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Model for selection of future target areas in the Danish Program for Cleaner Products

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Summary¹

During the past five years the main efforts of the Danish Program for Cleaner Products have been focused on selected industrial sectors and anchored in the respective trade associations. Experience shows that this procedure in most cases is successful.

However, an industrial sector-oriented action often starts with the production of the goods while the phases of use and final disposal of the products with their associated environmental impacts not in the same degree are subject to action. On the other hand the action has to be anchored on a suitable place and the trade associations appear to be useful in that context.

The very ideal of a future action would be to focus on improvements during the whole life cycle of the products and to involve trade associations and similar centrally placed players.

Background and aim

The Danish Council for Cleaner Products launched in the year 2001 a project for the development of a “Model for selection of future target areas in the Danish Program for Cleaner Products”. The model should assure that the future product-oriented actions had focus on the most relevant products and create a concise and correct basis for environmental assessment of all product groups. The model should also facilitate the selection of future areas of action.

The present project has the aim of developing the first, preliminary issue of such a model. The project is a forerunner for a more detailed study, which aim is the further development of the model as well as to strengthen the weak spots, which by nature are inherent in a first issue of a screening-based model.

A secondary aim of the project has been to relate the industry-oriented product actions carried out until now with the selection of product groups, which until now have not been submitted to an industrial sector-oriented action.

Method

The model for selection of future target areas consists of an Access-database, which is structured with an input of products and industrial sectors. The database is basically structured around the Danish Statistics of Goods (“Varestatistikken”), the Danish Statistics of Raw Materials (“Råvarestatistikken”) and the Danish Statistics of Foreign Trade (“Udenrigsstatistikken”). All three statistics are issued by Statistics Denmark. In order to have clearness the model operates with a total of 95 product groups (two-digit KN-code level) and 106 manufacturing industrial sectors supplemented

¹ This report comprises the main parts of the Danish report “Model til udpegning af fremtidige indsatsområder under Renere Produkt programmet”. The Danish version includes several appendices that are not translated into English.

with 40 non-manufacturing industrial sectors within the building industry and commercial activities (three-digit DB code level, correspondent to the international NACE code system). Via the Statistics of goods the product groups have been related to the manufacturing industries. Further information allows for calculation of the supply factor, which indicates the economic importance of the product group in Denmark. Via the Statistics of foreign trade the product groups are related to the non-manufacturing industrial sectors (the building sector and the commercial sector are not included in the Statistics of goods). Furthermore preliminary evaluations of the flow through the supply chain have been carried out based on information from the Statistics of goods respectively foreign trade. These evaluations cover the flow from extraction of raw materials, through manufacturing to marketing of finished goods. Since no information about the flow of goods in the supply chains is available, it has been necessary to draw a picture based on information from a number of other statistics.

Input of products

For each of the 95 product groups an environmental assessment has been carried out and subsequently the products have been ranked according to the three levels "High", "Medium" and "Low". This assessment is based on the American input/output database "eiolca" (Economic Input/Output LCA), which comprises information about 485 product groups. The American product groups are to a certain degree comparable to the Danish product groups. By using the American method it has been possible to create a consistent and uniform basis for evaluation of all 95 Danish product groups. This was not possible with the other two methods studied.

An input/output analysis does not cover the whole life cycle, but only the phases from extraction of raw materials until and including manufacturing. Therefore the phases of use and final disposal are not included. This in combination with the fact that the consumption of resources is not included in the environmental assessments probably is the most important limitation for use of the American database.

The database "eiolca" has a large number of environmental parameters of which the following eight have been selected as representative for an assessment at screening level:

| |
|-----------------------------------------------------------------------------|
| Emission of SO ₂ |
| Emission of NO ₂ |
| Consumption of water |
| Green house effect (GWP) |
| Consumption of energy |
| Consumption of copper |
| Dangerous wastes (amounts produced) |
| Total emission of toxic substances (weighted according to degree of danger) |

Figure 1: The eight environmental parameters used in the environmental screening.

For each of the 95 product groups an evaluation has been made with regard to the eight parameters, which results in the scores "High", "Medium" or "Low", and a total evaluation, which is the result of the environmental assessment and also results in a score of "High", "Medium" or "Low". This ranking having three levels has been chosen for the present study while the American method has a number of inherent uncertainties. Also the chosen

level of product groups presents uncertainties. Therefore a detailed ranking having more than three steps does not make sense.

The evaluation of a product group and the subsequent ranking of "High", "Medium" respectively "Low" has been carried out according to the following procedure:

1. For each of the chosen environmental parameters the product groups have been classified according to their environmental impact, starting with the most polluting ones. Subsequently the product groups have been divided into three groups featured by the scores "High", "Medium" respectively "Low".
2. After this a total assessment of the product group has been made based on the scores for each of the environmental parameters. The total assessment also is awarded a score of "High", "Medium" or "Low" according to the following principles:
 - For a product group having three or more environmental parameters ranking "High" the total assessment is judged "High". An individual parameter ranked "High" has thus a relatively higher weight in comparison to a simple average consideration.
 - For a product group having six or more environmental parameters ranking "Low" the total assessment is judged "Low". With other words a product group really needs many scores "Low" to achieve the total score of "Low".
 - In all other cases the product group has been awarded the score of "Medium".

Subsequently as a supplement to the environmental assessment an enviro-economic evaluation has been carried out. In this evaluation the supply factor, which is defined as the total of import and production minus export, has been multiplied by the total environmental assessment of each product group thus expressing the importance of the product group with regard to environment and economy.

Input of industrial sectors

The Access database also comprises information about the product-oriented environmental actions, which have been carried out until now. This information is divided into two parts, the industry-oriented action comprising product panels and branch-related projects, and the product-oriented actions comprising eco-labelling and environmental guidelines for the public purchasers issued by the Danish EPA.

The Access database also comprises information about earlier actions carried out under the Program for Promotion of Environmental Management and Audits launched by the Danish EPA as well as information about categories of companies submitted to environmental approval according to article 5 in the Act of Environmental Protection. This information may at a later time be included in the criteria for selection of a product-oriented action within the industrial sectors.

The development of the model for selection of future target areas and its application in selecting potential future areas of action has been carried out in five steps as indicated below, see Figure 2.

| | |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1: | Relation between industrial sectors and product groups using statistical information. That means which branches are producing which goods. |
| Step 2: | Environmental and enviro-economic evaluations of all product groups. This includes the award of the scores "High", "Medium" respectively "Low" to the product groups. |
| Step 3: | Selection of industrial sectors related to the product groups, which are ranked "High" in both the environmental and the enviro-economic evaluation. |
| Step 4: | Survey of the industry-oriented environmental actions, which have been carried out until now. |
| Step 5: | Selection of potential future areas of action with regard to products and a description of the product groups. |

Figure 2: The 5 steps in development and application of the model

Results of the projects

Selection of relevant product areas

Application of the model for selection of future target areas on all product groups (95) results in 45 product groups being ranked "High".

Simultaneously 34 product groups are ranked "High" according to the enviro-economic evaluation. As a total result, 19 product groups are ranked "High" in both evaluations.

For these 19 product groups it has been studied whether or not an industry-oriented environmental action according to the Danish Program for Cleaner Products has taken place within the related industrial sector. In the affirmative case the product group in question has been withdrawn from the study.

As a result of this, a number of 14 product groups represent a potential area for future product-oriented actions in which areas no former industry-oriented action has taken place. The selected product groups are:

- Salt, earths and stone
- Mineral fuels
- Inorganic chemicals
- Organic chemicals
- Fertilizers
- Miscellaneous chemical products
- Rubber and articles thereof
- Articles of stone, cement etc.
- Iron and steel
- Articles of iron and steel
- Copper and articles thereof
- Aluminium and articles thereof
- Miscellaneous articles of base metal
- Railway rolling stock and signalling equipment.

The above-mentioned potential areas of action have been selected exclusively according to environmental and enviro-economic evaluations. Other conditions such as "High" ranking political issues, the desirability of visible actions, reflections about the industrial sectors interest and willingness to carry out actions, have not been included in the present study.

Former actions have been environmentally relevant

A comparison of the industrial sectors submitted to an environmental action according to the Program for Cleaner Products with the present environmental assessment of product groups shows that the former actions have been environmentally relevant. Industrial sectors such as textiles, electronics, building and civil engineering, plastics, cleaning products, varnishes and paint and transportation which have had or still have environmental actions are all featured by products being ranked "High" in the present study.

Recommended future types of action

In order to choose the relevant type of action for future environmental actions the 14 selected product groups have been studied in detail based on the information in the Access-database. As an example, environmental information for each product group has been examined in order to find the most important environment parameters with regard to life cycle considerations until and including manufacturing. Furthermore the product groups' relation to one or more industrial sectors is described and the main features of the companies covered by the industrial sector have been identified. Information about the economic importance of the product groups for the Danish national economy, the relations between product group and industrial sector, as well as information about import-export is also included in the model for selection of future target areas. A large amount of information has been included in order to carry out preliminary considerations about the supply chain and the potential players in the field. This information is useful for an environmental action including the most important phases in the life cycle of the products.

Examination of the 14 selected product groups also shows important differences. Some product groups are featured by large imports. This applies to goods such as chemicals, rubber, iron and steel, copper and articles thereof. This finding indicates that it is relevant to put focus on international co-operation and supplier management in international supply chains.

Other product groups such as miscellaneous chemical products, iron and steel, articles of iron and steel are featured by an important role of wholesalers/retailers. In this case it is relevant to focus on actions involving both producers and wholesalers/retailers.

The types of action recommended by the present study are as follows:

1. Industry-oriented action targeting manufacturing companies, which until now have not been subject to environmental action. A prerequisite is that the action can be based in a trade association.
2. Supplementary industry-oriented action with relation to on-going activities.
3. Supply chain projects laying emphasis on management in international supply chains.

4. Supply chain projects laying emphasis on manufacturing, use and final disposal of the products in which producers, wholesalers and retailers are involved or in which the users have influence on the earlier steps in the supply chain.
5. Individual projects laying emphasis on utilization and spreading of existing knowledge including the use in public tenders.
6. Inclusion in other product groups such as product groups comprising primary raw materials and sub-products.

For each of the 14 selected product groups it has been examined which of the above-mentioned types of action present the most promising potential. Different types of action may be relevant to one product group.

Further development of the model

The model developed in the present project is based on screening. That means a number of delimitations and choices have been included during the process of development. By nature this has influence on the decisive power of the model.

The strength of the model for selection of future target areas is that it gives a uniform and consistent environmental base for selection of relevant product groups for future actions. The disadvantage of the model for selection of future target areas is primarily related to the information of American origin and the selected level of details concerning product groups and sub-trades.

Due to the fact that the American database is based on input/output analysis the phases of use and final disposal of the products are not included in the life cycle considerations. This should be kept in mind and emphasized in a possible further development of the model. Furthermore information about the consumption of resources and other environmental aspects such as waste and chemicals should be included in the model since these aspects are not respectively to a limited extent included in the American data base.

In order to handle the amount of information related to product groups and industrial sectors on a screening level a superior level comprising 95 product groups, 106 producing as well as 40 non-producing industrial sectors has been chosen. This choice implies that some information has been put together and therefore may cover a broad spectrum of products and industrial sectors. In a possible further development of the model for selection of future target areas the degree of details should be increased where practical possible. But it cannot be taken for granted to have access to more detailed information since the existing information already at the present level is limited due to confidentiality.

1 Methodology description

The chapter describes the methodology developed in the project “Model for selection of future target areas in the Program for Cleaner Products”. The description focuses on a number of new elements in environmental assessments and how they are combined with other types of statistical information. Not all details are given in the paper, and the interested reader is therefore referred to the original report “Model til udpegning af fremtidige indsatsområder inden for Program for renere produkter” (“Model for selection of future target areas in the Danish Program for Cleaner Products”), which contains some more details.

1.1 Purpose of the study

The purpose of the project was to develop a preliminary model for screening/identification of possible and relevant areas for future environmental efforts towards products and product groups as a part of the Danish Integrated Product Policy. The purpose signals a shift from a sector-orientated focus to a product focus and as a consequence it requires that new information sources are explored.

The model should be used to identify 3-5 relevant areas (sectors or product groups) for the product orientated environmental efforts in Denmark in 2002. Subsequently, the model should be developed further in order to support the Danish EPA in its future efforts for cleaner products.

The focus for the development of the model was on products and product groups rather than on sectors. In order to be able to implement the future efforts it is however necessary to know which sectors produce the product groups that are identified in the prioritization. In order to create and maintain this overview, all basic information and intermediate calculations have been stored in a database in Access, allowing for fast data retrieval as well as new calculations.

1.2 Methodology

The screening and prioritization is done in a six-step procedure that is outlined in Table 1.

| Step No. | Action | Result |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1 | a) Coupling of sub-sectors and product groups (based on information from Statistics Denmark) b) Establishing of figures for production, import and export for product groups (also from Statistics Denmark) | Overview of the sectors producing (selected) product groups Overview of the economic importance of the selected product groups |
| Step 2 | a) Environmental assessment of all product groups (using the EIO-LCA-software) b) Weighting by their economic importance | a) Overview of the environmental impacts from different product groups Ranking of product groups in three groups (with low/medium/high environmental impact) Ranking of product groups by combining environmental and economic importance |
| Step 3 | Selection of sub-sectors producing product groups with a "high" ranking in step 2 | Overview of the sub-sectors producing the "high"-ranked product groups |
| Step 4 | Mapping of previous sector-related IPP-efforts | a) Overview of the efforts so far b) Identification of sectors where none or limited efforts have been initiated c) Overview of sub-sectors producing product groups with a high environmental impact and no dedicated efforts so far |
| Step 5 | Mapping of the action potential in the sub-sectors pin-pointed in Step 4 | Overview of the basis for future efforts in the selected sub-sectors |
| Step 6 | Selection of 3-5 possible and relevant areas for the Danish efforts in 2002 | Selection and description of the knowledge compiled for the sub-sectors and their related product groups. |

Table 1.: The six step procedure in the selection of product groups

1.3 Step 1 - Coupling of economic information between sectors and product groups

On the economic product level, the core information source is the Danish Statistics of Goods ("Varestatistikken"). The statistics contains economic information about the value of product groups (95 groups in all on 2-digit KN-nomenclature level which is the chosen level in this project) being produced and/or used in Denmark. The respective values for production, import and export are combined in order to find the Danish supply of a given product group (Supply = Production + Import – Export). For import and export data, foreign trade information related to the Statistics of Goods are used to provide the requested information.

On the sector level, the core information regards 106 sub-sectors with a production. The sub-sectors are identified by a 3-digit DB-93 code. The DB-93 code system is a Danish parallel to the NACE code system, the first four digits in the two systems being identical while the two last digits in the DB-93 system are Danish subdivisions. Additionally, 40 sub-sectors from four general sectors (supply of electricity, gas, water and heat, building and construction, trade (retail and wholesale), and transportation) are identified.

Statistics Denmark provided information on the turnover of goods related to the specific production sectors. This coupling is made by using the Statistics of Goods that is based on information from companies. The companies are in turn characterized by belonging to one sector only, i.e. their main business area. With this information a coupling between the goods and the sectors is made, revealing which goods are being produced in which sectors and the value of the production in each sector and of each product group.

1.3.1 Assessment of economic importance

The economic importance is assessed by the Danish **supply** of a given product group rather than the Danish **production** of the same product group.

By taking import and export into consideration the shift from sector to product orientation is stressed. An obvious implication of this in the economic overview is that Danish sectors with a large export will be less important than sectors with a large import of certain product groups. In other words, the focus is shifted from “what can Danish industry do to produce cleaner products?” to “what can the Danish society do to secure that the products used in our economy are as clean as possible?”

It can be argued that the two approaches are supplementary to each other, i.e. that the combined knowledge is more suitable for prioritization of future efforts. This is probably true, and the current pilot project shall therefore be seen as a first step towards creating such an overview. Until it is created, the prioritization must be based on the new knowledge produced by the current methodology in combination with existing information from many years of experience with environmental efforts in Danish industrial sectors.

In practice, nine product groups were identified as having a “low” priority in relation to the supply figures, but at the same time having a high economic importance because most of the produced product groups are exported. Such product groups will always have a low ranking in the combined assessment, and it is therefore essential to examine these product groups manually in more details.

Five product groups had a negative figure for the Danish supply, i.e. there is a net flow of the product out of Denmark:

- Fish and shellfish (primarily produced in the fishery industries)
- Living and cut plants and leaves (primarily produced in the gardening industry)
- Grains (produced in agriculture)
- Furs, fur-coats and artificial furs
- Art-works, collectors' items and antiques

Four product groups were identified as having a large production and a large export:

- Mineral-based fuels, mineral oils and their distillation products, etc.
- Proteins, modified starches, glues and enzymes
- Knitwear
- Optical and photographic instruments, control and precision instruments, medical and surgical instruments and apparatuses, etc.

At the same time, however, the import of these product groups was relatively large and the Danish supply is therefore a relevant indicator.

1.4 Step 2 - Environmental assessment of product groups

The assessment and ranking of the environmental impacts of product groups is based on input/output analysis. Obviously, the most precise result would be

achieved if a (very) large number of life cycle assessments were available. This is not the case and instead environmental input-output analysis was used as the carrying element in the assessment. A number of options were available at the time of the study:

1. The EIOLCA (Environmental Input Output Life Cycle Assessment) software developed by the Carnegie Mellon Green Design Initiative in USA².
2. A Swedish IO-study with a relatively limited number of product groups and sectors, and with a limited number of environmental interventions. The Swedish approach³ calculates the impacts (CO₂, SO₂, NO_x, industrial waste, consumption of chemicals) from 46 product groups. The report summarizes the results and makes priorities that are similar to those established in the current project.
3. An older Danish study⁴, addressing a large number of product groups, but only using resource and energy consumption as environmental indicators.
4. The Danish NAMEA (National accounting matrices including environmental accounts) and PIOT (Physical Input Output Tables). Currently, the Danish NAMEA includes 40 types of energy, the reserves of natural gas and oil in the North Sea, emissions to air of eight types of substances, and trans-boundary flows of these substances to and from Denmark. PIOT tables exist for all products taken together and for various individual groups of products (animal and vegetable products, stone gravel and building materials, wood and paper, metals and machinery, and chemical products and fertilizers).

Option 4 is probably the best choice of model on the long term, because it relates to Danish conditions. It was however disregarded in the present study because it was not possible to determine whether the available information could be made operational at a sufficient level of detail during the very short period of time for the study. Options 2 and 3 were excluded due to the limited details of information in the reports.

1.4.1 The EIOLCA software

The assessment of the environmental impacts from product groups was therefore done using the EIOLCA (Environmental Input Output Life Cycle Assessment) software developed by the Carnegie Mellon Green Design Initiative in the USA. The basic function of the software is that it calculates the environmental impacts when purchasing for a given amount of money from a sector, and it is thus possible to compare different product groups by the same “functional unit”, e.g. environmental impacts per 1 million dollars worth of products within the product group.

Basically, an IO-model gives an overview of the trade in a national economy. It shows how products are being sold from producers either to final consumers or to other sectors for further processing. It can be visualized as a

² Carnegie Mellon University Green Design Initiative. (2002). Economic Input-Output Life Cycle Assessment (EIO-LCA) model [Internet]. Available from: <<http://www.eiolca.net/>>

³ Stockholms Universitets/Systemekologi och Foi 2001. Miljöpåverkan från olika varugrupper, fms Nr. 167, Rapport, Maj 2001. Finnveden G, Johansson J og Moberg Å, fms, Palm V og Wadeskog A, Miljöstatistik, SCB. Forskningsgruppen för Miljöstrategiska Studier.

⁴ Hansen E. Miljøprioritering af industriprodukter. Miljøprojekt Nr. 281, 1995. Miljøstyrelsen

set of large tables (or matrices) with one column and one row for each sector. The tables can represent total sales from one sector to others, purchases from one sector, or the amount of purchases from one sector to produce a dollar of output for the sector. The tables are a result of an iterative calculation, i.e. that production in one sector is based on inputs from all sectors, and the production of these inputs is in its turn based on production from all sectors, etc. An economic IO-model is linear, so that the effects of a €1000 purchase from a sector will be ten times greater than the effects of a €100 purchase from the same sector.

The IO-model in the EIOLCA-software is based on the 1992 goods/goods input-output matrix of the US economy as developed by the US Department of Commerce. The matrix includes 485 groups of goods/economic activities and is among the most detailed in the world. The buyers and suppliers on the market are grouped in production sectors and sectors for final use.

The economic IO-data are supplemented with information on environmental interventions (energy consumption, waste generation, water consumption, emissions of pollutants, etc.) from a number of sources that all are based on measurements and reporting of US conditions. The data for environmental interventions are divided by the annual economic output from each sector to derive average pollution coefficients for each sector. These coefficients are used with the supply chain computations to estimate supply chain pollution upstream of each product group.

The number of environmental interventions in the EIOLCA-model is large, 72 in total. This allows for a very detailed examination of the environmental profile of sectors, but is not operational in a screening procedure as in this project.

Therefore, a number of important interventions were selected and used in the further procedure. The following parameters were selected:

| Impact parameter | Relation to environmental impacts | Comments |
|----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Global Warming Potential | Global warming | Sums up the global warming impacts from CO ₂ , CH ₄ , N ₂ O, and CFC's |
| Sulphur dioxide | Contributes to acidification and human toxicity | |
| Nitrogen oxides (NO _x) | Contributes to acidification, human toxicity and eutrofication | |
| Water consumption | Water shortage | No distinction between water types, e.g. drinking water, ground water, lakes and rivers |
| Energy consumption | Use of non-renewable fuels | Energy-related emissions are accounted for under other headings |
| Consumption of copper | Use of non-renewable resources | Copper is chosen as an indicator because of a low supply adequacy |
| Hazardous waste | May cause toxicological and ecotoxicological impacts during the treatment | As defined in the US EPA Resource Conservation and Recovery Act (RCRA) |
| Total emission of toxic substances, weighted in proportion to the toxicity of the single substance | Human toxicity and/or impacts on ecosystems | As reported in the Toxic Release Inventory, weighted by a method developed by Carnegie Mellon |

Table 2. Environmental parameters selected for the prioritization of products.

The parameters that are omitted from the further procedure represent primarily an increased level of detail. Examples are energy consumption, where the software makes a distinction between 11 types of energy sources, use of non-renewable resources where the software calculates the consumption of 8 types of metals and alloys, and weighted toxics where the software makes a distinction point and non-point sources as well as between releases to air, water, land and underground. The only general omission from the procedure is fertilizers, where the software calculates the consumption of four different types. This omission is justified by the assumption that most fertilizer is consumed in agriculture and thus not will provide much additional information when a broad range of sectors is compared.

1.4.2 The pros and cons of EIONET-software

The use of the EIO-LCA-software data to assess Danish environmental impacts is of course associated with inherent as well as practical problems, some of which are discussed in the subsequent sections.

The validity of the data to perform an analysis of Danish conditions depends mainly on two assumptions:

1. The US sectors are comparable to Danish sectors with respect to the products produced within the sector.
2. The relative environmental impacts per produced value unit are the same in Denmark and the United States

Ad 1. The number of product groups in the EIONET-software is 485, whereas the Danish economic statistics in this project only can be divided into 95 groups of product groups. In most cases the Danish product groups cover less than 6 product groups in the EIONET-software. If so, an average was calculated for the US product groups and used in the further calculations. As an example, the Danish product group No. 49, "Books, newspapers, pictures and other printings, hand- or machine written works, and drawings" is divided into six sub-headings in the EIONET-software:

- Newspapers
- Book printing
- Periodicals
- Book publishing
- Commercial printing
- Greeting cards

If more than six sub-headings were available in the EIONET-software, an average was made of 5-7 representative product groups. For 11 product groups it was not possible to make an exact match between Danish and US product codes and descriptions. As an example, the Danish product group No. 50 and 51, "Natural silk" and "Wool, fine and crude animal hair, yarn and woven fabric of horsehair" cannot be identified in the EIONET-software and instead, "Yarn mills, and finishing of textiles" and "Broadwoven fabric mills and fabric finishing plants" were selected as representative for the economic activities for these product groups. Obviously, this is a potential source of uncertainty that must be taken into account in the final prioritization. In the calculations, both natural silk and wool are assessed as having a high environmental impact. This is probably true for wool, whereas it is more questionable whether it also is true for natural silk.

Ad 2. It is outside the scope of this study to verify that Danish and US production is comparable with respect to environmental impacts per produced unit of value. It seems, however, reasonable to assume that the technology used in the two countries in general is comparable, and hence also the environmental interventions from the processes.

There may however be exceptions that are overlooked in the automated calculation procedure. As an example, efforts to reduce the environmental impacts from a given sector through implementation of cleaner technology may have been initiated in one country and not in the other. This is presumably the case for steel production, where the only Danish producer after implementation of several cleaner technology projects claims to be more energy-efficient and less polluting than its European competitors.

It is an open question how subsidies and taxation of specific sectors and products affect the results. Obviously it has an influence of the economy of the sectors, but how this is reflected in the economic IO-tables has not been investigated in the present study. If such subsidies are included in the economic overview in the IO-model, the affected sectors will be comparably underrated with respect to environmental impacts, because the value of the products has been “artificially” increased.

The second assumption must thus be regarded as questionable, because there are potentially large differences between the Danish and US economy. It should, however, be remembered that the prioritization and selection in the project is not based on absolute values, but on impacts per produced value unit. The basic assumption is thus that the difference between the impacts from producing products with a certain value in different sectors is comparable in Denmark and the United States.

A third problem that is inherent to IO-analysis is that the use and disposal stages are not included in the calculations. The only way to include the two stages is to conduct a life cycle assessment of relevant or selected product groups, but this is outside the scope of this study. Obvious examples of the importance of the use stage are energy-consuming products like cars and electronic equipment, where life cycle assessments have shown that the use stage may cause environmental impacts that are more than ten times greater than in the production stage. An example of the importance of the disposal stage is lead-containing products that have a large potential for impacts if not disposed in the best possible way.

Despite the above shortcomings, the EIONET-software was nevertheless judged to be suitable for the purpose of the study. The main argument is that the software has a breadth and a depth that currently is unmatched in the world:

- The datasets relate to 485 economic activities
- Data are available on the product level, and a coupling to product groups is possible
- It is possible to cover almost all product groups being produced in Denmark
- A broad range of potential environmental impacts can be assessed with the information on environmental interventions

As the shortcomings of the method still may have a significant influence on the final prioritization, great care has been exercised in identifying potential pitfalls in the statistical background material and reporting this.

1.4.3 Results of step 2

1.4.3.1 Environmental ranking

The 95 product groups are rated in three categories, “high” “medium” or “low” importance in each of the impact parameters examined (see Table 2). For each of the parameters the 95 product groups have been sorted by their contribution to the parameter and subsequently been divided into three groups of equal size.

The overview of the relative importance of all impact parameters for all product groups is in the next step combined in an overall environmental assessment by using the following criteria:

- If the importance for three or more impact parameters is rated as “high”, the combined assessment is also “high”.
- If the importance for six or more of the impact parameters is rated as “low”, the combined assessment for the product group is also “low”.
- In all other cases, the rating of the product group is “medium”.

The criteria are chosen somewhat arbitrarily, the main points being that there should be a strong indication of the validity, if a product group is rated as “low” (6/8 categories rated as “low”), whereas only limited evidence (3/8 categories rated as “high”) was sufficient to give an overall rating as “high” for a product group. It can be noted in this relation that all impact parameters are given an equal weight, i.e. it is not determined *a priori* whether one parameter is seen as more important than others.

1.4.3.2 Combined environmental/economic ranking

Subsequently, the economic importance (measured as the Danish supply of a product group) is combined with the environmental importance (measured in impacts per value unit) for each of the impact parameters by a simple multiplication. Finally, the resulting figures are divided into three groups of approximately the same size by using the same criteria as applied in the environmental rating.

The following table gives an overview of the distribution of the ranking of the 95 product groups, both based on the environmental impact parameters alone, and in combination with their economic importance.

| Product group | Environmental ranking | Combined environmental and economic ranking |
|---------------|-----------------------|---------------------------------------------|
| High | 45 | 34 |
| Medium | 35 | 34 |
| Low | 15 | 27 |

Table 3. Distribution of the ranking with respect to environment alone, and a combined environmental and economic ranking.

As it can be seen from the table, the three groups in the combined environmental/economic ranking are not of exactly the same size. The reason for this is that several product groups performed equally in the relatively simple ranking system and therefore were placed in the same group.

Table 4 shows which of the 96 product groups that have been ranked as high with respect to environmental importance, combined environmental and economic importance or in both. Please note that the description of the product groups is very summarily and therefore only gives an indication of the actual products included under the heading.

| High environmental rating | Both high environmental rating and high combined rating | High combined rating |
|----------------------------------------------|---------------------------------------------------------|---------------------------------------|
| | | 2: Meat products |
| 3: Fish products | | |
| | 4: Dairy products | |
| 5: Misc. livestock | | |
| 8: Fruits | | |
| | | 16: Prepared meats |
| | | 17: Sugar and candy |
| | | 22: Drinks (soft, alcoholic, etc.) |
| | | 23: Pet food and other waste products |
| | 25: Minerals and stone | |
| 26: Ores | | |
| | 27: Mineral-based fuels and oil, asphalt, etc | |
| | 28: Inorganic chemicals | |
| | 29: Organic chemicals | |
| | | 30: Drugs |
| | 31: Fertilizers | |
| | 32: Paints and allied products, printing inks, etc | |
| | 34: Soaps and detergents | |
| 35: Adhesives, sealants, enzymes, etc | | |
| 36: Explosives | | |
| | 38: Misc. chemical products, e.g. pesticides | |
| | 39: Plastic materials and resins | |
| | 40: Rubber and rubber products | |
| 41: Leather tanning and finishing | | |
| | | 44: Wood and forestry products |
| 47: Paper and paperboard mills | | |
| | | 48: Paper and paperboard products |
| | | 49: Books, etc |
| 50: Natural silk | | |
| 51: Wool | | |
| 52: Cotton | | |
| 53: Natural textile fibres | | |
| 54: Chemofibres (continuous) | | |
| 55: Chemofibres (staples) | | |
| 58: Woven fabric | | |
| 59: Laminated and coated textiles | | |
| 60: Knit fabrics | | |
| | | 61: Women's hosiery |
| | 68: Products of concrete, stone, gypsum, etc | |
| 69: Ceramic products, e.g. tiles and pottery | | |
| | 70: Glass, glass products and glass containers | |
| 71: Jewellery, precious metals | | |
| | 72: Iron and steel foundries | |

| High environmental rating | Both high environmental rating and high combined rating | High combined rating |
|--------------------------------------|---------------------------------------------------------|----------------------------------------|
| | 73: Primary metal products | |
| | 74: Copper and copper products | |
| 75: Nickel and nickel products | | |
| | 76: Aluminium and aluminium products | |
| 78: Lead and lead products | | |
| 79: Zinc and zinc products | | |
| 80: Tin and tin products | | |
| 81: Non-precious metals and products | | |
| | 83: Tools and hardware from non-precious metals | |
| | | 84: Reactors, turbines, etc |
| | | 85: Electrical appliances, motors, etc |
| | 86: Railroad equipment | |
| | | 87: Vehicles |
| | | 90: Misc. instruments |
| 93: Weapon and ammunition | | |
| | | 94: Furniture and lighting equipment |
| 97: Art work, etc. | | |

Table 4. Overview of the products that have been ranked as high in the environmental assessment, the combined economic and environmental assessment, or in both.

1.4.4 Other product characteristics

1.4.4.1 Position in product chains

In order to provide a more detailed overview of the relation between sub-sectors and product groups, additional statistical information was requested from Statistics Denmark.

Firstly, the Danish Statistics of raw materials was used to create an overview of which raw materials (specified on 2-digit KN-nomenclature level) are used in which sectors (specified on 3-digit NACE-code level). This exercise gives a good indication of which sub-sectors that use a specific product group as raw material. Secondly, the Statistics of foreign trade was used to create an overview at the same level of detail regarding which product groups that are imported and exported to and from specific (sub-)sectors.

This statistical information can be used to give an indication of how the product groups (as defined in the statistical information) are positioned in larger product chains and accordingly also to indicate the environmental “properties” of such product chains. This was investigated in more detail for the 14 selected product groups (see below) and included in the total description of these 14 product groups.

1.4.4.2 Environmental labeling and green purchasing guidelines

A number of other product characteristics relating to Danish conditions were also entered in the database:

- Products and product groups for which criteria for environmental labeling (the European Flower and the Nordic Swan) exist or are on their way
- The number of licenses in Denmark for these product groups
- Products and product groups for which Danish green purchasing guidelines exist or are on their way

This information is included, too, in the total description of the 14 selected product groups.

1.5 Step 3 – Selection of relevant product groups

The third step – Selection of relevant product groups – was conducted by a combined search in the established database for product groups with a “high” environmental ranking **and** a “high” environmental/economic ranking at the same time. The products identified in this way are in the procedure regarded as those that potentially are relevant for future efforts.

The selected product groups were subsequently described with respect to their relation to the sectors that are most important for their presence in Denmark, characteristics of relevant sectors and their companies, important environmental parameters, and the position of the products in relevant product chains.

1.6 Step 4 – Previous efforts related to sub-sectors

In the fourth step information regarding the previous efforts on the sector level is integrated in the database. Based on published information the following information is used to describe the previous efforts in Denmark:

- Has a product panel been established?
- Has a sector-specific effort been conducted under the Program for Cleaner Products?
- Is an environmental approval required by companies in the (sub-)sector?
- Has a sector-specific effort been conducted under the Program for promotion of environmental management and environmental revision?

1.7 Step 5 - Selection of areas for future targets

The information compiled in the previous steps and stored in the database is assessed in step 5. Firstly, an overview of all previous efforts is created and secondly, suggestions for the targets in 2002 were developed. Both of these assessments are reported in separate chapters, but are not described in detail here.

1.8 Step 6 – Assessment of the action potential in relevant sub-sectors

In order to give a better decision support, additional information on companies, sub-sectors and main sectors was added to the database:

- The number of EMAS-certified companies, distributed on main sectors. Similar information regarding ISO 14001-certification is equally useful but is not currently available.
- The number of companies (specified on 3-digit sector codes) that have been supported by grants under the “environmental competence” system.
- The number of companies in a sector (specified on 3-digit sector code level), distributed on the number of employees in relevant companies.

Through the sector/branch organizations it may be possible to obtain more information about the level and status of previous efforts initiated by the sector and/or its member companies, e.g.:

- The environmental “capacity” in the sector (does the sector employ a person dedicated to environmental work, environmental work is integrated in the daily work of an employee, environment is not on the agenda in the sector).
- Does the sector participate in environmental networks (yes, no).
- Has an environmental policy been formulated (yes, the work is in progress, no).
- Has the branch organization or selected companies participated in environmental projects (yes - both, yes – the branch organization, yes – companies, no, no information available).

This type of information is currently not available in the database, but will in the longer term be relevant for establishing a full overview that at the same time is easily accessible for the Danish EPA.

1.9 Discussion of the methodology

The methodology presents a new approach to environmental assessment of products at a macro-economic level. As indicated previously, this is associated with a number of (large) uncertainties that must be kept in mind when the results are used for decision-making.

In the following sections, some of the most important uncertainties are addressed, and suggestions for future improvements are given. Firstly, however, it is stressed that precise information on environmental impacts from products and services can only be established by using very detailed life cycle assessments (LCA), and this can take months or even years for just a single product. As there are literally thousands of different product groups on the market - and several suppliers of each product group – the LCA approach is not possible on this level of decision-making.

1.9.1 Use of information from the United States in the assessment and selection of product groups

The major uncertainty in the methodology, at least on the psychological level, is probably that the assessment is based on environmental interventions in the United States. The economies in Denmark and the United States are very different in many respects, and this may also apply to the environmental impacts associated with the economic activities.

However, some main arguments can be used to justify the use of the EIONET-software:

- The EIONET-software calculates the environmental interventions per produced unit of value. The differences in the scale of the two countries are therefore not important.
- The technological level in the two countries is comparable on many points. As the figures for different product groups are a kind of averages, this will probably reduce the differences between the two countries.

- Production of electricity in the two countries is to a large extent based on coal as a fuel. Obviously, the use of nuclear power in the U.S. will cause different environmental interventions than the use of wind power in Denmark, but the impacts per produced kilowatt-hour do not differ by orders of magnitude.
- The EIONET-software has a high level of detail with respect to products and product groups. If this was not the case, interpretation of the results would be much more difficult. In fact, a high level of detail is a prerequisite, if the overall environmental interventions are to be distributed on products in a sensible manner.
- The EIONET-software includes a broad range of environmental interventions, 72 in total. Not all of these were used in the present study, but they give the possibility of examining the results in more detail if requested or necessary.

A major uncertainty is related to the fact that the economic statistics in Denmark and the U.S. are not fully comparable. The nomenclature used in the two countries sometimes differs significantly, and thereby reduces the possibility of finding matching economic information. This problem can only be handled by a manual inspection and comparison of statistical codes, followed by an educated choice of the basis for the comparisons. Experienced statisticians can be very helpful in this respect, and it is suggested for future improvements of the methodology that statistical and environmental expertise is combined.

1.9.2 No inclusion of final use and disposal

A major limitation of input-output analysis to examine the environmental impacts of products is that they do not include the use of the products or their final disposal.

There are no short cuts to handle this problem. The environmental impacts from energy-consuming products are in IO-analysis alone related to their production, taking all upstream interventions into account, but omitting downstream interventions that may be significantly higher. The only “numeric” solution seems to be to use knowledge obtained from LCAs as supplementary information, but as already mentioned this information is seldom readily available. Therefore, the only viable way at the present time seems to be to combine the information from the IO-analysis with “common sense knowledge” from experienced persons.

1.9.3 The level of detail in the environmental assessment is not satisfactory

It can be argued that the environmental interventions used for prioritization and selection in the current procedure are not sufficiently broad. Although 72 different types of interventions can be calculated, a full picture is not obtained.

The argument is true in the sense that the level of detail is less than in LCA, where a well-established methodology allows for inclusion of an infinite number of interventions and still creates a relatively operational overview.

It is possible to include more interventions in the current selection procedure, but it will of course require more resources to do so. In fact, some of the impact parameters are similar to those used in LCA, with global warming potential as a prominent example. It is also possible to aggregate other

interventions and produce results that are similar to those in a LCA. An example is acidification, where SO_2 and NO_x are the dominant contributors in almost all LCAs. This information is readily available from the IO-analysis, and it is very easy to aggregate these into sulfur dioxide equivalents as it is done in LCA.

It was a deliberate choice in the current project to only use a limited amount of impact parameters. Within the short project period, about two months, a methodology should be established that at the same time could address a total range of product groups in the Danish economy and provide an overview of the impacts that could be used for decision-making. If the full possible range of impact parameters were used, a matrix of 96 (product groups) times 72 (interventions) would have been the result. It was the opinion of the project team that this would not be operational, and it was therefore suggested to reduce the number of interventions to eight parameters, that each identified important environmental properties of a product.

It must be recognized that in doing so, important information may be missing. Water-borne emissions are only included as an element under the heading "total toxic emissions" and it is accordingly not possible to give an assessment of the eutrophication potential. Likewise, only consumption of copper is included in the present study as an indicator of consumption of non-renewable materials. The EIONET-software gives the possibility of including a broader range of metals and alloys, but in the current context, copper was used because of its short supply adequacy.

In a further development it may also be possible to use Danish statistical information on some impact categories that are currently integrated at a low level of detail.

Statistics Denmark is currently developing information on Direct Material Input (DMI) and Total Material Requirements (TMR). DMI and TMR are inventories for the draw on non-renewable resources, distributed on product groups and sectors in Denmark and globally. The sector definitions are identical to those used in the national accounting system, and are therefore different from those used in the present project. It is, however, possible to convert these with access to the basic statistical information and knowledge about how to convert.

Based on the report "Status og perspektiver på kemikalieområdet" (Miljøstyrelsen 1996) (Status and perspectives in the chemical area, the Danish Environmental Protection Agency 1996), it is possible to relate the compounds on the "List of unwanted substances" to a number of specific products. These can again be related to specific sub-sectors by their KN-codes. The work must be done manually and is assumed to be relative demanding on human resources.

Danish waste statistics is rather detailed and is based on the information that companies in different sectors are obliged to register and report to the authorities. It may be possible to extract information on sector-related waste production and transfer these to the product level. Another possibility is to use information from the project "Affaldstunge brancher" (industries with large amounts of dangerous wastes) that includes a mapping of amounts and types of waste in selected sectors that are known to produce relatively large amounts

of waste. This latter approach can, however, not be used consistently for all sectors.

1.9.4 Lack of detail on the product level

The model operates with only 95 product groups (on 2-digit KN-code level) that are related to 106 production sectors and 40 trade and service sectors. This is an intentional choice, based on the request for a consistent assessment of all product groups.

The consequence of the choice is that the calculated impacts from some product groups cover a broad range of products. The group “Products of iron and steel” thus includes products ranging from nails to stoves and bridges.

To increase the level of detail for products, it is necessary to use information on the 4-digit level for KN-codes. This will increase the number of product groups to about 1200 and thereby also increase the practical work with the assessment significantly. Furthermore, the EIONET-software only includes 485 product groups, and some additional work with relating the two lists of product groups to each other must be anticipated.

An increased level of detail for the product groups may cause problems when relating the information to the trade in some sectors. Even on the 3-digit DB-93 code level used in the current model it is necessary for reasons of confidentiality to aggregate information for several sub-sectors. Experience shows that it is possible to establish and use information on a 4- or 5-digit DB-93 code level for some sectors, but it is not possible to increase the level of detail in a consistent way. The effort will also require special extracts from Statistics Denmark to replace the current statistical background material.

2 Sources for development of the model

This chapter gives a description of the statistical information, literature and books consulted, and know-how used in the preliminary version of the model.

2.1 Input-output analyses

An economic input/output model divides the national economy into sectors. The use of such an input/output analyses on environmental matters has the advantage that the environmental impact is related to the added value of the product. Therefore the environmental impact can be compared across the borders of product groups and sectors respectively industrial sectors.

Three different sources to input/output analyses have been considered:

1. An American input/output database on product level having a reasonable high degree of details.
2. A Swedish report referring to different input/output analyses, which presents an environmental assessment for miscellaneous groups of products.
3. A Danish input/output analysis prepared by Statistics Denmark, which describes the environmental impact of a number of industrial sectors in Denmark.

The American input/output database has been chosen for the present project as the information is on product level and the degree of details is reasonably high. The Danish model is based on Danish conditions, but the environmental impact is calculated on industrial sector level. This level is not a suitable starting point for the environmental screening of products, which is the basis of the present study. The Swedish report has information on a superior level, which makes it unsuitable for the present study.

The American method is described in detail below while the other two methods are described in the chapter: Further development of a model for selection of future target areas (chapter 5).

2.1.1 **eiolca.net**

The American database **eiolca.net** (Economic Input-Output LCA) has been prepared by the Carnegie Mellon Green Design Initiative. It comprises detailed input/output information about 500 product groups. The home page www.eiolca.net presents information about atmospheric emissions, working environment, consumption of water, emission of toxic substances, green house effect, fertilizers, energy consumption, consumption of metals, dangerous wastes and costs due to pollution. The environmental costs refer to the added value of the product. The principle is called “cradle-to-port” in Life Cycle considerations. Further information can be found at the home page.

The information presented by the American database is used as background for the environmental assessment of product groups in the present study. The classification of near by 500 different product groups or services means that some of them have to be put together in order to match the Danish product groups as presented by Statistics Denmark, Statistics of goods, "Varegruppestatistik".

2.2 Information from Statistics Denmark

Statistics Denmark prepares a number of different statistics about products and their use in industrial sectors, imports and exports, production etc., but no statistical information about the movement through the supply chain is available neither on national nor on international level. It is therefore necessary to draw an outline based on information from different statistics and accept the uncertainty related to this procedure. A short description of the most relevant statistics issued by Statistics Denmark and their applications in this model is presented below.

2.2.1 Statistics of Goods

The Statistics of goods presents information about the goods produced and in which industrial sectors they are produced. This applies only to industrial sectors having a production in Denmark. The Statistics of goods is not so extensive as the Statistics of foreign trade (see below) since only companies with at least 10 employees are obliged to report to Statistics Denmark. The Statistics of goods covers all 10.000 product codes (8-digit KN codes), but covers only manufacturing companies, i.e. the industrial sectors 15.1-36.5 (3-digit DN code level). For the sake of clearness the present model is based on a two-digit product code level, which means 95 product groups. For these 95 product groups information about the value of imports, exports and indigenous production has been gathered from Statistics Denmark.

2.2.2 Statistics of Foreign Trade

Information concerning foreign trade allows establishing the relations between import-export and industrial sectors. This gives a clear picture of which goods are imported and to which industrial sectors and which goods these branches are exporting subsequently. In this way parts of the supply chain are illustrated. As an example iron is imported to the "iron and metal industry", which in turn is exporting articles made of iron. The Statistics of foreign trade is adequate since all companies in Denmark are obliged to report about import and export of goods to Statistics Denmark. The Statistics of foreign trade applies to all 10.000 product codes and to all industrial sectors.

2.2.3 CPA-nomenclature

Statistics Denmark also draws up a CPA-nomenclature, which relates products with industrial sectors. It gives information about which goods are expected to be produced and in which industrial sectors. It should be stressed that it deals with expectations contrary to the Statistics of goods and the Statistics of foreign trade, which are both based on reports of factual events.

A correlation between the CPA-nomenclature and the information about import/export of goods divided on industrial sectors in the Statistics of foreign

trade may thus give an overview of the relation between import and export. As an example, a product is imported to industrial sector 15 (manufacture of food and beverages), but is exported from industrial sector 53 (retailer). The above-mentioned correlation will show to which industrial sector the product really belongs and subsequently indicate the trade within the Danish borders (from producer to retailer).

2.2.4 Statistics of Raw Materials

Statistics Denmark has recently established an annually reporting of raw materials and sub-products giving information about the supply chain-of-goods before manufacturing. The statistics shows exactly the art and amount of raw materials and sub-products being acquired by Danish companies in order to do further processing. It shows which industrial sectors are using which raw materials and sub-products, but does not distinguish whether the raw materials are imported or bought in Denmark. The Statistics of raw materials is not covering totally since it only applies to mainly large companies having more than 50 employees, i.e. about 1,300 companies. In order to complete the picture some smaller companies from industrial sectors having few or none large enterprises have been included in the statistics. About 55% of the total turnover is included in the study. The Statistics of raw materials does not cover all product codes, but only raw materials and sub-products, which gives a total of 1,400 products. The statistics only applies to the manufacturing industry.

2.3 Sources describing the actions until now

The Model for selection of future target areas gives information about the industry-oriented actions carried out until now. The information comes from the following reports:

"Presentation of selected areas suited for main projects", May 19, 2001". Comprises a summary of preliminary projects, which have been started respectively concluded.

"General information and expectations to a preliminary project", 2000. Comprises a survey of industrial sectors in which preliminary projects have been started up and summary of concluded projects.

"Plan of priority for the Danish Program for Cleaner Products 1998-2002" – survey of possible branch-oriented actions.

"Basic information about selection of new preliminary projects", September 14, 2001". Comprises a survey of industrial sectors in which product panels have been established, branches having carried actions out and an overall evaluation of the industrial sectors from an environmental point of view.

"Environmental Management and Audits in Danish Companies". 2001. Survey of industrial sectors, which have had priority under the scheme.

2.4 Aspects of sustainability

The Danish Consumer Information has launched a database "*Etikbase*" (Ethics base) on the Internet. This service should not be regarded as a

warranty or an eco-label, but the companies involved have voluntarily presented sensitive information. An independent chartered accountant looks after the scheme.

The social responsibility of a company has three aspects: social, environmental and economic aspects, which can be expressed by three times P, i.e. People, Planet, Profit. In a first approach this service focuses on “people” taking the human rights into consideration.

Presently (June 2002) a total of 19 companies have joined the scheme while a number of other companies are thinking a membership over. This service will be open to the public in September 2002.

The companies joining the scheme are distributed on industrial sectors as follows:

| Branch code | Name of industrial sector | Number of companies in the Etik Database |
|-------------|------------------------------------------------|------------------------------------------|
| 212 | Manufacture of paper and articles of cardboard | 1 |
| 221 | Publishers | 2 |
| 244 | Pharmaceutical Industry | 1 |
| 501 | Trade in motor cars | 6 |
| 505 | Petrol filling stations | 1 |
| 521 | Retailers | 3 |
| 651 | Banks and finance houses | 1 |
| 703 | Administration of real estate | 1 |
| 741 | Business consultancy | 2 |
| 752 | Services for society | 1 |

Table 2-1: Survey of companies joining the Etikbase according to industrial sector.

When the service is opened to the public the number of registered companies could be an indicator of sustainable development either related to industrial sectors or related to product groups.

The Global Reporting Initiative (GRI) is an international initiative, which aims at the promotion of a total reporting of economic, environmental and social conditions in the companies.

GRI has issued “Sustainable Reporting Guidelines” for the companies. On the home page www.globalreporting.org/GRIGuidelines/Reporters.htm the companies, which have issued reports according to the guidelines are listed. The list is not complete, but in relation to sustainable development considerations on industrial sector level it tells about social and ethic aspects coming into the international agenda.

The model for selection of future target areas also has information about the number of companies and the size of companies. The search tool MultiMark, which is based on information from the business information service “Købmandsstandens Oplysningsbureau”, up to date on February 2002.

The companies in the sub-trades are divided into the following categories:

- Number of companies, total
- Number of companies, 0-1 employees
- Number of companies, 2-9 employees
- Number of companies, 10-19 employees
- Number of companies, 20-99 employees
- Number of companies, 100 or more employees

The reason for this relatively detailed classification is that the distribution between small and large companies may be decisive when initiating a branch-oriented action. Furthermore this detailed division may give precious information. As an example, all holding companies, branch and subsidiary companies are included in the total listing of companies, despite the fact that some companies do not report about production already reported by the holding company. Typically holding companies, branch and subsidiary companies have less than 9 employees and therefore belong to a group representing 74% of the total. If companies with less than 2 employees are subtracted, the share is only 21%.

It should be mentioned that the Statistics of goods does not cover production, which takes place in companies having less than 10 employees. Therefore the information with regard to industrial sectors having many small companies is misleading. Statistics Denmark states that the Statistics of goods covers more than 91% of the values turned over.

2.5 Other sources

The model for selection of future target areas also has information about the product groups, which are suited for eco-labelling as well as the number of companies, which have been awarded a licence. This information originates from the home page of the eco-labelling secretariat: www.ecolabel.dk. The information is up-dated February 1st, 2002.

The model for selection of future target areas also includes information about the superior product groups for which *environmental guidelines for Public Purchasers* have been prepared. This information originates from the home page of the Danish EPA. The list has been up-dated on February 19, 2002.

The model also includes information about the companies, which are submitted to environmental approval according to *chapter 5 in the Danish Environmental Protection Act*. The list has been prepared based on the recent ministerial decree No. 646 dated June 29, 2001 – "Bekendtgørelse om godkendelse af listevirksomhed" (Decree about approval of a company which is obliged to obtain an environmental approval of the company). It has not been possible to make a complete list since certain limitations concerning the size of production exist. Only companies having a certain production in certain industrial sectors are included in the list. The list thus represents the best possible estimation and gives a survey of the industrial sectors (three-numbered code level) submitted to the ministerial decree.

Finally on an industrial sector level the model includes information about the number of companies having received subsidies according to the *Environmental Competence Scheme* (miljøkompetenceordningen) launched by the Danish EPA.

The survey has been prepared based on information (six-numbered branch level) from the Danish EPA. This list has been transferred to the three-numbered level used in the model. Furthermore for each industrial sector the number of companies having received subsidies to product-oriented actions such as LCA, eco-labelling etc. is indicated.

2.6 Relations between the different sources of information

The model for selection of future target areas should as mentioned earlier be able to point out important areas for action with relation to products and supply chains, but also relate products with industrial sectors.

The relation between industrial sectors and products of Danish origin is established via the Statistics of goods. The relation between industrial sectors and products imported and marketed in Denmark, but not produced in Denmark, is established via the Statistics of foreign trade.

The supply chain aspect until and including production has been included in the present model via the Statistics of raw material and the commercial activities after production via the Statistics of foreign trade. No information about the flow of goods is available, but thanks to the numbers of import from the Statistics of foreign trade the following assumption can be made: Raw materials and sub-products imported to an industrial sector will probably follow the same flow. Statistics Denmark has stated that about half of all goods produced in Denmark are sold to end-consumers via wholesalers/retailers, and the other half directly to the consumers.

3 Potential areas of future action

For each of the 14 product groups, which have been pointed out as relevant for future product respectively industrial-oriented action, an overall description has been elaborated with regard to the following main items:

- Features of the product group
- Relation to trade and industry
- Environmental aspects
- Supply chain

The above-mentioned descriptions are based on information from the Access database, as well as evaluations and conclusions with regard to this information. It should be mentioned that information about product groups has a two-figured number (product group 31: Fertilizers) and information about the related industrial sector has a three-figured number (trade 241: Manufacture of base chemicals). This was needed for practical reasons in the first issue of the Model for selection of future target areas in the Danish Program for Cleaner Products but poses by nature certain limitations for going into details with the information.

It also should be stressed that the statistics has not been designed to follow the flow of goods in a supply chain. Based on the Statistics of raw materials and the Statistics of foreign trade it has been tried to point out possible relations in the supply chain but still large uncertainties are present. In the same way the methods used in compiling the statistics give rise to questions. Thus the raw material "Adhesives" seems to have no relation to the industrial sector "Wood and furniture manufacturing" despite the fact that the wood industry is a large consumer of adhesives for the manufacture of chipboards and blockboards.

The term "industry-oriented action" used in the following only means projects supported by the "Program for Cleaner Products" and the "Program for Environmental Management" issued by the Danish EPA. Other types of industry-oriented activities may have been carried out but have for practical reasons not been mapped in the present project.

Furthermore it should be underlined that the phases of use and final disposal of the products have only been subject to an overall description. This is due to the fact that the applied methods of environmental assessment are based on a "cradle-to-port" analysis and therefore do not include end use and final disposal.

3.1 Product group 25: Salt, earth and stone

The product group "Salt, earth and stone" is relatively small, but not insignificant, accounting for 0.7% of the total supply in Denmark. About one third of the supply is imported, but the production in Denmark exceeds the indigenous demand thus giving rise to a significant exportation accounting for about 40% of the total quantity available.

Extraction and processing of salt, earth and stone is related to 5 industrial groups of which 4 belong to the category "Extraction of raw materials, quarries and salt mines" and the last belongs to the category "Manufacture of cement, chalk and gypsum". There is a preponderance of small enterprises, in particular within "Industry group 142: extraction of gravel and clay", but also 8 large Danish producers are present.

From an environmental point of view the product group "Salt, earth and stone" has a large potential impact on the environment. During the life cycle until and including manufacturing of the end products the environmental impact is mainly related to the extraction of raw materials and the manufacture of cement, but the consumption of energy also contributes considerably. The cement works are submitted to an approval according to chapter 5 in the Danish Environmental Protection Act. This is also applied for the calcination of flint stones.

A specific product-oriented action concerning these raw materials has not been initiated, but the manufacture of cement and particularly its use in the building industry is subject to investigations under the existing "Buildings & Construction Panel". For cement life cycle assessments have been carried out earlier.

Criteria exist for eco-labelling of the product group "Chemicals for de-icing" (by June 2002 one company holds a licence in Denmark). One company has been certified according to EMAS and another company has received subsidies from the "Environmental Competence Scheme". An industry-oriented action aiming at the promotion of environmental management within "Industry group 265: Manufacture of cement, chalk and gypsum" has been carried out earlier.

It appears evident to relate a possible future product-oriented action to the on-going activities within the building industry, but the environmental gains will probably be rather limited due to the fact that the most important issues, which are related to the manufacture of cement, are already included in existing actions. Benefits may be achieved in spreading the systematic work with environmental issues, for instance by introducing environmental management to a large number of companies, but this is by experience not an easy task due to the large number of small enterprises.

Since about one third of the total supply is imported there may be environmental gains in imposing requirements on imported goods. A prerequisite is an analysis of the problem since the statistical information does not reveal which goods are imported and in which quantities. Therefore it is unknown which products are the most polluting, the products manufactured in Denmark or the imported ones.

3.2 Product group 27: Mineral fuels

The product group "Mineral fuels" accounts for 1.8% of the total consumption in Denmark and therefore has a certain importance. The production of mineral fuels exceeds the consumption in Denmark. Simultaneously large amounts of mineral fuels are imported. The exports therefore are four times larger than the consumption in Denmark.

The number of companies related to the product group is relatively small and several of these companies are large multinational groups.

From an environmental point of view the product group “Mineral fuels” has a large potential impact on the environment. During the life cycle until and including manufacturing the main contributors to pollution are extraction of raw materials, refining of oil and manufacture of bitumen, lube oils and grease.

Also in the phases of use and final disposal there are significant environmental impacts. The wastes from this product group are classified as dangerous wastes.

Several types of companies belonging to the related trades and industries are submitted to an approval according to chapter 5 in the Danish Environmental Protection Act. This applies to oil refineries, extraction plants for mineral oil, asphalt works and manufacturers of roofing felt.

Until now no specific product oriented action concerning this product group has been carried out with the exception of the elaboration of criteria for eco-labelling of lube oils. Presently (June 2002) no licences have been awarded in Denmark. On an international level focus has been put on environment and sustainable development in particular with regard to the oil companies of which several already have issued reports about sustainable development.

In order to cover all relevant parts of the product supply chain a future product-oriented action should include producers, wholesalers and retailers. Within several trades such as refineries and asphalt works the companies are actively involved in many parts of the supply chain from extraction of raw materials over production, distribution and sales until possibly maintenance.

3.3 Product group 28: Inorganic chemicals

The product group “Inorganic chemicals” is relatively small accounting for only 0.6% of the total consumption in Denmark.

Only one fourth of the consumption of inorganic chemicals is produced in Denmark. A minor part is exported representing 18% of the supplies. Imports are thus essential amounting to 93% of the supplies.

Neither criteria for eco-labelling nor environmental guidelines have been elaborated for this product group.

The number of companies in the related industrial sector “241: Manufacture of base chemicals” is less than 200 equally distributed among larger and smaller enterprises.

The industrial sector “241: Manufacture of base chemicals” is submitted to environmental approval belonging to the groups classified as “Companies producing organic or inorganic chemical substances, products and sub-products including enzymes”, “Fertilizer plants”, and “Petrochemical Industry”. This industrial sector has been covered by an action according to the “Program for Promotion of Environmental Management and Audits” supported by the Danish EPA.

The product group has not been submitted to a comprehensive industry-oriented product action, but a general action against undesirable substances.

From an environmental point of view the product group “Inorganic chemicals” has a large potential impact on the environment. During the life cycle until and including manufacture the main contributors to pollution are the manufacture and the emission of toxic substances originating from primary, non-iron metals. The numbers also show a high consumption of energy during manufacture.

Also in the phases of use and final disposal there are significant environmental impacts. Therefore the group is submitted to different types of regulation and control.

There are large similarities between the industrial groups using inorganic chemicals as raw material and the producing industries, which are importing materials. Therefore it is assumed that the producers are importing raw materials.

The wholesalers play an important role in particular with regard to imports. It is assumed that a certain but limited part is sold to the retailers and the major part is sold to the manufacturers. This assumption is based on the fact that the products within the group hardly find use in the private sector.

3.4 Product group 29: Organic chemicals

The product group “Organic chemicals” accounts for 1.0% of the total consumption in Denmark.

The amount produced in Denmark is considerably larger than that consumed (178% of consumption). An amount corresponding to the whole Danish consumption is imported and a much larger amount corresponding to 186% of consumption is exported. That means an important trade in organic chemicals is taking place to and from Denmark.

The number of companies in the two related industrial sectors is less than 200 equally distributed between large and small enterprises. The mentioned industrial sectors are “242: Manufacture of pesticides and miscellaneous chemical products” and “244: Manufacture of pharmaceutical products and miscellaneous chemical products”.

Ten companies within organic chemistry and pharmaceutical production have issued reports according to the guidelines of the Global Reporting Initiative, which indicates a considerable international focus on the aspects of sustainable development within these industries.

Industrial sector 242 is submitted to environmental approval being classified in the group “Companies producing, bottling and blending pesticides and biocides”. Industrial sector 244 is submitted to environmental approval being classified in the group “Companies producing medicaments via biological, chemical and other processes”.

From an environmental point of view the product group “Organic chemicals” has a large potential impact on the environment. During the life cycle until

and including manufacture the main contributor to pollution is the manufacture itself. There is also a considerable energy consumption. Also in the phases of use and final disposal there are important environmental impacts. Therefore the group is submitted to regulation and control in different areas.

Until now the product-oriented action within chemicals has been targeted at substitution of non-desirable substances across the borders of the different industrial sectors. No product-oriented branch action has taken place, neither in the chemical nor in the pharmaceutical industry.

Foreign trade is mainly related to the pharmaceutical industry, both with regard to import and export. Wholesales represent a major part of imports, but only a minor part of exports.

It is essential for a possible future action within the pharmaceutical industry that both producers and wholesalers are included in the action. But other players should be included too, as a number of strong NGOs promoting sustainable development are playing on the international scene and in Denmark.

3.5 Product group 31: Fertilizers

The product group "Fertilizers" is small but not insignificant accounting for only 0.3% of the total consumption in Denmark. About two thirds of the amounts produced and imported are consumed in Denmark. The remainder is exported. Production equals importation. Denmark has three larger producers, all of them having wholesales within their core business.

From an environmental point of view the product group "Fertilizers" has a large potential impact on the environment. During the life cycle until and including manufacture the main contributor to pollution is the manufacture itself. Fertilizer plants are submitted to environment approval according to chapter 5 in the Danish Environmental Protection Act.

Until now no specific product-oriented action concerning this product group has been carried out with the exception of the elaboration of criteria for eco-labelling of fertilizers. Presently (June 2002) no licenses have been awarded. The use of fertilizers is regulated via the Aquatic Environment Scheme (Vandmiljøplanen).

In order to cover all relevant parts of the supply chain a future product-oriented action should include producers (chemical industry) as well as end users (mainly agriculture) and traders (mainly wholesalers). As import equals production in Denmark an action must include environmental requirements with regard to imported fertilizers and their transportation. These requirements could be handled by the manufacturers importing raw materials for fertilizers and/or the wholesalers, which import an important share of the fertilizers.

3.6 Product group 38: Miscellaneous chemical products

The product group "Miscellaneous chemical products" is middle sized and accounts for 1.1% of the total consumption in Denmark.

Production of miscellaneous chemical products nearly equals consumption being only 6% larger. Imports are essential and correspond to 70% of consumption, while exports amount to 76% of consumption. That means an important trade in other chemicals products is taking place to and from Denmark.

Neither criteria for eco-labelling nor environmental guidelines have been elaborated for this product group.

The number of companies in the two related industrial sectors is about 600 featured by a small majority of small enterprises. The mentioned industrial sectors are "246: Manufacture of miscellaneous chemical products", and "266: Manufacture of products of concrete, gypsum and cement".

The industrial sector "246: Manufacture of miscellaneous chemical products" is submitted to environmental approval belonging to the group classified as "Companies producing paints, additives including additives to the food industry". The industrial sector "266: Manufacture of products of concrete, gypsum and cement" is submitted to environmental approval belonging to the group classified as "Concrete works and producers of mineral building materials".

None of the industrial sectors numbered 246 and 266 have been subject to an industry-oriented action under the Cleaner Products Support Program, but both have been subject to an action under the Program for Promotion of Environmental Management and Audit.

From an environmental point of view the product group "Miscellaneous chemical products" has a large potential impact on the environment. During the life cycle until and including manufacture the main contributor to pollution is the manufacture. The numbers also show a high consumption of energy during manufacture as well as a potential toxic impact on the environment.

Also in the phases of use and final disposal there are significant environmental impacts.

Wholesales play a major role in the foreign trade, especially in imports. Assumed is that the wholesalers deal with both retailers and producers since this product group comprises both consumer goods and industrial products. Imports to retailers are negligible.

Since this product group is very versatile it is difficult to carry out an overall action. On the other hand the product-oriented action could be included in the efforts related to other product areas – e.g. where the chemical products are used.

3.7 Product group 40: Rubber and rubber ware

The product group "Rubber and rubber ware" is relatively small accounting for only 0.7% of the total consumption in Denmark.

About half (45%) of the consumption in Denmark is produced in Denmark. On the other hand imports are larger than consumption (118%). Exports

amount to 63% of consumption. That means an important trade in rubber and rubber ware is taking place to and from Denmark.

Criteria for eco-labelling of the product group "Tyres for motor cars" have been elaborated and criteria for eco-labelling of "Tyres for lorries" are being prepared (June 2002). Actually (June 2002) no licences have been awarded. An environmental guideline for "Tyres" has been issued.

The number of companies in the related industrial sector "251: Manufacture of rubber products" is about 150 with a preponderance of small enterprises.

The industrial sector "251: Manufacture of rubber products" is submitted to environmental approval belonging to the group classified as "Rubber works". Until now no product-oriented branch action has taken place nor an action under the Program for Promotion of Environmental Management and Audit.

From an environmental point of view the product group "Rubber and rubber ware" has a large potential impact on the environment. During the life cycle until and including manufacture the main contributor to pollution is the manufacture. The numbers also show a high consumption of energy during manufacture. A certain environmental impact is due to earlier steps in the life cycle i.e. manufacturing of industrial organic and inorganic substances.

Denmark is a net importer of rubber, which is mainly used for vehicles. Since the largest consumer of the raw material rubber is the industrial sector 292, which does not import rubber itself, it is assumed that the wholesalers are the suppliers. Further sales to the retailers are also assumed since the product group also comprises consumer goods.

3.8 Product group 68: Goods of stone, gypsum etc.

The product group "Goods of stone, gypsum etc." accounts for 1.7% of the total consumption in Denmark. The production is only a little larger than the consumption in Denmark. Both imports and exports account for about one fourth of the total consumption. It is a trade based on the home market.

The number of companies in the two related industrial sectors is a little less than 600 equally distributed among large and small companies. The two industrial sectors referred to above are "266: Manufacture of goods of concrete, gypsum and cement" and "268: Manufacture of other non-metallic mineral products".

Industrial sector 266 is submitted to environmental approval being classified in the group "Concrete works and producers of mineral building materials". Industrial sector 268 is submitted to environmental approval being classified in the group "Asphalt works, roofing felt producers, tar-distillers and plants for extraction and manufacturing of asphalt and asbestos products".

From an environmental point of view the product group "Goods of stone, gypsum etc." has a large potential impact on the environment. During the life cycle until and including manufacture the main contributor to pollution is the manufacture itself. This is mainly due to a high consumption of energy during manufacture. Toxic substances in the production of cement also play an essential role.

Also in the phases of use and final disposal there are significant environmental impacts. Therefore the group is submitted to different types of regulation and control.

Via the Danish Buildings & Construction Panel emphasis has been put on the products used in the building industry, but this industry is using a very large number of different products. Therefore it could be relevant to launch a product-oriented action aiming at a number of selected product groups. Such an action could be related to a supply chain consideration comprising extraction of stone, gravel and similar raw materials.

3.9 Product group 72: Iron and steel

The product group "Iron and steel" accounts for 1.8% of the total consumption in Denmark and therefore has a certain importance.

A minor part (39%) of the Danish consumption is produced in Denmark. Imports account for more than consumption (113%) and the remaining part is exported (53%). That means an important trade in iron and steel is taking place to and from Denmark. It also means that Danish producers play a role in international supply chains.

The number of companies in the three related industrial sectors is about 250. Two of the industrial sectors "271: Iron and steel works" and "273: Other processing of iron and steel and production of alloys" have an equal distribution among large and small companies while the third sector "371: Recycling of metallic wastes" have a preponderance of small companies.

Industrial sector 271 is submitted to environmental approval being classified in the group "Iron and steel works". Industrial sector 273 is not submitted to environmental approval. Industrial sector 371 is submitted to environmental approval being classified in the groups "Recycling plants", "Plants for disposal of water", "Plants for transshipment and packaging of wastes", "Plants for biological, physical or chemical treatment of wastes" and "Shredders". All industrial sectors have been subject to an action under the Program for Promotion of Environmental Management and Audit. Therefore a certain basis for a further systematic environmental action exists.

From an environmental point of view the product group "Iron and steel" has a large potential impact on the environment. During the life cycle until and including manufacture the main contributors to pollution are the production of iron and steel in steel rolling mills and foundries. This is mainly due to a high consumption of energy. Iron and steel foundries are included in an industry-oriented action under the Cleaner Products Support Program, but iron and steel works as well as other works working up iron and steel are not.

Iron and steel used as raw material for production of iron and steel, i.e. the next step in the supply chain, is described under the product group "73: Articles of iron and steel".

Information from the Statistics of foreign trade shows that the iron and steel works primarily get their raw materials in Denmark. The iron and steel works also have a certain exportation, probably of finished products.

There is a certain import, but a very small export of smaller items such as metallic barrels, bolts and screws. This means that these items primarily are used in Denmark. Within the group civil engineering steel constructions (larger units) some export and some import take place.

Within wholesales a large import and a large export takes place, which makes the wholesaler an important player in the supply chain of goods in co-operation with the producers. The overall supply pattern shows that both import and export is larger than the production in Denmark.

3.10 Product group 73 Articles of iron and steel

The product group "Articles of iron and steel" accounts for 4.6% of the total consumption in Denmark. This group is one of the largest product groups.

Production nearly equals (99%) consumption in Denmark. Imports correspond to 47% of consumption and exports correspond to 46% of consumption. Thus an important trade in "Articles of iron and steel" is taking place to and from Denmark.

Criteria for eco-labelling of the product group "Wood-burning stoves" have been elaborated and criteria for eco-labelling of "Iron pipes for sewers" and "Fittings for water pipes" are being prepared. Actually (June 2002) no licences have been awarded. Environmental guidelines for "District heating pipes" and "Cookers" have been issued. None of these are pointing the product group iron and steel out as an essential source of pollution.

The number of companies in the three related industrial sectors is large, probably over 2000 and with a preponderance of small enterprises. The three industrial sectors referred to above are "272: Manufacture of pipes", "281: Manufacture of steel constructions and parts to steel constructions" and "287: Manufacture of metallic barrels, wire products, bolts and screws".

The industrial sectors 272 and 287 are not subject to environmental approval while industrial sector 281 is submitted to environmental approval being classified in the group "Companies making products of iron, steel and metals".

With exemption of being part of an action concerning packaging materials, which is applied across the borders of several industrial sectors, none of the above-mentioned industrial sectors have been subject to actions, which are supported by the "Program for Cleaner Products" issued by the Danish EPA. All industrial sectors have been subject to an action under the Program for Promotion of Environmental Management and Audit. Therefore a certain basis for a further systematic environmental action exists.

From an environmental point of view the product group "Articles in iron and steel" has a large potential impact on the environment. During the life cycle until and including manufacture the main contributor to pollution is the production of steel in steel rolling mills. It should be stressed that transportation of raw materials and semi-products between the individual manufacturing industries play a certain role. The numbers also show that the making of iron and steel goods has a high consumption of energy. Furthermore the environmental impact of toxic substances contained in non-iron metals should be considered.

The numbers from the Statistics of foreign trade show that nearly half of the imports (45%) is dealt by wholesalers while these are handling less than 10% of the exports. Exports are featured by a preponderance of finished products being exported directly from the producers.

A part of the products in this product group is typically used by households and private individuals while another part has its users among professionals such as artisans and contractors. Therefore it can be assumed that goods being imported by the wholesalers are partly delivered to retailers for use in the private sector and partly delivered directly to the professionals.

Imports and exports made by retailers account for less than 0.5% of the total value of imports and exports.

The wholesalers in co-operation with the producers therefore play an important role in the supply chain of goods while handling an essential part of the imports and having a direct contact to end users and retailers.

3.11 Product group 74: Copper and articles thereof

The product group “Copper and articles thereof” is small accounting for only 0.3% of the total consumption in Denmark.

Only 41% of the amount of copper and articles thereof used is produced in Denmark and copper as raw material is not produced in Denmark. Imports account for more than consumption (115%) and exports account for 56% of the supplies which means that a considerable trade in “Copper and articles thereof” is taking place to and from Denmark.

Neither criteria for eco-labelling nor environmental guidelines have been elaborated for this product group.

The number of companies in the three related industrial sectors is large with a preponderance of small companies. The three related trades branches are “287: Manufacture of steel barrels, wire products, bolts and screws”, “274: Manufacture of precious metals and base non-iron metals” and “323: Manufacture of radio, TV, antennae, loud speakers etc”. “Copper and articles thereof” is therefore to a large extent manufactured in the same industrial sectors as articles of iron and steel, but covers also the manufacture of audio visual equipment.

Industrial sector 274 is submitted to environmental approval being classified in the group “Companies producing other metals than iron and steel including scrap iron”. Neither industrial sector 287 nor industrial sector 323 are submitted to environmental approval.

Both of the industrial sectors numbered 274 and 323 have been subject to an industry-oriented action under the Cleaner Products Support Program. Concerning the first mentioned it was a special action aiming at tin and lead, which is not relevant for the group copper, and concerning the latter it was an action via the electronic goods panel. Industrial sector 287 has not been covered by an industry-oriented action, but an action aiming at packaging materials, which may appear to be irrelevant to this product group.

From an environmental point of view the product group “Copper and articles thereof” has a large potential impact on the environment. During the life cycle until and including manufacture the main contributors to pollution are extraction of copper ores and smelting/refining of copper. The numbers also show a high consumption of energy in the production processes.

Denmark is a net importer of copper, which is useful in many different industrial applications. A trade-oriented action for this product group is therefore not relevant. On the other hand a possible action aiming at large scale recycling could be relevant since copper is regarded as a scarce resource.

3.12 Product group 76: Aluminium and articles thereof

The product group “Aluminium and articles thereof” is relatively large accounting for 1.7% of the total consumption in Denmark.

Production nearly equals (92%) consumption in Denmark. Imports correspond to 74% of consumption and exports correspond to 66% of consumption. Thus an important trade in “Aluminium and articles thereof” is taking place to and from Denmark.

Neither criteria for eco-labelling nor environmental guidelines have been elaborated for this product group.

The number of companies in the three related industrial sectors is large, about 2000 and with a preponderance of small enterprises. The three trades referred to above are ”274: Manufacture of precious metals and basic non-iron metals”, ”281: Manufacture of steel constructions and parts to steel constructions”, and ”287: Manufacture of metallic barrels, wire products, bolts and screws”. Products of aluminium are prepared in the same industrial sector as products of iron and steel while the basic products of aluminium are produced in another industrial sector.

Industrial sector 274 is submitted to environmental approval being classified in the group “Companies producing other metals than iron and steel including scrap iron”, while industrial sector 281 is submitted to environmental approval being classified in the group “Companies making products of iron, steel and metals”. The industrial sector 287 is not subject to environmental approval.

With exemption of being part of an action concerning packaging materials, which is applied across the borders of several industrial sectors, none of the industrial sectors numbered 281 and 287 has been subject to actions supported by the ”Program for Cleaner Products” issued by the Danish EPA. Industrial sector 274 has been involved in a special action aiming at tin and lead. These metals are manufactured within this industrial sector. Furthermore should be mentioned “Cleaner Technology Projects”, which have been carried out for galvanic industries which also are included in industrial sector 274. All industrial sectors have been subject to an action under the Program for Promotion of Environmental Management and Audit. Therefore a certain basis for a further systematic environmental action exists.

From an environmental point of view the product group “Aluminium and articles thereof” has a large potential impact on the environment. During the life cycle until and including manufacture the main contributors to pollution

are extraction raw materials and manufacturing of aluminium products. Transportation of raw materials and semi-products between companies also has a certain influence. The numbers also show a high consumption of energy in the production and manufacturing processes. It is highly advantageous to recycle aluminium since recycling only requires one tenth of the energy consumption used for production of primary aluminium.

The numbers from the Statistics of foreign trade show that primarily raw materials and semi-products are imported respectively exported while finished products play a minor role. A certain part of the foreign exchanges is managed by the wholesalers while the major part is handled by the manufacturing companies.

Retailers represent a very little part of the total amount of imports and exports within this product group. Retailers handle less than 1.5% of the value of imports and less than 0.5% of the value of exports. Probably these figures refer to drums and containers, household and kitchen articles as well as sanitary articles.

3.13 Product group 83: Miscellaneous articles of base metals

The product group "Miscellaneous articles of base metals" is relatively small accounting for only 0.7% of the total consumption in Denmark.

Production of "Miscellaneous articles of base metals" nearly equals consumption (92%). Imports are essential and correspond to 75% of consumption while exports amount to 67% of consumption. That means an important trade in miscellaneous articles of base metals is taking place to and from Denmark.

Presently (June 2002) no criteria for eco-labelling of the product group "Miscellaneous articles of base metals" have been established. On the other hand an environmental guideline for "Office equipment" which represents a tiny fraction of the product group has been issued.

The number of companies in the two related industrial sectors is large, more than 1700, with a preponderance of small enterprises. The two related trades branches are "286: Manufacture of cutlery, scissors etc." and "287: Manufacture of steel barrels, wire products, bolts and screws".

None of the two industrial sectors numbered 286 and 287 respectively are submitted to environmental approval and none of them have been subject to actions, which are supported by the "Program for Cleaner Products" issued by the Danish EPA. Industrial sector 287 is covered by the packaging materials action. Both industrial sectors have had actions aiming at the promotion of environmental management according to the Program for Promotion of Environmental Management and Audit.

From an environmental point of view the product group "Miscellaneous articles of base metals" has a large potential impact on the environment. During the life cycle until and including manufacture the main contributor to pollution is the extraction of base metals. The numbers also show a high consumption of energy in the extraction and manufacturing processes. Transportation in the phase until and including manufacture also plays a certain role.

Wholesalers and agencies handle about half of the imports and a smaller amount of the exports. Therefore a certain trade in miscellaneous articles of base metals takes place in Denmark. This trade probably targets both retailers and manufacturers as well as wholesale directly to artisans.

3.14 Product group 86: Railway rolling stock and signalling

The product group "Railways" is middle sized and accounts for 1.3% of the total consumption in Denmark.

Imports nearly equal production in Denmark. Exports correspond to only 6% of total supplies. Thus it is to be assumed that the entire import and production is used in Denmark.

Neither criteria for eco-labelling nor environmental guidelines have been elaborated for this product group.

The number of companies in the two related industrial sectors is limited, less than 200 with a preponderance of small companies. The only exception is one large company belonging to an international group of companies. The related industrial sectors are "342: Coachwork" and "352: Manufacture of railway rolling stock etc."

Neither industrial sector 342 nor industrial sector 352 are submitted to environmental approval. None of the industrial sectors have been subject to an action under the Cleaner Products Support Program, and none of them have been subject to a branch-oriented action under the Program for Promotion of Environmental Management and Audit.

From an environmental point of view the product group "Railways" has a large potential impact on the environment. During the life cycle until and including manufacture the main contributor to pollution is the manufacture of steel. The numbers also show a high consumption of energy in the manufacturing processes.

Numbers from the Statistics of foreign trade show that imports mainly concern the group "Other land transportation" (not including railways and pipes) and is entirely consumed in Denmark, since no exports are present in this group. Exports originate from the group "Manufacture of railway traction" – probably from the company Bombardier, which is the only large company within this industrial sector. Wholesales have no importance in this product group.

4 Recommended target areas in 2002

As mentioned in the previous chapter the use of the model points out a total of 14 product groups with potentially “high” environmental *and* environmental impacts, which have not earlier been subject to an industry-oriented product action:

- 25: Salt, earths and stone
- 27: Mineral fuels
- 28: Inorganic chemicals
- 29: Organic chemicals
- 31: Fertilizers
- 38: Miscellaneous chemical products
- 40: Rubber and articles thereof
- 68: Articles of stone, cement etc.
- 72: Iron and steel
- 73: Articles of iron and steel
- 74: Copper and articles thereof
- 76: Aluminium and articles thereof
- 83: Miscellaneous articles of base metal
- 86: Railway rolling stock and signalling equipment.

The present model for selection of future target areas is a first issue. It means that the amounts of information involved as well as the details of information are limited. Moreover, the model primarily includes environmental and economic information. In order to find the most suitable areas of action for the year 2002 it is necessary to have supplementary information in the decision-making process such as information about capacity and needs within the industrial sectors themselves.

It could also be relevant besides the technical-environmental aspects to have other aspects included in the study such as political issues and the prospects of achieving public visibility and widespread information about the actions. Such points of view may result in another ranking of product groups and consequently in actions oriented against products groups, which do not have the ranking “High”.

As an example the product group “motor cars” is ranked “Medium” and not “High” in the environmental assessments, but motorcars represent a large and visible product group in Denmark. Motorcars also cause several important environmental problems related to use and final disposal. On an international level the car manufacturers put emphasis on sustainable development aspects. Several companies are registered in the Danish Ethics Database and are issuing reports about sustainable development based on the guidelines laid down by the Global Reporting Initiatives. It could be relevant to join the existing information in order to create a consumer-targeted campaign about environmentally friendly cars comprising consultancy with regard to purchase, use, maintenance and final disposal. Several consumer groups and

trade associations would probably be interested in joining such an initiative. It is also important to involve the automobile dealers and the importers.

4.1 Fourteen product groups

The 14 product groups are listed below. The list shows the related industrial sectors as well as the most important trade associations, which could be involved in the actions.

| Product group | Related industrial sector | Trade associations |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25: Salt, earths and stone | 141: Quarrying 142: Gravel, sand and clay 144: Extraction of salt 145: Other raw materials extraction 265: Manufacture of cement, lime and gypsum | Danish Building Employers Confederation (Byggeriets Arbejdsgivere) |
| 27: Mineral fuels | 232: Refining of oil 268: Manufacture of other mineral products | Danish Petroleum Industry Association (Oliebranchen i Danmark) Danish Asphalt Industry (Asfaltindustrien) |
| 28: Inorganic chemicals | 241: Manufacture of base chemicals | The Danish Association of Chemical Distributors (Kemikaliebranchen) |
| 29: Organic chemicals | 242: Manufacture of pesticides and agro-chemicals 244: Manufacture of pharmaceutical products | The Danish Association of Chemical Distributors (Kemikaliebranchen) The Danish Association of the Pharmaceutical Industry (Lægemiddelindustriforeningen) |
| 31: Fertilizers | 241: Manufacture of base chemicals | Danish Farm Supply Environmental Working Group (Grovvarebranchens Miljøgruppe) |
| 38: Miscellaneous chemical products | 246: Manufacture of other chemical products 266: Manufacture of articles of concrete, gypsum and cement | The Danish Association of Chemical Distributors (Kemikaliebranchen) |
| 40: Rubber and articles thereof | 251: Manufacture of rubber products | |
| 68: Articles of stone, cement etc. | 266: Manufacture of articles of concrete, gypsum and cement 268: Manufacture of other mineral products | Danish Building Employers Confederation (Byggeriets Arbejdsgivere) Concrete Element Association (Betonelement-Foreningen) Danish Contractors' |

| Product group | Related industrial sector | Trade associations |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | Association (Danske Entreprenører) |
| 72: Iron and steel | 271: Iron and steel works 273: Processing of iron and steel, ferrous alloys 371: Recycling of metallic waste | Association of Danish Steel-Stockholders (Stålforeningen) (stålgrossister) |
| 73: Articles of iron and steel | 272: Manufacture of pipes 281: Manufacture of steel structures 287: Manufacture of drums, wire products, bolts, screws etc. | Danish Blacksmith Association (Dansk Smedemesterforening) The Danish Plumbing, Heating, and Ventilation Constructors Association (Dansk VVS) Danish Federation of Manufacturers of heating, ventilation, sanitary, and metering equipment (VVS Fabrikkerne) Danish Locksmith Association (Dansk Låse Smede Forening) Danish Hardware Association (Dansk Isenkramforening) Dansk Radiatorindustri Tekniske Samråd The Association of Danish Shipbuilders (Foreningen af Jernskibs- og Maskinbyggerier i Danmark) |
| 74: Copper and articles thereof | 274: Manufacture of precious metals and non-ferrous base metals 287: Manufacture of drums, wire products, bolts, screws etc. 323: Manufacture of audio-visual equipment | Association of Danish Recycling Industries (Genvindingsindustrien) |
| 76: Aluminium and articles thereof | 274: Manufacture of precious metals and non-ferrous base metals 281: Manufacture of metallic structures and parts thereof 287: Manufacture of drums, wire products, bolts, screws etc. | Association of Danish Recycling Industries (Genvindingsindustrien) |
| 83: Miscellaneous articles of base metal | 286: Manufacture of cutlery, knives and scissors, hand-tools etc | |

| Product group | Related industrial sector | Trade associations |
|----------------------------------------------------|-------------------------------------------------------------|---------------------------|
| | 287 Manufacture of drums, wire products, bolts, screws etc. | |
| 86: Railway rolling stock and signalling equipment | 342: Coachwork 352: Manufacture of railway traction etc. | |

For each of the selected 14 product groups the types of action judged relevant are listed below. All the 14 product groups are featured by an economical and environmental importance and the lack of a sector-oriented action. A sector-oriented action means an action for cleaner products based in a trade association and/or in a product panel. A further order of priority between the selected 14 product groups has not been established since it requires a number of supplementary evaluations, which are beyond the scope of this study.

The evaluations and recommendations as described above are based on the fact that several types of product-oriented action are judged relevant such as the actions mentioned below:

1. Sector-oriented action targeting manufacturing companies, which until now have not been subject to environmental action. A prerequisite is that the action can be based in a trade association.
2. Supplementary sector-oriented action with relation to on-going activities.
3. Supply chain-of-goods projects laying emphasis on management in international supply chains-of-goods.
4. Supply chain projects laying emphasis on manufacturing, use and final disposal of the products in which producers, wholesalers and retailers are involved or in which the users have influence on the earlier steps in the supply chain.
5. Individual projects laying emphasis on utilization and spreading of existing knowledge including the use in public tenders.
6. Inclusion in other product groups such as product groups comprising primary raw materials and sub-products.

Experience gained from earlier sector-oriented actions shows the importance of having central players within or in relation to the supply chain. Another essential aspect is market-orientation. Market-orientation means the endeavours to include the environment as a natural parameter of demand and supply. In other words the actions being launched should put focus on environmental benefits and market development in such a way that the companies are motivated to continue even after termination of the project and withdrawal of the support by the Danish EPA.

The following table gives an overview of the recommendations described above with relation to the selected 14 product groups.

| Product groups | Action | 1. New sector-oriented action | 2. Suppl. actions | 3. Internat. supply chain management | 4. Use and final disposal | 5. Spreading of knowledge | 6. Inclusion in other product groups |
|----------------------------------------------------|---------------|--------------------------------------|--------------------------|---------------------------------------------|----------------------------------|----------------------------------|---------------------------------------------|
| 25: Salt, earths and stone | | | X | X | X | | |
| 27: Mineral fuels | | | | X | X | X | |
| 28: Inorganic chemicals | | | X | X | | | X |
| 29: Organic chemicals | X | | X | X | X | X | X |
| 31: Fertilizers | | | | X | | | |
| 38: Misc. chemical products | | | X | | | | X |
| 40: Rubber and articles thereof | | | | X | | | X |
| 68: Articles of stone, cement etc. | | | X | | X | | |
| 72: Iron and steel | | | | X | | | X |
| 73: Goods of iron and steel | X | | | | | X | |
| 74: Copper and articles thereof | | | | X | X | | X |
| 76: Aluminium and articles thereof | | | | X | X | | X |
| 83: Miscellaneous articles of base metals | | | | X | | | X |
| 86: Railway rolling stock and signalling equipment | | | | | | X | |

Table 4-1: overview of the recommendations with relation to the selected 14 product groups

4.1.1 25: Salt, earths and stones

Until now no specific product-oriented action has covered the extraction of salt, earths and stones, but the manufacture of cement etc. and in particular the use of these products in the building sector is covered by the actions initiated by the Buildings & Construction Panel. The product cement has earlier been subject to life cycle assessments.

It appears logical to relate a future product-oriented action to the on-going environmental activities in the building sector. The environmental benefits of such an action may be rather limited due to the fact that the most important aspects, which are related to the production of cement, already are or can be included in the on-going activities. On the other hand benefits may be achieved in spreading the systematic work with environmental issues such as environmental management to a larger number of companies within the industrial sector. This is by experience a demanding task while so many small enterprises exist. A combined view on Life Cycle and Market may indicate a potential in stimulating companies to carry out actions based on supply chains from the extraction of raw materials such as stone and gravel over the production of building materials to use of the products in the building sector. Gravel pits, quarries etc. will hardly on their own initiate a product-oriented environmental action if such an action is not demanded.

Since about one third of the total supply is imported environmental gains may be achieved in imposing environmental requirements on imported goods. A prerequisite is a more detailed analysis since the already gathered information does not show exactly which materials are imported and in which quantities. It is therefore unknown whether the imported goods are the most polluting ones or not.

4.1.2 27: Mineral fuels

A future product-oriented action must include producers as well as wholesalers and retailers in order to cover all relevant parts of the supply chain of goods. Within several sub-trades the companies are actively involved in more elements of the supply chain of goods such as extraction of raw materials, production, distribution and sales and perhaps also maintenance. This applies for instance to the refineries and the asphalt works. This means that an integration of life cycle considerations in the environmental management of the companies can be recommended especially concerning the earlier phases of the life cycle.

The asphalt industry has during several years made efforts to promote cleaner technology, environmental management and development of cleaner products. The most important customers of the asphalt industry are public authorities and private contractors, which also put a certain focus on the environment, but until now the environmental aspects do not play a role in marketing. Therefore a product-oriented action could strengthen the inclusion of environmental aspects in the tenders.

4.1.3 28: Inorganic chemicals

Until now the product-oriented actions covering chemicals primarily have targeted the substitution of non-desirable substances across the borders of different industrial sectors. No sector-oriented action has taken place.

While an important share of the inorganic chemicals used in Denmark is imported it is recommended to focus on a sector-oriented action with international co-operation. As an example projects aiming at supply chains submitted to management by the supplier. The Danish Association of Chemical Distributors comprising more than 50 importers/distributors could be a potential partner.

4.1.4 29: Organic chemicals

Until now the product-oriented actions covering chemicals primarily have targeted the substitution of non-desirable substances across the borders of different industrial sectors. No sector-oriented action has taken place neither within the chemical nor the pharmaceutical industry, which are the most important related industrial sectors.

A possible future action within the pharmaceutical industry could focus on a further development and integration of the product-oriented environmental aspects in environmental management and other management systems used in the industry. As an example could be mentioned the environmental management of supply chains. This also implies co-operation on international level since the market for pharmaceutical products to a high degree is global. Furthermore the pharmaceutical industry in general puts emphasis on sustainable development

4.1.5 31: Fertilizers

A future product-oriented action must include producers (mainly chemical industry), users (mainly agriculture) and traders (mainly wholesalers) in order to cover all relevant parts of the supply chain of goods. Since imports equal production in Denmark a future action should include environmental

requirements to imported fertilizers as well as requirement to the transportation of imported fertilizers. The manufacturers importing raw materials for fertilizers and/or the wholesalers importing an essential share of the fertilizers could handle these requirements. The market is featured by three larger producers, which also have wholesales within their core business.

4.1.6 38: Miscellaneous chemical products

This product group is very versatile. It is therefore difficult to point out a specific action to be taken, but such an action should probably be linked to an action covering other areas and/or industrial sectors in which the products are used.

4.1.7 40: Rubber and articles thereof

The raw material rubber is imported and used in Denmark for the manufacture of products mainly to vehicles. There is no basis for a sector-oriented action, but a future action could instead be linked to a broad action covering manufacture, use, maintenance and final disposal of vehicles.

Furthermore rubber finds use in the manufacture of pharmaceutical articles. A sector-oriented action within the pharmaceutical industry could thus comprise articles of rubber.

4.1.8 68: Articles of stone, cement etc.

Via the Buildings Panel (Byggepanelet) emphasis has been put on the products used in the building industry, but this industry is using a very large number of different products. Therefore it could be relevant to launch a product-oriented action aiming at a number of selected product groups. Such an action could be related to a supply chain consideration comprising extraction of stone, gravel and similar raw materials (see product group 25).

4.1.9 72: Iron and steel

For many years iron and steel works have been synonymous with the Danish Steel Works. The recent bankruptcy of this company makes it irrelevant at the present moment to discuss a sector-oriented action for the product group iron and steel.

On the other hand it is even more important to improve the environment in the international supply chains of goods. A possible partner could be the Association of Danish Steel-Stockholders, which is an association of wholesalers in steel (see also product group 73).

4.1.10 73: Articles of iron and steel

Articles of iron and steel are one of the largest product groups in Denmark. This fact itself argues for an action. On the other hand the product group is very broad and comprises a large number of mainly small production companies. The product group also has several related trade associations. Therefore a study aiming at the identification of the most important environmental issues and the major players is needed. A part of the products are used by artisans (plumbers as an example), which are working on behalf of private consumers and others having virtually no knowledge about the products. Therefore it could be advantageous to target a co-operation

between several players comprising producers and artisans. Until now the artisans have only been involved to a minor degree.

Another possibility is an action targeting the building materials stores in order to promote supply and demand of cleaner products and/or products from manufacturers being actively involved in environmental activities. As an example: a campaign promoting “green” maintenance of houses including guidelines to the do-it-yourself people.

4.1.11 74: Copper and articles thereof

Copper is not produced in Denmark, but copper is used in the production of a large number of goods. Therefore a large number of manufacturers are involved. A sector-oriented action for this product group is therefore not relevant. On the other hand a possible action aiming at large scale recycling of copper could be relevant since copper is regarded as a scarce resource.

4.1.12 76: Aluminium and articles thereof

Aluminium finds application just like copper in a number of different areas and based on environmental assessments it could be recommended to have recycling to a large extent. The smelting of aluminium only costs 10% of the energy used to produce primary aluminium. A product-oriented action could have the aim of finding out in which areas recycled aluminium is advantageous and subsequently promote the use of recycled aluminium to the largest possible extent.

Goods of aluminium comprise furniture, kitchen and household articles as well as sanitary articles. An action could preferably be related to an action involving the plumbers and heating contractors.

4.1.13 83: Miscellaneous articles of base metal

The extraction of base metals and the transportation of base metals are the main pollution contributors from a life cycle point of view. Only the life cycle until and including manufacturing is regarded. Therefore it is relevant to pose environmental requirement to the international supply chains, which could involve the wholesalers and agencies being responsible for about half of the imports.

4.1.14 86: Railway rolling stock and signalling equipment

The Danish production of locomotives and railway rolling stock is decreasing. It means that environmental requirements should be applied in international tenders for equipment to Danish railways. It is obvious to focus on the steel used for manufacture of rolling stock.

4.2 Types of action

With regard to the earlier mentioned 6 different types of action the recommended future actions can be summarized as follows:

4.2.1 Sector-oriented action targeting manufacturing companies, which until now have not been subject to environmental action

The product groups, which appear most relevant for initiating a sector-oriented action, are the following: iron and metal industry, pharmaceutical industry and probably also the chemical industry. Within all these industries there is a certain level of knowledge of environmental management, which is due to previous projects about the promotion of environmental management. The pharmaceutical and the chemical industry are both internationally oriented and featured by large companies. The iron and metal industries also take part in international supply chains, but mainly rely on the home market and are featured by a large number of smaller companies.

4.2.2 Supplementary sector-oriented action with relation to on-going activities

Within the chemical industry the general action has been the substitution of dangerous substances. This work is important and should have a high priority in the future, as the environmental impact of many chemical substances is very high. A supplementary sector-oriented action should be taken into consideration. In this action the industry itself should find solutions in order to speed-up the on-going activities and spread the knowledge about less polluting alternatives.

Also within the building sector it could be relevant to have a supplementary action with relation to the on-going activities in the Buildings Panel (Byggepanelet). Special emphasis should be put on extraction of raw materials and manufacture of building articles. This can perhaps to a certain degree be included in the new project referring to the tenders of Danish EPA in 2002.

4.2.3 Supply chain-of-goods projects laying emphasis on management in international supply chains-of-goods

Some of the selected product groups are featured by a high degree of import. In these cases it is a challenge to find methods, which can effectively handle environmental requirements in international supply chains. Typical examples are:

- Mineral fuels
- Iron and steel as raw materials
- Inorganic chemicals and miscellaneous chemical products
- Cobber, aluminium and miscellaneous goods of base metals

This type of projects does not need to be related to a trade association. The efforts could instead be organised in networks in which producers, wholesalers and other players within the industrial sector co-operate on one or more development projects.

4.2.4 Supply chain projects laying emphasis on production, use and final disposal involving producers, wholesalers and retailers

In many supply chain projects the wholesalers play an important role with relation to import and distribution of the products. In this way the wholesaler is the central body handling environmental requirements and improvements up-stream (foreign producers) and down-stream the supply chain (retailers). An action involving the wholesalers requires improved information from the

database. The present information is available on a three-numbered level and it is not sufficient for pointing out the relevant players for the individual product groups.

4.2.5 Individual projects laying emphasis on utilization and spreading of existing know-how

Within several industrial sectors environmental activities have been carried out during recent years putting emphasis on the promotion of cleaner technology, environmental management and cleaner products. Contrary to the activities about cleaner technology and environmental management, which take place in the individual companies, the work with cleaner products requires a direct co-operation with other players and in particular with the market. As a matter of fact environmental issues have not had a break-through in the market. Therefore it is important to maintain and develop further the on-going activities in order to achieve a market break-through. Market orientation is by nature something new in many fields.

A special area may be to strengthen the environmental aspects in public tenders. With regard to the selected 14 product groups the areas of asphalt and railway rolling stock and signalling equipment could be relevant.

4.2.6 Inclusion in other product groups

Many of the selected 14 product groups are featured by primarily raw materials and/or sub-products, which are used for manufacturing of other articles belonging to other product groups. From a life cycle consideration it appears relevant to relate the effort to actions where the products (raw materials/sub-products) are used. This applies to:

- Organic and inorganic chemicals and miscellaneous chemical products diverse
- Iron and steel as raw material
- Rubber
- Copper, aluminium and articles of base metals

5 Further development of the model

The screening model, which has been developed in the present project, has the aim of selecting relevant areas for future industry-oriented and product-oriented environmental actions. In the same way the model should be suited for further development aiming at giving priority to future actions by the Danish EPA within the framework of the Program for Cleaner Products. Thus the model should be able to relate products with the industrial sectors in which they are produced taking earlier industry-oriented actions as well as future product-oriented actions into consideration.

As basis for the environmental assessments an American input/output database was chosen. The reason being that this database allows a consistent environmental screening of all the relevant product groups. The first issue of the model, which is available now, is based on screening. It means that a number of delimitations were introduced and a number of courses were chosen. Therefore this preliminary issue of the model has the following delimitations:

- The environmental assessment (input/output analysis) is not based on Danish conditions, but on American industrial conditions. On the other hand this allows for an adequate environmental assessment of a large number of product groups.
- The environmental assessment (input/output analysis) does not cover all relevant environmental aspects. As an example the production of waste is not included, but the production of dangerous waste is included. The consumption of natural resources and raw materials is only included to a limited extend and local environmental problems such as dust, noise and odour are not covered by the method.
- Furthermore the environmental aspects during use of the products and final disposal of the products are not taken into consideration.
- The environmental aspects included in the model are given the same weight even though they may have different environmental importance.
- The degree of detail is limited (95 products groups) which means an inherent limitation for a screening model.
- Finally the method is based on American product codes. These codes are not in all cases comparable with Danish product codes.

In the following these delimitations will be treated in detail. Furthermore a proposal to minimize these delimitations is described as well as a presentation of the sources, which are expected to be included in the further development of the model. The descriptions are based on the knowledge acquired during the present study. A more detailed analysis and the laying down of future wishes and needs will probably reveal a number of further possibilities.

5.1 Inclusion of further environmental aspects

The use of the American database for environmental screening by nature poses some limitations. Only the environmental aspects included in the American model can be taken into consideration. In total the model comprises

72 different parameters such as economy, air polluting substances, working environment, water consumption, green house effect, emission of toxic substances to air, water, soil and subsoil, nutritive substances, energy consumption, consumption of raw materials, dangerous wastes and estimated costs of the detrimental effects of pollution. Among these environmental parameters eight parameters have been selected in order to handle the amount of information used in the screening. The eight parameters used in the first issue of the model are:

- Air-polluting substances - Emission of SO₂
- Air-polluting substances - Emission of NO₂
- Consumption of water (total)
- Green house effect (GWP)
- Consumption of energy (total)
- Consumption of mineral raw materials - Consumption of copper
- Dangerous wastes (amounts produced)
- Emission of toxic substances, total and weighted according to degree of danger

The further development of the model for selection of future target areas of course makes it possible to include more of the environmental aspects used in the American model, but it is estimated useful to include the consumption of resources, waste and consumption of chemicals since these parameters represent the weak spots in the American method. Possible sources to be taken into consideration in this context are:

Total Material Requirement

Statistics Denmark is preparing information about *DMI – Direct Material-Input and TMR – Total Material Requirement*, which are statements of the consumption of resources distributed on product groups and industrial sectors in Denmark as well as on an international level. The consumption of resources are stated in the national account according to industrial sectors which unfortunately are not directly comparable with branch codes settled by the DB-93 standard, and on product groups having another code than the KN nomenclature.

This study of Statistics Denmark will probably be finished simultaneously with the present project. Therefore the information under preparation by Statistics Denmark has not been included in the first issue of the model for selection of future target areas. For the further development of the model DMI and TMR are judged potential relevant, but a prerequisite is further working cycles at Statistics Denmark.

Chemicals

The study about state of the art and prospects in the field of chemicals "*Status og perspektiver på kemikalieområdet, 1996*" comprises an survey of the industrial sectors which are featured by a high consumption of chemicals as well as an overview of the products which are containing the non-desirable substances listed specifically. In the further development of the model for selection of future target areas the products from the above mentioned list could be related to the products codes used. This represents a comprehensive load of work for which reason it is not included in the first issue of the model, but it is evident to do it in the next issue.

Waste

Furthermore statistics about wastes (*Affaldsstatistikker*) is prepared annually based on information from a number of companies representing different industrial sectors which by law are obliged to report about wastes to the Danish EPA. It has to be examined whether information about the production of wastes can be extracted and used in a product assessment. Apparently this represents a considerable effort, but on the other hand it could strengthen the environmental assessment of the product groups with regard to wastes.

The recent study about industries featured by large amounts of dangerous wastes "*Affaldstunge brancher, 2001*" may as an alternative give information about the most important industries with regard to wastes. The study maps the amounts and the types of waste generated by the industries in question which are the pharmaceutical industry, the manufacturer of electronics, the iron and steel industry as well as the wood and furniture industry. Unfortunately this study is not able to establish a basis for a consistent assessment of all sub-branches contrary to the present model.

5.2 More detailed information in the model

The present issue of the model for selection of future target areas operates with a total of 95 product groups (two-digit KN code level) and 106 producing industrial sectors as well as 40 industrial sectors covering commercial activities and service (three-digit DB-93 code level). It was a choice in the present project to keep the number of product groups and sub-sectors at this level in order to carry out a screening consistent in the treatment of information from all product groups.

Products

The disadvantage arising from this choice is that the accuracy for the individual product groups is less high. This is in particular the case for large and non-uniform product groups such as " 73: Articles of iron and steel" which comprises screws and nails, cookers and pre-fabricated sections to bridges, and the product " 74: Copper and articles thereof" which comprises nearly everything ranging from non-refined copper to household appliances made of copper.

In the further work with the model it should be examined whether the accuracy – and thus the possibility to focus the actions – could be improved by increasing the number of details mainly with regard to the product groups for instance by introducing a four-digit KN code level (use of a three-digit level is not possible). Introduction of a four-digit code level for products means that the number of product groups will rise to about 1200, which in turn will increase the time needed for the environmental assessment. The American input/output database only operates with about 500 product groups and services. It therefore has to be examined in which fields the American database allows for more details of the product groups in order to obtain a higher accuracy.

Industrial sectors

Use of more details may cause problems with the information about the different industrial sectors given by Statistics Denmark. Statistics Denmark is submitted to a confidentiality clause, which gives rise to problems if only a few companies are represented in the statistics demanded. The numbers from Statistics Denmark already show that even at a three-numbered level some

information has to be kept confidential which is handled practically by putting information from several sub-trades together. By experience it is known that for some industrial sectors information can be obtained on a four or five-numbered code level whereas other trades branches only allow information retrieval on a three-numbered code level or not at all. As an example Denmark only have very few producers of heat insulation materials.

The use of the Statistics of foreign trade shows a need for more details about the different industrial sectors in particular within wholesales. Otherwise the information given by this statistical source has no practical use. It should therefore be examined whether in general more details about the industrial sectors are wanted or more details in selected product groups are wanted. Statistics Denmark should be asked which influence more details corresponding to a four or five-numbered code level have on the confidentiality.

If the number of product groups and sub-sectors is increased this requires new and more comprehensive treatment of information to substitute the present ones in the existing database.

5.3 Adaptation to Danish conditions

The model for selection of future target areas in the Danish program for Cleaner Products is as mentioned earlier based on American conditions. In the further development of the model it should be examined to which extent the difference between American and Danish conditions has influence on the results. If so which possibilities are available to adapt the results to Danish conditions?

It is recommended to start the further development of the model by an examination of the consequences of using American data instead of Danish data. The sources referred to below have been examined in the present project and may be included in a new project. If the American conditions appear to be too different from the Danish ones it has to be examined whether the use of a corrective factor will be useful or the model should be developed in quite another way.

The statistics issued by Statistics Denmark about input-output and analysis of imports, employment and environment denominated "*Input-output tabeller og analyser 2000 - Import, beskæftigelse og miljø*" comprises surveys of energy, water and miscellaneous atmospheric emissions. Environmental information is presented either as a total for the industrial sector, for instance in tons CO₂ or tons CO₂ per DKK i.e. related to value produced in the industrial sector. Environmental information is related to 130 national accounts for individual trades, which are not exactly coinciding with the DB-93 codes, but still comparable. This input/output model was not included in the first issue of the model as the information relates to industrial sectors and not to products. In a further development environmental information from this Danish input/output model can be transferred to product level via the relations between products and industrial sectors in Statistics Denmark. This implies an uncertainty concerning the information about the product groups, but the results could be used to estimate how far the American conditions are from the Danish conditions in the first issue of the model.

The *UMIP-database* comprises information about the environmental impact of individual processes. For use in the development of the present model the *UMIP-database* appeared to be a too detailed and too time-consuming tool. On the other hand a number of selected products groups treated in this way may be useful to determine whether the American conditions are far from the Danish conditions. The *UMIP-method* should only be used on the more homogeneous product groups in order to have basis for comparison. Alternatively it is judged necessary to have more *UMIP-evaluations* i.e. evaluations of several products within the same product group.

5.4 Inclusion of the phases of use and final disposal

The Input/output analysis is a "cradle-to-port" assessment, which means that the phases of use and final disposal are not included in the environmental assessment. In giving priority to future environmental actions it is essential to include the phases in which the product is used and finally disposed of. Mainly the phase of use is important for a life cycle assessment.

From an overall view there are two ways to include these phases in the environmental assessments. Either as an "add-on" parameter to the environmental assessment – perhaps only a statement whether or not the phase of use is energy consuming or the size of the environmental impact of the final disposal phase indicated as a ranking between the levels high, medium and low. It is also possible to include the phases of use and final disposal in the model itself submitting these phases to environmental assessment using all eight parameters as a minimum. How this inclusion shall take place depends to a certain degree on other choices made in the development of the model and shall naturally be taken into consideration in the total account.

If the phases of use and final disposal should be included entirely in the model it may be useful to rely on the *UMIP-database* or a similar database. It should be mentioned that the use of *UMIP* is time-consuming if the number of product groups is enlarged considerably during the development of the model.

5.5 Further development of the model itself

The above-mentioned aspects taken into account it is relevant to consider a development of the evaluation methods, for instance whether the individual parameters should be weighted in relation to each other, and if so in which way.

In the present model all eight parameters have the same weight, but a better and more correct ranking could perhaps be achieved by weighting the parameters in relation to each other.

In the further development of the model it should be studied how relevant a weighting of the individual parameters is and how this weighting in the affirmative case should be carried out, as an example with regard to political priorities. The need for weighting the parameters and the methods to do so of course depend on the number of supplementary parameters included in the model, but the way in which the phases of use and final disposal are included in the model also has importance.

5.6 Relation to other international methods

Finally, the relation to other international methods should be studied, in particular with regard to uniformity in the pointing out of environmentally important product groups. Furthermore a study of the methodology used in the projects may give mutual benefits. A few examples are listed in the following, but certainly more examples exist.

In connection with the development of the model dk-TEKNIK ENERGY & DEVELOPMENT attended a workshop organized by the European Union about the project EU (DG V) "*Study on external environmental effects related to the life cycle of products and services*". The aim of this project is to create an overview based on a number (20-30) of selected product groups showing where the largest environmental impacts are. The product groups have been selected using "common sense" and the expectations of finding suitable LCA information. In each product group more detailed LCA will be carried out on five actual products in order to map the difference between "good" products having for instance an eco-label and the "bad" ones. Presently (August 2002) the project has not been ended for which reason it is not included in the first issue of the model, but if useful results are found they will be included in further development of the model.

The Swedish report about the environmental impact of different product groups is named "*Miljöpåverkan från olika varugrupper*" and was issued in 2001. It refers to different input/output analysis of Swedish, American and Danish origin. The latter is denominated "*Miljøprioritering af industriprodukter fra 1995*" (Environmental priority of industrial products from 1995). The report ranks different product groups according to the following environmental categories:

- The Swedish study: CO₂, SO₂, NO_x, industrial wastes, consumption of chemicals
- The American study: human tox, CO₂, and resources
- The Danish study: energy and resources

The Swedish study was not included in the present project since it in no way is so detailed as the American counterpart (only information from 46 product groups). On the other hand it will be relevant to make a comparison of assessment and ranking in order to see whether the two methods give equal results for similar product groups.

5.7 Conclusions

As reported above the model for selection of future target areas can be improved in a number of fields. These fields are:

- Inclusion of more environmental aspects
- More details in the information used in the model
- Inclusion of the phases of use and final disposal
- Adaptation to Danish conditions
- Further development of the evaluation method itself – weighting of the environmental parameters
- Relations to other international methods – comparative analysis

Improvement and further development in all these fields will be very expensive in resources and it is not granted from the beginning that essential improvements can be achieved in all fields without creating simultaneously new problems in the form of weak spots.

It is therefore recommended to create a structure of three superior phases in the further work:

First, it is essential to stress which role the model has to play in the future product-oriented environmental action. Shall the model deal exclusively with the technical aspects or shall it also consider other aspects such as economy and political issues? How detailed should the information be for the desired use of the model? In which areas can overviews be accepted and in which areas are detailed information essential?

Second, the amount of delimitations as described in this chapter shall be studied further. Is it of crucial importance that the model is based on American conditions and if so should the information be adapted to Danish conditions? The resources needed for adaptation and further development of the model in each area should be estimated.

Finally, the model should be developed further with emphasis on the areas that will be ranked high.

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