but a functional unit was not defined.

In the studies the data connected to the inventory and/or the impact assessment are not related to any firm unit. Some of the data are related to the g/wash as mentioned above. Other data are connected to predicted environmental concentrations, PED while others use other units.

As mentioned above the criteria are related to units for comparison but not what is normally meant to be a functional unit.

In the study of *hairsprays* (7) a functional unit was defined. This was determined to be the volume of liquid formulation. The quantity used was determined to be an equivalent pump litre (p. V-3).

The functional unit was not used in the inventory stage of the LCA. It was argued that this is not necessary in order to determine which stages of the life cycle that contributes the most to the environment (IV-8).

The criteria are set up with the equivalent pump litre as a basis for comparison.

In the study of *packaging* (21) a functional unit is not defined. The subject is not discussed but in the section of the report dealing with "Packaging as a group of products" some considerations concerning "Determining a reference base for packaging" are made. However, the reference base is not used in the study. Criteria are not established in the study.

In the study of *paints and varnishes* "the functional unit used for analysing the inventories of the paint is: the amount of paint necessary to cover 20 m^2 with an opacity of 98%" (8, p. 9). Further, in the section dealing with "The General Methodology for Life Cycle Inventory", it is stated that the flows listed in the Life Cycle Inventories are not calculated for physical quantities of the products, but on the basis of the performance of an equivalent service.

The criteria of paints and varnishes are split up into several groups. These groups are gloss and non-gloss paints, and water- respectively VOC-based paints and varnishes. In the report (8) it is argued (at page 12) that the classification is based on the function of the paints and stems from the discussions of the ad hoc working group members about the volatile organic componds content of the paints which have shown that the VOC content and various characteristics of the paints (washability, gloss, hiding power, corrosion resistance ...) are closely related through the Pigment Volumic Concentration (PVC). This split up on the basis of funtion makes it look like either another definition of product group should have been chosen or the criteria should have been presented in a more general manner. Seen from a Danish perspective another understanding could to a much wider extend have lead to criteria promoting non-VOC products.

Some of the criteria are related to the functional unit. Some of the criteria are not related to the defined functional unit directly. These are set up with a general purpose like general requirements with respect to information to the end user.

In the first published report on *paper products* (12, 13, 14) a functional unit was not discussed and it was not defined. Some attention was paid to the so-called grammage effect but this matter was not further developed. The data used for the inventory were based on a per kilogramme basis.

The set of criteria that was developed first also related to a kilogramme basis. Except for the criteria that are related to more general issues like sustainable forestry.

At later stages of the work it was concluded that the per kilogramme basis was the right choice, and it was concluded that the grammage effect was the best factor to use. For the case of kitchen rolls that was later corrected by a factor of absorption.

When a per kilogramme basis is chosen as a functional unit for these types of products, this does to some extent include a measure of quality as well.

For *textiles* the definition of a functional unit was paid much attention, and it was decided to use kilogramme of fabric as a basis. The data in the inventory are not related to a specified functional unit.

The criteria are related to the defined functional unit except in the situations where this is too rare, e.g. the fitness for use criteria. Some of the criteria

deal with general environmental aspects and these are not related to the functional unit.

In the study of *thermal insulation* the functional unit was defined very early in the process of developing criteria. The functional unit includes some quality aspects, e.g. the products thermal insulation property, while the durability of the product and e.g. technical building characteristics as carrying capacity are not included.

The data of the inventory are presented both with respect to per kilogramme basis and with respect to per functional unit basis.

The criteria are in general related to the defined functional unit. Some of the criteria deal with general environmental aspects and these are not related to the functional unit.

In the study of *washing machines* no functional unit was defined. However, the data in the inventory use a per kilogramme basis for comparison and the criteria, except the general related ones, are set up with a per kilogramme basis.

4.2.1 **Summing up the results of the going through of all studies**

As already indicated in the introduction to this section it is varying very much to which extent a functional unit is defined or for the matter of that if and how the functional unit is used in the study and in the criteria. In many of the studies it is very hard to determine whether one could say yes or no to these questions. However, in *Table 4.1* it is indicated with the sign of plus or minus what is the closest answer to these questions. The table can not stand alone but it is meant to be a help in order to get an overview.

Table 4.1[17]

In the table it is indicated - by the use of "+" and "-" - to which extent the functional unit is defined and used in the studies.

Functional unit / *Product group*	*Defined*	*Used in the study*	*Used in the criteria*
Light bulbs	+	+	+
Soil improvers	-	+	-
Cooling appliances	-	-	
Detergents	-	-	+
Hairspray	+	-	+
Packaging	-	-	
Paints & varnishes	+	+	+
Paper	-	+	+
Textile products	+	-	+
HH	+	+	+
Washing machines	-	-	+

More of the functional units include to a certain degree other aspects than the primary function. This can be aspects like life time and quality. Life time of the products is included in the functional unit of light bulbs. In the studies of hairspray, paints and varnishes, textiles and washing machines life time is a part of the study, e.g. durability is discussed. In these studies it has been chosen not to include the matter in the functional unit but the subject has been

[17] The table presents a rough overview. It can not stand alone.

taken care of when relevant in other ways, e.g. in the criteria or in the fitness for use criteria.

Quality

The quality of the products is a very general issue in the investigated EU eco-labelling studies. In most cases it is argued that for the credibility of the scheme it is very important that the coming-to-be-eco-labelled products are of high quality.

For some of the products the quality aspect is partly included in the functional unit. This seems to be the case in the study of hairspray, paints and varnishes and paper products.

The quality aspect is further discussed in the section dealing with the setting of criteria.

The definition of product groups and the definition of functional units are areas that arise too many potential conflicts. This is often because the functional unit can cover a wide area of product groups which in fact are more (different) product groups. This conflicting situation arises in several of the studies where a functional unit is defined. That is the case for light bulbs and partly the case for cooling appliances, hairspray, paints and varnishes, paper, textile and thermal insulation. This situation can be difficult to handle and one has to take care in order to make exact references and definitions.

4.3 **Purpose of the study**

In this section it is described how different eco-labelling studies have handled the item "purpose of the study".

Several of the investigated studies refer to the eco-labelling regulation in the description of the purpose of the study. It is, however, not the same articles of the regulation they are referring to.

In the study of *paper* (12, 13, 14) there is a reference to article 1, section 3 defining environmental impact in the following way: "The reduction of the environmental impact will be achieved through minimisation of:

- use of natural resources and energy resources,
- emissions into air, water and to soil,
- generation of waste and noise

and through the maximisation of product life, and where applicable, through the use of clean technologies to ensure a high level of environmental protection".

In the study of *thermal insulation* reference is made to article 1 in it's full length. The text in the report of thermal insulation states that the "criteria should be able to meet the demand of the Council Regulation, which in this context is defined as promotion of design, production, marketing and use of products which have a reduced environmental impact during their entire life cycle and at the same time to provide consumers with better information on the environmental impacts of products(23, p. 23). The same reference to the Regulation is made in the study of *textiles* (15, p. 4) and *detergents* (11, p.2).

As mentioned above the *paper study* is divided into two parts. In this context the scope and system boundaries will be considered on the basis of the full study. The first part is a qualitative description rather than a quantitative collection of data upon which the most important phases with respect to the en-

vironment have been pointed out. This report was made by an expert (from the Swedish Pulp and Paper Research Institute) and discussed among experts and to some extent member states within the EEC - a sort of open peer review was made then.

In the study of *paints and varnishes* articles 4 and 5 of the Council Regulation are emphasised, and it is stated that "three kinds of criteria are distinguished:

- *the ecological criteria*, which are determined according to a global approach (from cradle to grave),
- *the criteria which refer to general principles* (toxicity...),
- *the fitness for use criteria*, to ensure that the product should have at least a minimum level of quality."

Some of the studies do not refer to the Council Regulation but state a purpose of the study.

In the study of *hairspray* one of the purposes is to investigate and settle with the assumptions (of the organisations) of consumers and environmentalists. This is in order to clarify whether for instance CFC's and HCFC's are used etc. The purpose of the study is furthermore to identify significant eco-impact (7).

The study of *packaging* mentions that one of the aims of the use of LCA is to single out which of the life cycle phases that are most significant to the environment (21, p. 56).

In the study of *washing machines* the text says that "the aim of the cradle to grave assessment carried out in this study is to enable the identification of those aspects of the life cycle of a washing machine which have the most significant environmental impacts" (3, p. 10).

As already indicated in the Prestudy it is possible to group the purposes of studies in some items that are overall covering and some items that are more specific to each of the studies. In the following these trends will be presented.

Promotion of products that have throughout their entire life cycle and their entire useful life, lower environmental impacts than comparable products

Promotion of products that have throughout their entire life cycle and their entire useful life, lower environmental impacts than comparable prod*ucts* is one of the most common of more purposes in the investigated eco-labelling studies. This is the purpose of the studies of refrigerators and freezers, soil improvers, paper, thermal insulation, detergents and textiles. While other of the studies mention the purposes of reduced impacts to the environment as the purpose. This is relevant in the case of light bulbs, washing machines and packaging.

Other environmental aspects e.g. removal/prevention of environmental impacts, efficient use of raw material, application of polluter-pays principle and maximisation of useful life of products are mentioned indiscriminately in the different studies.

Information of consumers on environmental impacts associated with specific product

Information of consumers on environmental impacts associated with specific products is also a very common purpose of a study. This is the case in the studies of thermal insulation, textiles, detergents and hairspray.

4.4 Product group definition

The definition of a product group is an important task when establishing eco-labelling criteria. The definition of a product group sets the borders for the types of products that have to be compared. On the basis of the product group the criteria are established and therefore it is very important that the definition of the product group is put correctly. Otherwise types of products, that have not been thought of during the process of establishing of criteria, can apply and even get the label. This means that if the product group is not defined correctly the criteria can be misleading.

This section deals with if and how the product groups within the different studies are defined. It will be presented how the studies solve the work on definition of product groups. In the end of the section differences and similarities in the product group definition will be presented.

In the study of *detergents* the expert group agreed in the following definition of the product group: (Laundry) detergent (washing and cleaning) products which are used in washing machines. The product group of detergents is used for different purposes resulting in various product types. This includes all temperatures: high, medium and/or low temperatures. Further, it includes bleaching agents, dehardener and/or surfactants, and it includes heavy, light and component systems (11, p.21).

In the study of *hairsprays* it is settled "that product groups may be defined according to two characteristics. The characteristics are the function and method of use. Other characteristics - those that differentiate members of the product groups from each other, but do not define a new group - are regarded as secondary characteristics" (7, p. II-2). In the report, hairsprays are defined "as products that maintain or "fix" a finished hairstyle subject to normal physical movement and atmospheric conditions (wind, humidity, dryness, heat and cold). They are sprayed directly onto styled, dry hair" (7, p. II-3).

In the *packaging study* it is pointed out "that packaging should be considered as an integral part of the product and that the attribution of the label is dependent on the content/container pair. As a result, packaging may not be considered as a group of products, but as having the required characteristics in order to be defined as such. The study limits itself to suggest certain parameters that may then be used as references for the various products that request the environmental quality control label. Thus for these categories of products, packaging may be considered as a GROUP OF PRODUCTS, insofar as the items they contain may not apply for environmental labelling" (21, p. 103).

In the study of *paints and varnishes* the definition of the product group was agreed as "decorative indoors paints and varnishes for professional and do-it-yourself users", (article 3 of the Regulation). Included in the field of application are in particular:

- liquid or paste formulas which have been pre-conditioned or prepared to meet the consumer's needs,
- white base products intended to be tinted with "tinting" machines at the consumer’s reguest.

Excluded from the field of application are:

- anti-corrosion coatings,
- anti-fouling,
- wood preservation products,
- wood strains,

- coatings for particular industrial uses,
- floor coatings,
- facade coatings.

In the study it is also mentioned that "according to the European Council Regulation (EEC no. 880/92), article 3 this definition is based on the function: the group to be labelled has to contain products having the same function. However, when the criteria are set up in the end the product group is split up in sub-categories, e.g. high and low VOC-content. Each sub-group got its own set of criteria.

In the *paper study* it is in a general turn of phrases mentioned that "eco-labelling should only be considered for well defined and very narrow ranges of products. The basis for defining these groups is a careful analysis of the function of the products" (12, 13, 14). Further in the same reference (p. 40) more thoughts are presented with respect to which systems that are to be compared, e.g. disposable diapers (made of plastic and paper) and re-usable diapers (of textiles). However, no conlusions are presented.

In the study of *thermal insulation*, an insulation product is defined as a material or a product which is intended to reduce heat transfer through the structure on which or in which, it is installed (23, p. 9). In the report the results of a rather long debate is presented concerning whether to split up in a number of product groups or to have as many products as possible in the same groups of products. As will be explained in the section concerning fitness for use there are some further criteria which turns to the point of the thermal insulation properties of the products in question.

In the study of *textiles* a definition of T-shirts and a definition of bed linen are presented. A T-shirt is defined as a lightweight, weft knitted, unadorned, crew-neck, short- or longsleeved garment, giving a T-shape when laid flat, designed for outerwear. T-shirts covered by these criteria can not be equipped with buttons, ribs or a collar made of other materials. Bed linen is defined as wowen bed sheets, pillowcases, valances and removable, washable quilt or duvet covers. Bed linen covered by these criteria may be equipped with buttons or fasteners made of other materials.

In the study of *washing machines* the working definition of the product category assumed for this study was: "washing machines sold to the general public, including front loaders and top loaders" (August 1992, p. 3). It is concluded later in the study (p. 9) that this definition works all right.

4.4.1 **Discussion**

The use of sub categories

The three studies presented in the Prestudy deal with the matter in different ways. In the study made for *light bulbs*, the definition of the product is specified very much with respect to the outfit of the product, while aspects concerning the identity of the consumers are toned down. In fact, this procedure leads to a very narrow rank of products which excludes many types of products. In the study of *refrigerators and freezers* a number of divisions leading to a very large rank of specified product types is introduced. This approach does not seem to be very visionairy since it illustrates the status quo of the products very well but does not reveal specific advantages or disadvantages of the products. In fact, except in very few special cases this does not lead to distinctions of a number of product types. It rather leads to generalisations that simplifies the work on criteria. In the study of *soil improvers* the starting point is a mixture between a general definition based on the technical performance of the products and at the same time a demand saying that the products must be *branded*. This approach is at the same time broad be-

cause of the definition based on the function of the product and narrow because of the demand on branded products.

On the basis of the Prestudy and further underlined by the results of the other studies, two main solutions of how to deal with the product group definition appear. One of the possibilities is to make the product group definition as broad as possible. The other solution is to divide the product group into a number of subcategories. The broad approach leads to a solution where one set of criteria covers a lot of product categories, e.g. all thermal insulation applications for walls and roofs. This approach has been used in the studies of detergents, paper and thermal insulation. The other approach where the product goup is divided into subcategories could lead to two cybernetic solutions. One route is to end up with a number of criteria corresponding to the number of subcategories. This is the case in the studies of packaging and refrigerators and freezers. The other route is to end up with a rather narrow product group definition. This seems to be the case in the study of light bulbs, soil improvers, paints and varnishes, textiles, washing mashines and to some extent in the study of hairspray.

The definition of product group with respect to new products

In the regulation it is a requirement that the established criteria deal with existing products. In practise this demand leads to some exclusion of new not very settled products at the market. It is important to see if potential obstacles to new products are introduced in the initial phase. These obstacles could occur by making many restrictions when the product group definition is set. Restriction could be introduced in order to make a precise definition. This happens especially in the case of refrigerators/freezer (the sub categories are based on products already available on the market), soil improvers (branded products), thermal insulation (constants are only available for a limited number of basic materials) and packaging (the limited amount of types of products). This is partly the situation of the studies of detergents (different temperatures and systems are introduced) and textiles (focus has been put on bed linen and T-shirts) while this seems to be less limiting in the studies of hairsprays (except that it has to be sprayed on), paints and varnishes, paper and washing mashines.

In the study of *light bulbs,* product categories based on the function for which the light bulbs are purchased, might appear more relevant for the consumers. Thus, the light bulbs could with advantage be divided into product groups of domestic and non-domestic light bulbs. However, the aspect was toned down in the study. In the study of *soil improvers* it was mentioned that informed consumers do not have difficulties when distinguishing among different types of products.

Technology driven approach in the product group definition

The definitions of product groups are in some instances technology driven. This means that the definition excludes or includes different types of technology. This happens in the cases of light bulbs, refrigerators and freezers and partly in the case of thermal insulation. This does not happen in the other studies.

4.5 **Methods for identification of environmental key features**

All the investigated studies use LCA as a basis methodology for the developing of criteria. However, in most of the studies it is explained that a simplified approach has been used. In this section it is presented whether a simplified method of LCA is used in some of the studies and if that is the case in what sense the method is simplified. In several of the studies identification of key features or similar is used as methodology. The use of key features is

explained with respect to when and how in the process of establishing criteria.

In the study of *detergents*, results of different LCA studies were used. The results of the different approaches were compared. One approach was to investigate which environmental aspects that have been put into focus for detergents when different EU and non-EU memberstates where asked. Another approach was to use the "Assessment Matrix" in Annex 1 of the Regulation in order to establish relevant parameters. The Assessment Matrix of the Regulation has been critisised extensively. This is due to the fact that there is no guidance in the Matrix as it stands on its own and from an impact assessment point of view the wording in the matrix is a little rare itself. This critisism has later been obliged by the establishing of general guidelines.

In the report "Detergent in Western Europe: Environmental labelling" (11) it is made very straight that no attempts are made to perform a full LCA. It is very clear that only very little information for the phase of pre-production is collected, and in the end no criteria are established for that phase.

The conclusions of the different approaches in order to establish criteria used by member states as well as non-member states were compared. Since the conclusions from study to study were very similar, saying that the use phase and phase of disposal are of very large importance it was concluded that the simplified LCA method was sufficient for the purpose. Further it was noted that the gaps of data and knowledge might be closed within three years, thus the criteria would be improved in the future.

The *hairspray* study is based on a streamlined LCA since, it is argued, the resources for producing a full LCA were not available.

The objectives of the study were to identify:
- The most significant environmental impacts.
- Directionally correct ways of reducing environmental impacts.

The methods used in the study claim to be broadly consistent with those identified by SETAC at its workshop for LCA practitioners in Leiden 1991 (24).

The method is following the frame of SETAC. This includes goal definition and scoping, setting of system boundaries, an inventory, an impact analysis assesment. The study is in the first place conducted for one product. This does not pretend to purport the full market as such. On the basis of the first study a number of environmental issues were marked with special interest. These environmental issues were for more products further investigated in order to verify and to give ranges for the relevant parameters. The impact assessments are followed by a section dealing with the reliability of the results. It is suggested that conclusions are drawn very carefully, when they rely on small differences between numbers of which are sensitive to assumptions made, such as in the general fuel and power modules.

The streamlined LCA consists of an analysis of one standard product. In the report it is emphasised that (7, p. IV-8) the process steps which are considered are reasonably representative of current practice but do not purport to be weighted average of all commercial operations. After finishing the inventory and partly the impact assessment based on one product, the main environmental issues are pointed out and further information about relevant aspects is collected. The functional unit is defined relatively late in the study. That is

after the goal definition, the inventory and the impact assessment, but before criteria are set up.

The study of *packaging* consists of a survey of a number of packaging studies. These studies includes different types of packaging. That is among others packaging for foods, drinks, liquid detergent etc. The different studies do not have the same setting of system boundaries or the same purposes which makes it difficult to compare and use the results of the different studies. On that basis the impacts to the environment are summarised, and each of the relevant aspects are discussed. It seems like the idea, by summarising all the different studies, is to establish criteria on that basis. The criteria are intended to cover more types of packaging but no clear distinction in the discussion of potential criteria is made to what type of packaging the criteria are relevant for.

In principle the study on *paints and varnishes* was made as a full LCA. LCA studies on four paints and varnishes were made. This was later extended to additional seven products in order to provide sufficient data. The method used in the LCA claimed to be in accordance with general principles made by SETAC (16).

A number of exclusions were made, e.g. contribution from processing equipment. Contributions from raw materials, intermediates etc. of which there is less that 5% content in the final product. This is done unless significant contributions can be identified. Specific site relevant effects are not taken into account.

For paints and varnishes many ingredients are needed. It can therefore be very doubtfull whether the methods of excluding all ingredients which are less than 5% of the final product. In the study it is stated that the production of 80 to 100% of total input at each stage is included in the study. The average is 95%.

In the first part of the study on *paper* products the screening was discussed qualitatively and thereafter data were collected. On the basis of the qualitative conclusions in the first part of the work information was collected. Since a screening LCA which was primarily qualitative was made. The identification of key features seems to be some how prejudice. The second part of the work was not presented to the public. In this part data were established by collecting data among the branch organisations, the specialists and others that were members of the expert group and the group of member states. There was an open atmosphere in the work attitude in order to include as much information as possible. Therefore, the conclusions on the identification of key features may happen to be fair and may be less prejudiced than assumed immediately. The inclusion of interest groups and branch organisations should help to assure that the collected information is both correct and relevant.

5 Methodological aspects analysed on the basis of the adopted criteria

In chapter 4 ”Comparison with other selected studies” special focus was put on goal and scoping (fitness for use, product group definition, functional unit and purpose of study) and on methods for identification of environmental key features. The aspects in question are discussed under the impression of what have been done for each of the investigated product groups.

In the present chapter (5) the LCA methodological aspects are analysed on the basis of adopted criteria. The focus is then the opposite way around since it starts with the criteria and then goes backwards to check the correlation to the earlier identified key features. The product group that are brought into attention is textiles (bed linen and T-shirts), detergents, tissue products (toilet paper and kitchen roll), copying paper, paints and varnishes and washing machines.

Thus the linkage between the property of the product, the approach in the background analysis and the design of criteria are analysed for the product groups where criteria currently are adopted under the EU-Scheme and which has not been analysed in the Prestudy. This is done in order to investigate if some sort of pattern appears.

The analysis are done by categorising the background for the criteria in a table related to respectively the criteria, LC-screening, life cycle phase, cleaner technology aspects, sourcebasis for criteria and basis for levels.

For each product this is done followed by a short description of the particular categories.

In chapter 6 ”Features of criteria of the established product groups” the methodological features from this chapter are further discussed.

In the tables in this chapter an overview of the relation between a number of features and the adopted criteria are given. ”+” means that the feature is reflected in the adopted criteria. ”-” means that the feature is not reflected in the criteria.

5.1 **Relations between life cycle screening and criteria for bed linen and T-shirts**

In this section an overview of the specific eco-labelling criteria for bed linen and T-shirts is given with respect to the above mentioned aspects: LC-screening, life cycle phase, cleaner technology aspects, sourcebasis for criteria and basis for levels. The overview is presented in a table and thereafter shortly discussed.

Table 5.1
Bed linen and T-shirts (cotton/polyester)

Criteria	*Relation to LC-screening*	*Life cycle phase*	*Cleaner technology aspects*	*Source basis for criteria*	*Basis for levels*
Pesticide residues	key feature	pre-production	+	LCI	EU-list of chemicals
VOC (polyester)		pre-production	+		
Residues of antimony (polyester)	feature for processing of polyester	pre-production	+	LCI	IARC presentation of industrial chemicals
PCP (banned)	-	pre-production/ production	+	-	-
Size agents (recyclability/bio-degradable)	key feature	pre-production	+	analytical conclusion	LCI
Detergents	key feature	pre-production	+		IARC toxicity evaluation
Bleaching agents	key feature	pre-production	+	LCI	ELTAC limit/AHWG-compromise?
Dyes, pigments and carriers	key feature	pre-production	+	LCI/ETAD	EU directives/ ETAD limits
Printing	key feature	pre-production	+	LCI	
Finishing	key feature	pre-production	+	EU-Commission	EU-Commission
Waste water treatment	key feature	pre-production	+	LCI	EEC directive (91/271/EEC)
Organics to water	key feature	pre-production	+	impact assessment	
Mechanical and physical properties	-	use phase	-	standardisation	ISO standards
Colour constancy	-	use phase	-	standardisation	ISO standards

Criteria

The criteria cover quite many processes since both cotton and polyester are covered by the product group definition. Further a garment potentially undergoes several manufacturing and processing stages from the pre-production to the end use. Processes which when carried out without attention to environmental issues will have significant environmental impact caused by the character (toxicity, ecotoxicity and other impacts) of the substances used.

There are 12 criteria related to environmental issues, and additionally fitness for use criteria based on mechanical and physical properties and the colour fastness of the product is included.

Criteria concerning the finish treatment were changed by the EU-Commission. Originally the LCI pointed out specific detergents to be banned within this process. The final criteria only put a ban on formaldehyde.

The fitness for use criteria reflects the fact that the quality range of the product is not enabling an adequate definition of the functional unit. Therefore the fitness for use aspect is a set of criteria placed beside environmental related criteria to ensure that the quality is not decreased as a consequence of reduced environmental impact.

Relation to LC-screening

The criteria are based on a comprehensive LCI which is interpreted into criteria by a life cycle impact assessment. The life cycle impact assessment is focused primarily on assessments of substances. These assessments have been done by a number of organisations beforehand. They are not prepared especifically for the eco-labelling studies.

Life cycle phase

The criteria focuses on the pre-production phase and fitness for use. This is partly explained by the character of the product. The pre-production phase (pre-production is interpreted as cradle to final fabric) covers the use of several substances with severe environmental impact. The substances used or added in the pre-production phase also have influence on the physical property in the use phase.

The choice of either cotton or polyester garment influence heavily on the consumption of water, energy and detergent during the use phase. However it was concluded early that eco-labelling criteria will have little if any influence at all on the consumer's choice of garment.

The focus on the pre-production and production phase is a selection probably done in order to be able to make it possible to administrate and control the criteria afterwards. In other studies it is showed that for example the consumption of energy and discharge of wastewater are related to the use phase (25) by maintenance (laundry etc.). It is, however, not possible to cover these activities by criteria for the textile products since such activities are linked to the behavior of the user and the equipment he/she uses (washing machines/detergents etc.). This issue will be discussed later in this report.

Cleaner technology aspects

The product group shows very close links between concepts for cleaner technology and cleaner products. Especially for the cotton-based products the pre-production phase is a key feature since the residues (which can be eliminated in this phase) will otherwise cause impacts in the use phase of the product.

Source basis for criteria

The criteria are based on the LCI-report, the following impact assessment and the defined key features. Concerning the fitness for use the criteria refers to ISO-standards.

Basis for levels

The setting of levels are partly based on definitions made by international organisations with specific knowledge for the selected areas. The levels are not part of specific survey of environmental assessment. The levels are directly taken from recommendations, evaluations and assessments from the relevant organisations and researchers, dominated by International Agency for Research of Cancer (IARC), EU lists of chemicals and Ecological and Toxicological Association of the Dyes and Organic Pigments Manufacturers (ETAD).

5.2 Relations between life cycle screening and criteria for detergents

In this section each of the final eco-labelling criteria for detergents are hold against the selected aspects: relation to LC-screening, life cycle phases, cleaner technology aspects, source basis of criteria and basis for level of criteria (how tough they are). The overview results are presented in ***Table 5.2***.

Table 5.2
Detergents

	Relation to LC-screening	*Life cycle phase*	*Cleaner technology aspects*	*Source basis for criteria*	*Basis for levels*
Criteria for substances:					
Total amount of chemicals	key feature	use phase/ disposal	-	market analysis/impact assessment on aquatic environment	sensitivity analysis
Toxicity	key feature	use phase/ disposal	-	market analysis/impact assessment on aquatic environment	LCI/ EEC directive 88/327
Phosphates	key feature	use phase/ disposal	-	market analysis/impact assessment on aquatic environment	sensitivity analysis
Non soluble nonorganics	key feature	use phase/ disposal	-	market analysis/impact assessment on aquatic environment	sensitivity analysis
Market analysis/impact assessment on aquatics	key feature	use phase/ disposal	-	market analysis/impact assessment on aquatic environment	sensitivity analysis
Non-biodegradable org. substances (aerobes)	key feature	disposal	-	market analysis/impact assessment on aquatic environment	sensitivity analysis
Non-biodegradable org. substances (anaerobes)	key feature	disposal	-	market analysis/impact assessment on aquatic environment	sensitivity analysis
BOD	key feature	disposal	-	market analysis/impact assessment on aquatic environment	-
General criteria:					
Packaging	key feature	disposal	+	market analysis	pass/fail sensitivity
User instructions	key feature	disposal	-	LCI-conclusion	LCI
Purity of enzymes		disposal	-	EU-Commission	?[18]
Performance criteria:					
	key feature	use phase	+	LCI	selected standards

Criteria

The criteria are dominated by a point system where levels of substances are linked together. The point system includes all textile chemicals and the environmental impact they cause on the aquatic environment. Beside this system there are criteria related to packaging. Both the point system for de-

[18] The question mark is put here because it is not possible to assess whether the requirement is strong one or not.

tergents and the criteria for packaging criteria are related to quantity consumed per kg of garment washed.

In order to avoid thinning of the products as a method of making them look more environmental friendly a criterion for washing performance is designed.

Relation to LC-screening

The criteria set is widely based on LC-screening, the included market survey and the following environmental assessment. The results are used as a guideline for the design of criteria in order to put the right levels for the different parameters in relation to environmental impact of the substances and the market share of the products affected by the level setting.

Life cycle phase

Much of the effort is pointed towards the use phase and disposal of the product by the wastewater from washing. This is well in line with the fact that the entire product is discharged in the waste water during the one and only time it is used. The environmental impact from the disposal can not be allocated to several cycles of use, and therefore the proportion of the disposal has a major influence of the environmental impact in the entire life cycle.

Cleaner technology aspects

Since the key features are pointed towards the use phase and the following disposal by waste water, the cleaner technology aspects are of low priority in the set of criteria for detergents. The criteria are more related to a cleaner product approach. This priority is based on the relation between the environmental impact and the property of the detergents. By linking environmental parameters to the wash of a certain amount of clothes. The criteria are setting up relations between environmental impact and fitness for use. E.g. an environmental friendly product which is less effective in its main function (cleaning of clothes) can not fulfil the criteria. The fitness for use is part of the demands that are set up by the criteria.

However the property of the product can also affect the production phase. If it is possible to mix an effective formulation with use of less resources like the compact washing powder, the customer will use less of the product and the production per wash unit will be reduced. In this term the product will cause improvements in the pre-production phase and the production phase too.

Sourcebasis for criteria

The inventory is primarily based on research done in the LCI, and the substances are selected by the sensitivity analysis linked to the impact assessment. The fitness for use criteria are based on a logical statement in the LCI concerning the essential importance of the property of the product.

Basis for levels

The levels are based on a linkage between the sensitivity analysis and the market study in order to ensure that the limits only exclude the requested amount of products, i.e. that only a certain part of the market will be able to get the label.

For the enzymes it is not possible to locate any links between the LC-work and the final criteria. One possibility could be that the final criteria is a product of negotiations between members of the AHWG and the EU-Commission.

5.3 Relations between life cycle screening and criteria for kitchen rolls/toilet paper/copying paper

In this section each of the final eco-labelling criteria for kitchen rolls/toilet paper/copying paper are hold against the selected aspects: relation to LC-screening, life cycle phases, cleaner technology aspects, source basis of criteria and basis for level of criteria (how tough they are). The overview results are presented in ***Table 5.3***.

Table 5.3
Kitchen rolls/toilet paper

Criteria	*Relation to LC-screen-ing*	*Life cycle phase*	*Cleaner technology aspects*	*Source basis for criteria*	*Level settings for criteria*
Forest management		pre-production	+	Helsinki Commission	No levels
Combined pointrelated criteria					
Renewable ressources	key feature	pre-production/ production	+	LCI/ Haskoning/ Buwal	LCI/pointrelated criteria
Nonrenewable ressources	+	pre-production/ production	+	LCI/ Haskoning/ Buwal	LCI/pointrelated criteria
CO_2	+	pre-production/ production	+	LCI/ Haskoning/ Buwal	LCI/pointrelated criteria
SO_2	+	pre-production/ production	+	LCI/ Haskoning/ Buwal	LCI/pointrelated criteria
COD	+	pre-production/ production	+	LCI/ Haskoning/ Buwal	LCI/pointrelated criteria
AOX	+	pre-production/ production	+	LCI/ Haskoning/ Buwal	LCI/pointrelated criteria
Waste	+	pre-production/ production/ disposal	+	LCI/ Haskoning/ Buwal	LCI/pointrelated criteria
Fitness for use					
Absorbtion	analytical conclusion	use phase	+	LCI-conclusion	selected standards
Strength	analytical conclusion	use phase	-	LCI-conclusion	selected standards

Criteria

The background study covers 3 products: Kitchen rolls, toilet paper and copying paper. Below the criteria for toilet paper and kitchen rolls will be analysed within the same section since it is only parts of the final criteria that differ for these two products. The criteria proposed by the consultants was based on a pointrelation for several emission parameters and renewable fuels - a socalled matrix system.

The aim of this design of criteria was to enable a single set of criteria to cover different kinds of pulp methods, raw material and configurations of non-/ and integrated manufaturing systems.

Concerning the copying paper it was not possible to reach consensus in the AHWG about continuing with the matrix system. Therefore the final criteria were defined by the Commission after long and detailed negotiations with members of the AHWG (mainly industrial organisations and competent bodies) who pointed out that the criteria should be transparent and easy to handle for the holder of the licence. This demand could not be achieved by the nature of the point system since a fixed maximum level for each parameter can not be found before all parameters are known.

The criteria linked to the copying paper were based on the following 4 parameters:

COD: 30 kg per Adt
AOX: 0,3 kg per Adt
S: 1,5 kg per Adt
Energy: 30 Gj per Adt (purchased energy > 18 Gj per Adt).

These maximum hurdles concerned the consumption in the various stages of pulp and paper of the production process. The criterion concerning safeguard of forrests was identical for all 3 product groups. The product groups are presented below.

The criteria were based on research which was pointed towards kitchen rolls, toilet paper and copying paper. The criteria were developed for the matrix system, except for the definition of forest management and fitness for use. The matrix system was designed in order to meet the different environmental profiles of the various pulp processes (e.g. some processes are high at one parameter and low on others).

Relation to LC-screening

The product group concerned was one of the first to be established within the EU scheme. The participation from the different competent bodies was very enthusiastic. Thus much detailed information was added to the inventory by competent bodies from nations where pulp and paper production is a major industrial activity including nations which at that time were not EU-members (Sweden, Norway, Finland).

Life cycle phase

The criteria are mostly pointed towards the pre-production and production phase. This is well in line with the fact that the pulp and paper processes potentially caused servere environmental impact. The fitness for use aspect is an analytical conclusion based on the fact that if the fitness for use property is influenced negatively by environmental improvements, the consumption of the product will increase and by then affect the environmental impact from the pre-production and production phases, caused by an increasing volume of paper for the same specific use.

Cleaner technology aspects

The criteria do definitely point toward cleaner technology in a well defined type of processing (pulp processing and paper manufacturing). The possibilities of developing cleaner products for this group is limited to a few items which are linked to the fitness for use aspect.

Source basis for criteria

The pulp and paper processes have been in focus for several years because of the potential significant environmental impact which ealier on threaten this trade. Therefore source basis for criteria is a combination of the LCI results combined with the demands resulted from international negotiations like PARCOM- and HELCOM-recommendations.

Level settings for criteria

The criteria of the different parameters are linked together in a point load system for which a limit is defined (combined system of linked hurdles and cofficients). There are hurdles for maximum levels for each parameter but it

is not possible to state an average level for one parameter before all parameters are known. By then there are no fixed levels for any parameters, but the multiplication factors are developed by an ongoing try and error procedure until the best performing mills could match the cofficients and hurdles no matter what kind of pulp process is used.

The intention of this process was to ensure that the less polluting manufacturer could fulfil the criteria. Improvements were required no matter what kind of technology utilised unless the mills were among the small squad of Best Environmental Performance.

5.4 Relations between life cycle screening and criteria for copying paper

In this section each of the final eco-labelling criteria for copying paper are hold against the selected aspects: relation to LC-screening, life cycle phases, cleaner technology aspects, source basis of criteria and basis for level of criteria (how tough they are). The overview results are presented in ***Table 5.4***.

Table 5.4
Copying paper

Criteria	*Relation to LC-screening*	*Life cycle phase*	*Cleaner technology aspects*	*Source basis for criteria*	*Basis for levels*
COD	key feature	pre-production/ production	(+)	LCI (Haskoning)	Commission decision
AOX	key feature	pre-production/ production	+	LCI (Haskoning)	Commission decision
Sulphur	key feature	pre-production/ production	+	LCI (Haskoning)	Commission decision
Energy consumption	key feature	pre-production/ production	+	LCI (Haskoning)	Commission decision
Forest management	renewability	pre-production	+	Helsinki Commission	Commission decision

Criteria

The criteria for copying paper were established by a simplified approach based on the inventory for kitchen rolls and toilet paper. The design of criteria was managed by the Commission when the AHWG was unable to reach concensus for the matrix approach that was proposed in line with the design of criteria for kitchen rolls and toilet paper.

Relation to LC-screening

The relation between the LC-inventory and the criteria is not fully obvious. There is a correllation between the identified key features and the final criteria The reason is that the criteria proposed by the consultants on the basis of the inventory were rejected by the AHWG. The Commission developed the criteria (which were later adopted) directly by negotiations with members of the AHWG.

Cleaner technology aspects

The criteria are closely related to the environmental key features defined in the research performed earlier for the other products mentioned. Cleaner technology aspects are indeed linked to reduction of the parameters concerned.

Source basis for criteria

The source basis is related to references used for the former adoption of kitchen rolls and toilet paper. The proposal based on the research was closely linked to the experience and patterns made for the former product groups.

Basis for levels

The basis for levels is basicly unknown. The criteria were at first developed with a combined point/hurdle system as the skeleton. After this idea was given up the actual levels of the criteria were placed using the levels in the point system as a reference.

5.5 Relations between life cycle screening and criteria for paints and varnishes

In this section each of the final eco-labelling criteria for paints and varnishes are hold against the selected aspects: relation to LC-screening, life cycle phases, cleaner technology aspects, source basis of criteria and basis for level of criteria (how tough they are). The overview results are presented in ***Table 5.5***.

Table 5.5
Paints and varnishes

Criteria	*Relations to LC-screening*	*Life cycle phase*	*Cleaner technology aspects*	*Source basis for criteria*	*Basis for levels*
Pigments					
SOx emissions (TiO_2)	key feature	pre-production/ production	+	LCI of 11 paints	confidential data
Waste of Sulphate	key feature	pre-production	+	LCI of 11 paints	confidential data
CO2 emissions (TiO_2)	key feature	pre-production	+	LCI of 11 paints	confidential data
VOC	key feature	use phase	-	LCI of 11 paints	confidential data
Aromatic hydro carbon	key feature	use phase	-	LCI of 11 paints	confidential data
Emissions					
Effluents from cleaning of tools	analytical conclusions	pre-production/ production/ use phase	(+)	LCI of 11 paints	confidential data
Solid waste	analytical conclusions	disposal	-	analytical conclusion (hypotheses)	analytical conclusion (hypotheses)
Harsardous residues in pigments	LCI-based conclusion	pre-production	-	LCI of one TiO_2 producer	confidential data
Hasardous substances	LCI-based conclusion	pre-production/ production	+	Eliminated in LCI	EU directive 67/548
Fitness for use	part of def. of functional unit	use phase (design)	+	LCI of 10 paints	Opacity/ confindential data

Criteria

The criteria cover both paints and varnishes for indoor use. The criteria are dominated by the results of the LCI in which it is pointed out that the production of pigments (especially TiO_2) is the major environmental key feature for the life cycle of paints.

At the same time the pigments are the major contribution to the essential property of the product: The opacity. Thereby a link between the environmental key features and the fitness for use of the product is established.

The character of the product enable an adequate definition of the functional unit to be linked to the fitness for use and thereby linking the property of the product to the environmental impact. As mentioned earlier, in the LCI the amount of paint for covering 20 m^2 is in the range of 1,16 liters to 3,13 liters. These data are further used as a basis for the establishing of criteria concerning opacity where it is demanded that one litre of paint should be able to cover 7 m^2.

Relation to LC-screening

The selection of criteria is based on the LC-screening in which the production of TiO_2 is highlighted. The LCI was originally based on screening of 4 types of paint, but demands from industrial groups initiated extention of the study to other 7 paints. The criterion related to toxic substances is not based on the inventory. These substances are eliminated by an exclusion method (5%) in the study.

Life cycle phase

The production of TiO_2 is part of the pre-production phase. Therefore, the manufacturer of paints and varnishes is forced to select the subcontractor of pigments in order to fulfil the demands required by the criteria.

Several demands are pointed to the use phase of the paints. Both the opacity, the hasardous emissions when drying and the fitness for use is linked to the use phase. Beside that the property of this kind of product leads back in to the life cycle. If the opacity of the product is poor then more of the product has to be used with more emissions from the pre-production phase as a result.

Cleaner technology aspects

The cleaner technology aspects are by the criteria focused on pre-production for which the emissions from production of TiO_2 are central.

Since the formulation of the paints (mixing of substances) has a minor environmental impact compared to the manufacturing of raw materials (pre-production), the manufacturing phase does not have a high priority.

Source basis for criteria

The life cycle inventory has been used as a basis for criteria settings. Some of the criteria are developed after the LCI. That is the case for the harsardous substances. The hasardous substances were elimininated from the study by a 5% exclusion level. But by the criteria concerning hasardous substances products containing such substances will be excluded no matter if there are below 5% of the specific substances. It is simply not allowed to add toxic substances to the paints.

Basis for levels

Most levels are based on the LCI. The data used are confidential and only the consultant knows the source. The study does by then not give any information that makes it possible to assess the actual level for the criteria.

5.6 Relations between life cycle screening and criteria for washing machines

In this section each of the final eco-labelling criteria for washing machines are hold against the selected aspects: relation to LC-screening, life cycle phases, cleaner technology aspects, source basis of criteria and basis for level of criteria (how tough they are). The overview results are presented in ***Table 5.6***.

Table 5.6
Washing machines

Criteria	*Relation to LC-screening*	*Life cycle phase*	*Cleaner technology aspects*	*Source basis for criteria*	*Basis for levels*
Key criteria: Energy	environmental key feature	use phase	-	performance survey of products/-manufactures	part of market share
Water	environmental key feature	use phase	-	performance survey of products/-manufactures	part of market share
Detergent loss		use phase	-	LCA-report concerning diapers	standardised testmethods
Best practice criteria: Instruct the user	analytical conclusions	use phase	-	analytical conclusions	analytical conclusions
Encourage recycling	analytical conclusions	disposal	+	analytical conclusions	analytical conclusions
Performance criteria: Wash adequately	analytical conclusions	use phase	-	analytical conclusions	standardised testmethods
Rinse adequately	analytical conclusions	use phase	-	analytical conclusions	standardised testmethods
Provide information on noise		use phase	-	analytical conclusions	analytical conclusions

Life cycle phase

The criteria for washing machines are mostly pointed towards environmental parameters linked to the use phase. The reason is that the use phase dominates the contribution of environmental impacts by a large margin (most parameters app. 90%). The data in the report verify this fact.

Relation to LC-screening

The criteria are closely linked to the inventory report and the conclusions pointing to the fact, that environmental impacts in the use phase exceed the impacts of the pre-production and production phase by large numbers.

Cleaner technology aspects

Since the criteria focuses on the use phase of the life cycle very little attention is pointed towards the manufacturing (pre-production and production phase). This is rather obvious due to the fact that the chosen parameters for environmental impact are several times higher during the use phase than in the other phases of the life cycle.

Thus very little attention is pointed towards cleaner technology aspects since these aspects are closely linked to the manufacturing of the product (pre-production and production phase).

Source basis for criteria

Since the environmental impact is dominated by parameters in the use phase the sources that the criteria are based on are not deriving from analysis based on real LCA principles. The sources for criteria are mainly based on data for performance of the product during use. The parameters are not affected by any discussions concerning methodological allocation-, classification-, valu-

ation- or normalisation elements since the variations are only related to quantification of well defined parameters.

6 Features of criteria of the established product groups

This chapter deals with which factors that are linked to the properties of the product groups. The product groups in question are those for which eco-labelling is adopted. In chapter 3 ”Methodological aspects from the Prestudy” and chapter 4 ”Comparison with other selected studies” the criteria of each product group were analysed separately. In chapter 5 ”Methodological aspects analysed on the basis of the adopted criteria ” there is an overview of the relation of the life cycle screening and adopted criteria for at number of product groups. The aim of this chapter is to discuss the trends that are seen and further, whenever possible, to identify common patterns. Such patterns can be useful in future criteria developing.

6.1 **Criteria design**

From the work described in former chapters it can be summarised that the concept for design of criteria depends on the following characteristics of the product.

Among others the characteristics are related to:

- which life cycle phase the environmental key features are linked to,
- to which extent it is the same environmental parameters that are identified,
- how similar products made by different materials can be compared.

These requirements seem rather obvious but when AHWG-members and the European Commission add the demands that the number of criteria should be at a minimum and that the criteria at the same time should be clear and transparent, the design of criteria sets gets quite complicated.

For the 15 product groups that currently (primo 2000) are adopted in the EU-labelling scheme the number of criteria varies significant. The number of criteria for a single product group varies in a range between 4 (washing machines)[19] and 34 (textiles). Apparently the criteria are concentrated on certain phases of the life cycle in several of the adopted criteria sets. As shown in chapter 5 ”Methodological aspects analysed on the basis of the adopted criteria ” the reason for this tendency is closely related to the character of the product. E.g. the production of textiles covers a large number of different processes for which the difference between average solutions and application of best available technology is large. Opposite for the criteria for washing machines that are concentrated on the use phase. The environmental impact in the use phase is linked to relatively few well defined parameters (energy, water, detergents, best practice instructions). The approach for criteria design is simple compared to the textile products.

Criteria can only be clear and transparent if they contain the same kind of parameters. The key issues for the same kind of products made of different materials are hardly the same. Neither are the parameters to describe the environmental impact.

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19) Some criteria sets are now 2. generation and has been changed. However, the general perception is varying.

When turning from equal parameters to allocation and assessment factors transperancy is decreased. However, this is the essence of LCA methodology - the tool designed in order to be able to assess different manufacturing systems for the same functional unit.

Therefore the design of criteria has to overcome this crossroad either by redefining the scope of criteria development, narrowing the product groups or making specifications for the use of LCA-methodology. This crossroad will be further discussed in chapter 7 Discussion and future development of criteria ".

As earlier mentioned the definition and the particular role for the analysis of a functional unit are defined in different ways in the studies concerned. In some studies the definition of product group and the definition of functional unit are defined very narrow, e.g. bed linen of cotton, polyesters or blends hereof or textiles of 10 different sources of fibers. From a product related point of view this can be problematic - especially when products or materials manufactured by different processes should be compared.

When the environmental key features are linked to the pre-production phase it does not influence much on how the functional unit is defined. It is more important that the specific manufacturing processes which cause the basis potential environmental impact and thereby give rise to the key features of the product are described by a well-defined unit, which suits normal rutines for environmental reporting and auditing of the particular manufacturing system.

For instance for the paper- and pulp-based materials (copying paper, toilet paper and kitchen rolls) most of the criteria are related to a weight-based unit of the product. The reason is that the main environmental key features of the products are linked to the pulp processes and paper manufacturing activities. The functional unit for the product is not a central issue for establishing well-defined criteria for this product group.

However, this discussion is closely linked to the balance between the functional unit and the fitness for use aspect. The range of quality of the substances made in the pre-production phase is for many products linked to the selected processes for the manufacturing. The demands for quality related to fitness for use aspect and the functional unit do for many products affect the environmental impact of the pre-production/production phase.

This is the point concerning paints. Due to the fact that the opacity is linked to the amount of TiO_2 added to the mix and the production of TiO_2 is the environmental key feature of the production chain, there is a close relationship between a well-defined functional unit, the fitness for use aspect and the environmental impact of the product.

6.2 **Relations between design of criteria and the LC-screening**

The relations between the LC-screening reports and the formulation of criteria are not always obvious. One reason is that the formulation and level setting of criteria very often are done by complex negotiations based on long discussions between the interested parties of the AHWG (NGO's, national competent bodies and industrial representatives, the consultants and the Commission). In the beginning of the EU eco-labelling scheme the final design of criteria was often done several years after the first draft of the re-

ports. Thus, the criteria were often based on additional data and technological concepts to what the first draft is based upon or the design of criteria was redesigned. The copying paper illustrates this route for adoption of criteria. However, the speed of this process has increased dramatically.

The quality and the focus of the LC-screening has a major influence on the way criteria can be designed and in the end it also influences on the precision of the criteria.

For other groups the LC-screening can not be used as a basis for priority of key features, no matter how correct and adequate this activity is actually made. The reason is that the products made for the same purpose can derive from processes that are so different that design of criteria covering all processes are considered quite difficult. This is the experience concerning thermal insulation products that are manufactured of either polymers, wood, stone or glass. Further they are more or less processed during manufacturing (by different processes). At last they have different properties during the use phase appart from the property of insulation (construction temperature, weight, volume, moisture resistance etc.). It is very difficult to make transparent criteria for this product group without dividing the materials in several comparable groups.

6.3 **Life cycle phase**

The specific life cycle phase that the criteria are linked to varies significant within the different product groups. This is due to the character of the products. The general picture is that criteria are placed in the phase where they origin. However, there are variations to this. For hair spray, there is established a criterion on the VOC content in the product. The impact to the environment of the VOC is in almost all life cycle phases. The criterion on the content is thus a both direct and indirect way to deal with this. For paints and varnishes the energy consumption of extraction (pre-production) of TiO_2 is of major concern. Instead of only having a criterion related to the energy consumption while extracting the matter is also dealt with in setting a criterion for the TiO_2 content in the product. TiO_2 is not considered to be an important environment issue in itself. As can be seen, criteria are set up both for the life cycle phases where an issue is directly relevant but also sometimes in phases other than where the environmental issue is relevant. For instance waste paper is used in the paper production in order to reduce the waste aspect and at the same time contributing to lower emmissions from the production phase. This indicates that the criteria really are based upon a screening of the entire life cycle. The criteria focuses on the manufacturing of cleaner products rather than on how clean the technology in the production of the products is.

However, it should be highlighted that when no key features are within the production phase, the conclusion is not necessesarily that cleaner technology is not relevant for the specific production. It is a fact though, that within the proportions of the life cycle phases the manufacturing phase is not the only phase, that is relevant for the specific product group. The production and the choise of technology linked to the manufacturing system can, when analysed from other points of view be of particular importance. This could for example be the case concerning degreasing and varnishing of elements for washing machines and dish washers. The issues are not part of either the inventory or the final criteria, but they might very well be a key feature when considering the manufacturing system as a black box.

The holder of the license of the label will very often be the manufacturer of the product. Depending on which phase of the life cycle the criteria are linked to (pre-production, use phase etc.) the holders ability to demonstrate compliance with and administration of the criteria is varying. The holder can select the subcontractors. He/she has to rely on their performance which can be invisible on the final eco-labelled product. The emissions and energy consumption when extracting TiO_2 are not possible to measure in the final delivered pigment. The liberty of action for the licence holder is reduced to the selection of a subcontractor and no further action can be taken by him except reducing the use of the pigment.

When the criteria are within the use phase the actual performance is often settled in the pre-production phase, e.g. the consumption of energy is decided upon in the design phase. This means that several products on the market never will be able to fulfil the criteria unless the manufacturer redesigns the product or replaces some of the subcontractors.

If the criteria are pointing towards the subcontractor several issues are getting uncertain for the holder of the licence. This concerns both the control of the subcontractor for the specific product and the control of the parameters in charge of the subcontractor.

Furthermore, the holder of the licence will always have challenges in handling environmental impacts in other life cycle phases than his own (pre-production and production). As illustrated by the criteria for washing machines the environmental key features to some extend can be controlled by actions taken in the design phase.

As mentioned in chapter 5 ”Methodological aspects analysed on the basis of the adopted criteria ” most of the criteria for textile products are related to either the pre-production or the production phase. In fact the environmental key features for many textile products are related to the use phase concerning use of energy and discharge of waste water during laundry of the products (15). However, these activities are out of the direct control of the holder of the licence. At the same time this example indicates the limits of life cycle related key features when focusing on a single product during design of criteria. The key features for the use phase of a garment product have to be covered by criteria for washing machines and detergents. This is pointing towards that the future selection of product groups should indeed cover product systems. This will be further discussed in the next chapter.

6.4 Cleaner technology and cleaner product aspects

For many product groups the specification of the criteria and the interaction between different criteria is a question when discussing how and when the criteria will promote cleaner technology. Specific criteria limiting emission of certain parameters are regarded as an environmental improvement of the performance of a manufacturing system. However, there is a level for the limit of lowering emissions of specific parameters without fundamentally changing the chosen technology.

The effluents for COD for example can to some extend be lowered both by waste water treatment, recycling and alternative technical solutions within specific processes. In some examples a further lowering beyond a certain limit causes further and other environmental impacts, e.g. emission on CO_2. Waste water treatment is energy consuming. There is an environmental

break[20] even when discussing purification of the "last fraction" of organic matters. However, in the studies in question it seems that the selection of parameters are guided by the data available. Thus, criteria are focused on lower values of parameters which have been defined as key features earlier. The COD parameter is a good example. The COD loads from pulping exceeded 1500 kg per tonne earlier on (26). Today, 15 kg per tonne is a common level in modern mills. Despite this, the parameter is still rated as a key feature without surveying the environmental impact caused by the waste water treatment needed to get this value.

This discussion is both a matter of the environmental impact assessment and the system bounderies defined for the product concerned.

The concept of *cleaner products* was (at the beginning) beyond the scope of this study in which the focus should be pointed towards implementation of cleaner technology (i.e. environmental improvements in pre-production and production phases).

When analysing the complete life cycle of a product group the phases concerning cleaner technology (pre-production and production) for several products are of minor importance as cleaner technology will only contribute very little to the total environmental impact in the life cycle. Since the criteria are intended to reduce the environmental impact from a given product in its entire life cycle, the focus is not necessarily linked to the production phase.

This aspect was not very clear from the beginning of this study and when the EU-Scheme for environmental labelling of products was initiated the focus was oriented towards information of the consumer about the environmental performance of the product as a method for implementation of cleaner technology too. In the meantime there has been a mutual recognition of cleaner technology as an integrated part of the cleaner products policy. Naturally, the environmental key features of the products are not necessarily linked to the manufacturing process. To some extend this recognition has been influenced by the results of environmental screening activities of products within the eco-labelling schemes. Today it is recognised that environmental impacts do not disappear by cleaner technology alone. Environmental impacts are a consequense of the products' entire life cycle.

6.5 **Source basis for criteria**

The sources used as a basis for the design of criteria mostly depend on the character of the key features that are in focus for the specific product group (e.g. which life cycle the specific key features are linked to).

Lists of different contaminants, hasardous materials etc. serves as basis for several criteria. The essence of this is, that the environmental assessment is external of the projects or in other words the projects are based on assessments experienced for other (earlier) purposes.

The levels of environmental impacts from the pre-production and production phases are mostly based on data from companies involved in the specific manufacturing chains. Earlier the data was of rather poor quality. The data quality has increased dramatically on the basis of development of environ-

[20] This probably varies from the economic break even.

mental reporting systems and a more conscious registration of the flow of in and output in the manufacturing systems.

6.6 **Basis for levels**

The study has shown that the basis for levels are closely linked to the selected environmental key features and the provided knowledge of these features.

In designing the criteria environmentalists/consultants and civil servants have faced the difficulties in fixing a value of an environmental parameter so it will cover the 30% of the products which performs most environmentally sound. There are several reasons for these difficulties:

Firstly, the different parameters selected do not necessesarily act proportionally. Processes giving rise to low emission of one parameter are perhaps high on others. The pattern of emission levels can rarely be described as a normal distribution. Thus the level on one parameter can cover 80% of the trade and the best performing standards for other parameters might either cover 5% or all of the manufactureres.

Secondly, the basis for levels is linked to the quality and age of the data provided in the inventory. The quality of data has always been a matter of discussion in the AHWGs. Thus levels of values of specific parameters have been rejected on the basis of the quality of the presented data.

Thirdly, it seems like a tendency of conservatism hits the choise of parameters despite the possibility of substitution. E.g. the level of AOX continues to be discussed when criteria for paper-based products are designed despite it is possible - and often happens - to avoid the AOX-relevant emissions (fully eliminating chlorine as the bleaching agent).

When the features and criteria concerns toxic and carcinogeniceffects of substances used or contained in the products, the basis is dominated by levels defined by internationally based organisations and institutions or investigations performed on large scale by well approved laboratories.

This is illustrated in the criteria for textiles (bed linen and T-shirts) where the levels for chemicals and toxicity are based on lists published by different organisations.

These lists prove to be very useful for this purpose because the criteria can be designed on the basis of these lists when it is relevant, i.e. when the substances concerned are part of the processes or substances. In this context several organisations for different manufacturing systems have established lists which in some examples are more detailed than the lists developed by environmental authorities (e.g. CEPE (The European Confederation of printing Ink and and Artist Colours Manufacturers Associations) recently published a negative list concerning substances in inks and dyes) (27).

In addition the European Commission has developed several lists concerning carcinogenic and hasardous substances. These lists are included in several criteria sets.

7 Discussion and future development of criteria

Originally the aim of the study was to survey the methods and data used as background of design of criteria for specific product groups in order to give input to general guidelines for future development and design of criteria. Within this aim the study also focused on the ability of implementing cleaner technology and cleaner products by design of criteria. A more differentiated picture than anticipated in the first set up emerged during the study.

This finalising chapter firstly provides an overview of the overall picture of the development within EU eco-labelling scheme. Introducting this chapter presents a few statements about methods, data and horisontal and it discusses the outcom of the project in general. Thereafter, aspects relevant for the future development are discussed specificly.

Firstly, the *studies* turned out to be very different both concerning the methodological approach used and the way of designing criteria. A brief view would judge this as methodological inconsistency but when going through several studies another picture occured. The conditions for the studies turned out to be very irregular due to lack of data and other essential information. In addition the characteristics of the product groups turned out to influence heavily on how the analyses were performed and criteria designed. Each study turned out to include unique aspects in several ways leaving the possible standardisation of criteria design very difficult. The characteristics of the analyses were often affected by the specific life cycle phase(s) where the environmental key feature(s) was (were) located.

Secondly, the study showed a crossroad concerning the aim of transparent criteria. The reason is that the EU-Commission tries to define wide product groups in order to be able to cover large market volumes by the same set of criteria. By expanding the product group the number and complexity of criteria increases rapidly. There are three possible solutions to this paradox. Either to accept more narrow defined product groups or accept more complex design of criteria or at least by making several sets of process related criteria for the same (wide) product group.

Thirdly, the study shows a demand for further standardisation and simplification of specific and horisontal environmental features. Whenever approved lists exist they are used as a simple effective basis for criteria, e.g. use of substances listed in a certain list is prohibited.

The projects show different approaches to horisontal aspects e.g. energy consumption andtransport both concerning methods and complexity. This area develops a crossroad, too. One way is to develop accurate, sophisticated modelling and calculation methodology in order to have very accurate measurements of horisontal elements. Another way is to have rough estimates.

Basically, the result of the study is that the crossroads mentioned have to be solved or decided before it is possible to develope a more direct and adequate methodology for eco-labelling routines. The antagonisms linked to demands of transparency along with aims of wide product groups can only be

solved by narrowing the product groups or by accepting more complex sets of criteria.

The study demonstrates that development of criteria for a product group by the rigid imagination of going through the 6 working phases presented by Groupe des Sages, makes a simple and wrong picture of the adequate procedure for this kind of tasks. The steps in the procedure are all right as such, but much more focus on the iterative procedure and how to involve this in the methodology will be a great advantage.

This in fact corresponds with the approach used in LCA's.

In this chapter, input to future development of criteria based on the experience obtained by the examination of the products that currently are ready for labelling under the EU-Scheme are discussed. The identified themes are relevant for future criteria development and for the ongoing revision of the EU Regulation. The guidelines include several links between the location of key features in the life cycle, definition of functional unit/fitness for use and the final design of criteria.

In general, there is a demand of transparency in the process of developing criteria as well as in the background documentation when a set of criteria is adopted. The demand of transparency already started when the first regulation was adopted and has been further emphasised by the guidelines of the Groupe des Sages as early as 1994. Below, different aspects of demand of transparency" are highlighted and discussed.

7.1 The demands of transparency

7.1.1 Definition of product groups

The complexity of criteria varies significantly. For several product groups the complexity of the criteria is linked to the wide definition of the product group. The intention of a wide product group definition is usually to increase the market volume of the product group that can be covered by the same single set of criteria. Often the wide variety of products fulfilling the same functions increases the complexity of the criteria.

How broad the product group is defined depends on the type of product, but it is evident that the broad product group definitions are much more prevalent in the EU-Scheme than other eco-labelling schemes. In the two last mentioned schemes many product groups are narrowly defined. For instance, the criteria of thermal insulation were in the EU-Scheme defined almost as broad as possible, starting at "thermal insulation of walls" but ending at "thermal insulation of walls and roof". The reason for the broad definition that actually became even broader was the wish of not excluding specific applications and materials. This reasoning was supported from all sides during the process since it soon appeared that there is a large cultural heritage regarding how and which thermal insulation is applied in different countries. This is true both for the actual applications that are chosen and for the materials chosen for the application.

7.1.2 Criteria based on hurdles or point-based matrix systems

For some product groups the criteria are linked together by a point-based matrix system. The idea of this method is in general that different technologies are used to produce the same function and the environmental profiles of these processes are very different from each other. In order to be able to compare different processes that might have an advantage for some environ-

mental parameters and a disadvantage for others, each individual contribution is linked in a matrix system. Basically, the sets of criteria promote cleaner technology and if the right multiplication factors are selected, these kind of systems should be fair for the different processes involved for the same product group. Like other sets of criteria the point/matrix system also involves hurdles that should be met in any case.

Until now the point systems only have had moderate succes. It has been argued both by AHWG-members and NGO's that there is a lack of transparency when criteria are designed and linked by point systems. It is difficult to assess if the levels that the point system dictate are high or low before the data of several productions (with well known environmental profiles) are placed in the point-based matrix system. And even then the result is a matter of much continuous discussion both in the AHWG's and in the environmental debating in the press. Especially concerning the art of being able to assess and compare the importance of different environmental parameters.

There are in general demands especially from the industry and its organisations to keep the number of criteria on a minimum in order to reduce the cost of administration and control of criteria. However, the industry seems ambigious on this issue. During the discussions about converted paper products, the industrial organisations on one hand tried to reduce the number of criteria and on the other hand it was criticised that there were no criteria specifically concerning the converting processes and the different properties of the same kind of products.

The discussion of combining several environmental parameters is linked to the discussion of LCA methodology (normalisation) and is central in the handling and assessing of different impacts. For the two paper-based product groups toilet paper and kitchen rolls the point related criteria was made in order to cover the different kinds of pulping methods (sulphite, mechanical, magnephite and sulphate). A mechanical pulp has very low COD emissions but the energy consumption is high compared to the chemical mills. A point system designed to cover such ranges can reduce the work of designing criteria compared to the alternative of making a single set of criteria for each kind of pulp. However, the point system turned out to be regarded as non-transparent and the concept was later abandoned for copying paper. As a result the point system concept has never been considered during the following study of converted paper products.

If a matrix is based on well-known data of different manufacturing methods it could be argued that the transparency could be lost if the different processes got separate hurdles which kept each of them on the best environmental performance. And if the matrix is based on uncertain data, the criteria are based on an insufficient basis anyway.

7.1.3 The implication of the transparency demand on product group definition, fitness for use and functional unit

Demands of transparency are closely linked to the definition of the product group, the fittnes for use and the functional unit. Transparency is easy to achieve within a narrow well-defined product group, but the market volume will be limited. Thus the environmental improvements will also be limited. The same could be argued for fitness for use and functional unit. The transparency can easily get lost if it is not certain which of more functions that are valued in a study.

7.2 **Identification of key features**

The identification of key features is both during this study and by Groupe des Sages recommended to be identified on the basis of the Life Cycle Inventory. This is contradicting to what happened in many studies, since the identification of key features for many kinds of products is given from the beginning. In these cases this is based on different interested parties' environmental presumptions about the product group. In the study of hairspray these presumptions were dealt with directly, while in the study of light bulbs the presumptions were incorporated as well qualified input to the process - even before the inventory was performed.

The main task during the life cycle screening is in many eco-labelling studies to find the most suitable *level* for the parameters concerned. As mentioned earlier this task gets more complex each time a new parameter is added. Another main task is to link these well known parameters to a functional unit of the product that can be handled easily by the holder of the licence.

In the guidelines from Groupe des Sages: some antagonisms can be identified. It appears in the description of the inventory analysis that is introduced as follows:

> *The inventory analysis should be comprehensive. It should not be guided by pre-concieved ideas. However this does not exclude subsequent research on key issues, based on obtained results which should be scientifically recognised and agreed upon by all interest groups (Groupe des Sages 1997).*

For some product groups the environmental key features are obvious. For other product groups the inventory shows several gaps for which the environmental impact is totally blank, e.g. it is mentioned in the paint study that the total spillage of paint in the application phase (the use phase) is 30%. This is an estimate and no further reflections are presented concerning this issue. One could argue that if the waste of the paint product was that high then efforts to reduce it should be part of the criteria. Just a few percent of reduction could reduce the environmental impact of all the other life cycle phases in proportion with the same amount (the same percentage). However, this did not take place.

Environmental key features are not always suitable for a manageable set of criteria, no matter how obvious the environmental impact of the parameter is, e.g. the environmental key features for many garment products are the washing processes in the use phase. But this proces is not in control of the potential holder of the license but must be covered by eco-labelled detergents, washing machines etc.

7.3 **Demands for standardisation of environmental elements**

Criteria concerning chemical substances do for several product groups refer to lists of chemicals. For instance criteria for T-shirts and bed linen are linked to lists of toxic pesticides and other chemicals. This is a short cut in designing the criteria because the evaluation and assessment of the chemicals is done earlier when the substances are categorised in the lists. However, this implies that the lists are approved by authorities and the organisations taking part in the work.

In parallel, equal handling of several horisontal elements would easen the design of criteria, e.g. several approaches have been found to calculate and rate energy consumption and the related emissions and most of the approaches are not fully alike. This item will be further discussed below.

7.4 The linkages between functional unit/fitness for use and environmental key features

The functional unit is the key to compare environmental performance of the products (chapter 3). For some products it is essential to link the functional unit to fitness for use criteria.

For others this linkage however LCA-relevant will complicate the administration of the labelling activities for the company in charge.

E.g. for paints the linkage is obvious, because the performance of these products is affected by the environmental features. The more titandioxide contained in the paint the better opacity. At the same time the pigment is a central environmental key feature since a large proportion of the waste and energy consumption comes from the manufacturing of titandioxide. As a result the property of the paints is linked to the environmental impact. Therefore it is reasonable to link the fitness for use to the criteria whenever possible.

However, this is not the condition for all product groups. E.g. for the paper-based products the environmental key features mostly derive from the pre-production phase, no matter for what purpose the paper is manufactured. The pulp and paper processing are dominating the environmental parameters concerning emissions and energy consumption. In some instances there is a correlation between the quality of the paper product and the weight and therefore also to the environmental impacts. The environmental impact from one kg of toilet paper, one kg of kitchen rolls and one kg of copying paper is equal and is in all cases linked to the pre-production phase.

Therefore it is reasonable to design some criteria in relation to a weight-based unit despite the fact, that the weight does not necessarily have anything to do with the function of the product and thereby no relation to a functional unit either. For the paper products it could as well have been m^2 or the ability to absorb different matters.

For paper products the weight-based unit has another advantage because the paper usually is traded in weight and parameters from the environmental reporting from pulp and paper mills are related to weight units. Thus the environmental parameters can be part of the technical specifications when ordering the raw material from the supplier. The transparency of the criteria for copying paper is therefore obvious because the levels of the criteria can be directly compared with the values in environmental reports from the pulp and paper mills.

Thus, the balance between the functional unit and the fitness for use aspect depends much on the characteristics of the product. The criteria can for many products be related to a well-defined functional unit, i.e. a weight- or amount-based unit. But in order to ensure that the property or the quality of the product is not reduced by taking environmental care, the fitness for use aspect can be an independent criterion besides the functional unit. For example concerning the paints it is obvious that if the environmental considerations reduce the lifetime or the opacity of the paint, then a weight-based comparison is not adequate for this product group. For paints and varnishes a

criterion exists both related to the fitness for use (a minimum requirement for the opacity) and it is incorporated in the functional unit.

The right decision is very closely linked to the relation between the defined functional unit and the fitness for use and to the character of the individual function or product. Therefore, an advice could be to take into account matters like: In which life cycle phases are the environmental key features located? Who is the coming-to-be holder of the licence? How does the environmental loads affect the performance? Property of the product?

7.5 Links between product group definition and functional unit

In parallel to the discussion of when in the process it is possible to define key features, the selection of product groups and definition of the functional unit are given some thoughts. The full schedule of design of criteria is presented in chapter 2 ”Methodological aspects - Vocabulary”. In the first 3 phases (preliminary choice of product group, market survey and inventory) of the establishing of criteria the view of the product group can change several times.

From first sight it seems like a logical way of decisionmaking but when going into details these 3 phases do interact. One of the reasons for this antagonism is based on the intention of defining a functional unit that covers several product groups fulfilling the same functions. The covering of as many products as possible could be seen as both an optimisation of obtaining the maximum volume of a single set of criteria and as an attempt to overcome different national variations. When enlarging the product group definition it reflects the function (indirectly) as well. For thermal insulation the inclusion of a great variety of products also includes more functions like construction and noise insulation.

Another example of the iterative nature is the definition of product group in the preliminary phase. If it later appears in the market survey that the product group is too narrow (meaning it only includes a minor proportion of the market) this could lead to redefinition of both product group and functional unit.

In all the LCA standards that were not yet adopted when the EEC regulation was adopted, it is heavily emphasised that LCAs are an iterative process.This means that one has to go back and forth in the LCA process until expectations and possible achievements are adjusted to each other. In principle nothing hinder the same approach to be applied in the eco-labelling except that this process is done in a political, multinational arena. In the political multinational context it can be very difficult to change decisions - even upon new knowledge - if a certain degree of harmonisation (finally) has been obtained.

7.6 Standardisation of horisontal elements

The horisontal elements (energy consumption, emissions from transport, electricity etc.) are very heterogenious in the studies so far. The electric power generation is different within the borders and that affects the emissions from electricity. The current development in the common European energy market as well as the latest development in LCA seems to make the decision more simple in the future. The cohesion of the European grid seems increased over borders and by then electricity produced in one part of the

community will often be utilised after crossing several borders. The traditional concept that the emissions should be linked to the manufacturer is definitely unlogical concerning the manufacturing of power. Like the standardisation of assessments of chemicals a simple formular for electricity would make design of criteria much easier.

The quality of electricity is the same no matter what type of fuel or technology is used to produce it. Therefore electricity based on cleaner methods, windturbines or hydro power is able to substitute coal- or oil-based energy in other parts of a region. On this basis the power should be treated equally since the hydropower could substitute coal-based power. This area has changed dramatically within th last couple of years (1997-1999) and has to be considered carefully in the near future due to discussion of market-based marginals.

The LCA development seems to support this. The right dogma seems at the moment to be that if the purpose of the LCA is decision-making like for the eco-labelling the data should be market-based.

7.7 The role of the consensus orientated decisions

The process of developing criteria affects the final results for several product groups. When strong interests are represented in the AHWG the focus of the analysis is not only directed by the advice of the consultant but very much by the statements and oppositions from the members. Apart from competent bodies from different EU-countries the AHWG usually consists of industrial organisations, NGO's (mainly environmentalists) and others who each of them all put their effort on different points.

The *national bodies* have an interest in getting the criteria oriented in order to suit their industries, environmental regulation and recipients.

The *industrial organisations* have an interest in getting the criteria oriented in order to suit their members. Since industrial organisations are very often trade-based the motivation to get the criteria designed and levelled so they do not affect the average activity of their members is obvious. If these AHWG members forced the levels so only a fraction of their members could be labelled, they would conflict their own justice. Further more reduction of environmental impact based on new investments and costs is always treated as negative in the economic terms.

The environmental NGO's force the design of criteria in another direction by putting efforts in getting the levels oriented so the environmental impact is reduced as much as possible. Since environmental improvements are their single goal their points can often be impossible to reach but their voice can have the result that the specific item is left as a possibility for criteria.

7.7.1 Changes due to the consensus oriented decision-making process

When the facts from the studies of a product group are grinded in the discussion processes by the AHWG, the final result of criteria can be far from the first draft of criteria. There is much reasoning for this. I.e. the basic definition of the product group can be changed during the processes causing split ups of the product into subgroups or extensions of product groups.

Due to the many iterative processes the reports of each product group can not be studied in isolation. The final criteria are based on many arguments - some of these can be obtained from the life cycle screening in a draft report,

while others are put forward by the members of AHWG during the AHWG meetings.

7.8 The range of eco-labelling as an environmental regulation tool

The present survey examines the methodology used in the background studies of the product groups criteria adopted within the EU eco-labelling scheme and gives an overview of the limitations and possibilities for the use of eco-labelling as a voluntary tool of environmental regulation. The experiences from this examination points out several issues.

When the entire life cycle of the products are screened the environmental key features often can be located in activities that relate to suppliers rather than coming-to-be eco-labelling holder.. This is the fact for paints and varnishes where the environmental key features and the following criteria are related to emissions during production of the pigments. The action taken from the paint and varnish manufacturer concerns selection of subcontractors that are able to fulfil the criteria. For converted paper products the same conditions appear since the environmental impacts from the converting processes are of minor importance compared to the pulp and paper process.

The demands on keeping the number of criteria on a minimum in combination with sufficient transparency of them causes difficulties if the criteria should both cover the environmental key features from a product related point of view as well as a trade related approach. If transparency and a limited number of criteria should be emphasised it is obvious that some environmental features must be ignored. It is also obvious that less parameters eventually can lead to less equality if different methods to obtain an equal function has to be assessed with few parameters.

All this indicates that environmental labelling is a supplement for other kinds of regulation and not a substitute.

7.9 Products' suitability for eco-labelling

When the scheme was established several requirements were listed as preferable for products which should be labelled.

When selecting the product groups considerations should be made. Below a few of these considerations are mentioned:

- relevance for the environment, and for the use of natural resources,
- interest of consumers and the general public,
- interest of industry and other interest groups,
- international aspects.

With the analysis in this study in mind one could question these requirements for selecting product groups. The tendency of the experience shows that other demands might suit (and be included in) the process as well. An important issue is the possibility of defining the product group and how closely it is linked to the functional unit. If this alternative way of selecting new product groups can not be accepted then there definitely is a need to accept more complicated screenings and more complex design of criteria.

The selection of product groups for coming labelling activities should take these discussions into acount.

One approach could be to establish labelling systems for groups of products like it happened (although without the intention) with textiles, detergents and washing machines. This is pointing towards that the future selection of product groups rather should cover product systems.

7.10 **Final views of future development of criteria**

This study shows that it is not possible to make a simple standardisation of the study as a basis for eco-labelling of products. On the basis of the criteria examined in this study the experience could be listed in the following items:

- Product groups have to be selected carefully in order to avoid complicated limitations late in the work. Selection of product systems might be a relevant solution.
- The balance between functional unit, fitness for use and design of criteria should not be handled as rigid as earlier proposed since this will not necessarily promote either design of criteria or the later administration by the holder of the licence. In other words the iterative approach has to be kept.
- Agreement of some parts of the impact assessment, e.g. normalisation of global and regional impact would ensure that some issues would be treated equally in all criteria-development-studies. This could both lead to less time consumption in the development of criteria as well as more transparency.

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