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Miljøprojekt

Ranking of industrial products

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Appendix 2 and 4-6 has a size making publishing as separate appendix reports the preferred choice. These appendix reports are located on a number of Danish university libraries.

Preface

Purpose and results

This report describes the results of a project the purpose of which is ranking of all industrial products sold in Denmark on the basis of loss of resources and energy consumption related to these products.

This ranking is to be considered an initial, systematic attempt to identify the commodity groups (groups of industrial products) that can be assumed to be considerably harmful to the environment, and thus should be prioritised in the future efforts to introduce cleaner technology in Denmark.

It is stressed that this ranking is based on two simple criteria (loss of resources and energy consumption) and does not consider other kinds of environmental impact (e.g. emissions from productive activities), related to industrial products. Consequently the ranking itself is *not* an explanation of the industrial products resulting in the most serious environmental impact, but simply an explanation of the ranking according to the selected criteria.

The selected criteria are however considered covering a significant part of the total environmental impact by industrial products. Thus the results of this project will form an important basis for prioritizing of the environmental measures to be taken as concerns the product - measures to be taken in conformity with the action plan of cleaner technology 1993-1997/1/ of the Danish Ministry of the Environment.

The preparation of this ranking of industrial products has required collection and estimation of a considerable amount of data on the material composition of industrial products, energy consumption in connection with production of materials and recycling of materials etc. These data are expected to be reusable in other connections and were therefore organised in a database, which was installed in the computer system of the Danish Environmental Protection Agency as part of this project.

Financing and accomplishment

The project was financed by the Council for recycling and less polluting technology. The project was accomplished by COWI A/S within the period of May to December 1993.

Steering group

The accomplishment of the project was supervised by a steering group with the following members:

Søren Kristoffersen	Danish EPA (chairman)
Mariane Hounum	Danish EPA
Pia Jellinggård	Danish EPA
Peter Grau	Danish EPA
Helle Petersen	Danish EPA
Kurt Søndergård	COWI
Henrik Kærgård	COWI
Kristian B. Lauritsen	COWI (substitute for H. Kærgård)

Following group

Additionally a following group was set up to discuss and comment on the progress and the results of the project. This following group included the members of the steering group and representatives of the following institutions:

Tina Sternest	Confederation of Danish Industries (DI)
Svend Erik Nielsen	Economic Council of the Labour Movement
Birgitte Blahaut	Association of County Councils in Denmark
Helen Amundsen	Consumer Council
Lis Husmer	Danish Society for the Conservation of Nature
Dorthe Maimann	Danish Energy Agency
Klaus Sørensen	Danish Working Environment Service

Project organisation

In this project approx. 40 different specialists from COWI have been involved. To mention them here would be going too far. The members of COWI's management were: Kurt Søndergård (administrative project manager), Erik Hansen (specialist project manager), Ole V. Holm, Henrik Kærgård og Kristian B. Lauritsen. Additionally Lisbet Seedorff was responsible for quality assurance.

Sub-suppliers

In order to accomplish this project it has to a wide extent been necessary to involve expertise from outside COWI. The following institutions have made valuable contributions as sub-suppliers: Statistics Denmark (production and supply data), Danish Technological Institute (textiles, leather and many other materials), I. Krüger AS (environmental harmful materials and loss of resources for selected products), Dvinger Marine Consult (material composition etc. for ships and similar products), RISØ (how to make Danish industry more energy-efficient), Rubicon (application of rubber materials) and KTM Consulting (energy data of rubber materials).

Other contributions

It is further emphasised that the project could not have been carried out without a considerable assistance by a large part of Danish industry that has contributed obligingly with information of the composition of industrial products and energy consumption for production of the same. Also the recycling trade has assisted by providing information of recycling of various materials.

Report

This principal report was prepared by Erik Hansen, COWI.

Translation

This report is a translation of a report originally published in 1995 by the Danish EPA as Environmental Project No. 281. Erik Hansen, who was the author of the original report, has also been responsible for this translation.

Summary and conclusions

Objectives and principles

In this project all industrial products sold in Denmark have been ranked according to the loss of resources and energy consumption that are connected to these products.

Loss of resources is in this case defined as the amount of material that is not recycled. Loss of renewable materials that are recreated concurrently with their use (e.g. wood) is however not included in the loss of resources.

Energy consumption is in this case defined as:

- ? Energy consumption for producing and manufacturing the materials that make up the industrial product (including their energy content)
- ? plus the energy consumption during use
- ? minus the energy that can be regained by incinerating the loss of resources (including the loss of renewable materials).

The goal of this ranking was to identify the types of industrial products that over their entire life cycle (from extraction of raw materials to the final disposal) can be assumed in particular to have an impact on the environment and therefore should have priority in the further efforts for introducing cleaner technology in Denmark.

The parameters "loss of resources" and "energy consumption" are in this case used as indicator parameters of the total environmental impact that is connected to the industrial products through their life cycle. The choice of these indicator parameters is due to the fact that together they represent an essential part of the total environmental impact of industrial products, and at the same time it is relatively easy to estimate/calculate these parameters for all industrial products.

It is however stressed that these indicator parameters do not take into account the many other types of environmental impact (e.g. emissions from industrial manufacturers) that are connected with industrial products. The very ranking is therefore not a statement of the industrial products that have the greatest environmental impact, but only a statement of the rank according to the chosen indicator parameters.

This project has in principle focused only on actual industrial products, in other words finished goods. Raw materials, semi-manufactures and products made as handicraft are therefore in principle not included in the ranking. Since it is difficult to draw a line between finished goods and semi-manufactures, some semi-manufactures, among these packing materials, are included in this project.

1. All industrial products sold in Denmark are divided into commodity groups. This was done based on the Commodity Supply Statistics

compiled by Statistics Denmark. Of a total of 10,376 item numbers in these supply statistics, 3,729 are considered to be raw materials, semi-manufactures or handcraft - and are therefore sorted out. The remaining 6,647 item numbers are divided into a total of 966 commodity groups (see section 1.2 and appendices 3 and 4).

2. The material composition is determined for all product groups (see section 1.4 and appendix 5). In other words, the materials that make up the products of a group are identified, and the amount (in %) of each material is estimated. The products are chosen to be described including the packing that they are delivered in and the spare parts and working means that are needed during their life span. For example a washing machine would include soap, softener and water. Here, there is distinguished between the materials specified in table 1.5.
3. For all materials, the average loss of resources (the amount that is not recycled) is estimated, and it is determined whether the material is renewable, and whether it is recreated at the same rate as its use. The energy needed to extract, produce and manufacture each material is also estimated along with the energy content (the amount of latent energy (see section 1.5 and appendix 6)).
4. For all commodity groups the energy consumption during use is estimated (total energy consumption in the life span of the products), and it is estimated whether the use and disposal of a product result in a loss of resources for the materials in the commodity group that is different from the average loss of resources (see section 1.5 and appendix 5).
5. For all commodity groups, figures for production and supply (production + imports - exports) are retrieved from Statistics Denmark. The information is retrieved as average figures for the years 1990 to 1992. In the cases in which this information is confidential, an estimate was made of the probable size of the production/supply (see section 1.3).
6. Finally a computer system was developed to carry out the calculations of loss of resources, energy consumption and the rank according to these parameters. The fundamentals of the calculations are shown in diagram 1.1, whereas the calculations of each commodity group are found in appendix 2.

Results

The result of the ranking is shown in appendices 1a and 1b. Appendix 1a shows the rank as it appears, when the quantity data used in the calculation are an average of the production and supply. Appendix 1b shows the rank, when only the supply data are used in the calculation. It should be noted that there is no essential difference between the two ranks.

That the calculations i.a. are based on the average of production and supply figures, should be regarded as a pragmatic way of solving the problem that certain types of industrial products may have a high impact on the environment in Denmark in the production phase of their life cycle (this is the case for the products for which the export from Denmark is high as compared to the consumption), whereas other products will have an impact mainly in the consumption and disposal phases.

The results show that the industrial products of high ranking are characterized by one or more of the following properties:

- ? The product has an active energy consumption (e.g. a car that uses energy in the form of gasoline)
- ? The product has a large consumption of working means (e.g. a washing machine that uses soap and water)
- ? The product is sold in very large quantities and primarily consists of non-renewable materials (e.g. cement and asphalt)

Also products that primarily consist of renewable materials (e.g. newspapers and magazines that consist of approx. 97% paper and 3% printing ink) can be of high ranking. In this case the products are sold in such large quantities that even a small content of non-renewable materials will give considerable loss of resources.

A considerable number of products among the 50 highest ranked commodity groups are characterized by being connected to the civic sectors of energy, transportation, agriculture and construction.

For the energy sector this regards products such as coal, oil, natural gas, gasoline, kerosene and coke. In this case the products are sold in very large quantities. When these products are ranked high on the list, it is partly because they disappear completely when used, and partly because they have a considerable energy content, which cannot be utilised by the current combustion technology.

In the transportation sector there are products such as ships, automobiles, trucks and trains. These products are characterized by a very large energy consumption during their use, combined with a considerable loss of resources as lubricating oil and other working means, for example tyres on cars.

In the agricultural sector the high-ranked products are primarily fertilizer and feed, but also produce such as meat and cheese. These products are also sold in very large quantities. Although these products (except fertilizer) primarily consist of renewable materials, they do have a small portion of non-renewable packing materials (especially plastic), which is considered to be lost. Aside from this, all of these products represent considerable energy content.

The high-ranked construction products include cement, concrete, asphalt, gypsum, mineral wool, reinforcing iron etc. Again products that are sold in very large quantities and only to a certain degree recycled. For example it should be pointed out that although 70% of all concrete is recycled today, the remaining 30% still represents a very large quantity that inevitably takes up space in dump sites.

Among the 50 highest ranked commodity groups a number of well known household products, such as refrigerators, freezers, washing machines and televisions can also be found - all characterised by a large energy consumption during their use. Washing machines are in addition characterised by a large consumption of working means, such as soap, softener etc. Measured over the life span of a washing machine the soap consumption constitutes 86% of the total material weight excluding water. Also a number of consumer goods are

high-ranked, for example newspapers, magazines and bottled beer, all of which are sold in very large quantities. The same is the case for furniture made of chip boards or wood fibre boards, which are also high-ranked.

It should be noted that the ranking carried out here does not take the social utility value of the industrial products into consideration. A product that is ranked high on the list is not necessarily a poor or environmentally harmful product. A number of these products (e.g. refrigerators and televisions) are on the contrary products in connection with which Danish companies have initiated efforts for introducing cleaner technology, thereby developing environmentally safer products.

When a product is high-ranked, it should be taken as documentation of a very large loss of resources and/or energy consumption connected with that product, and therefore it can be in the interest of the public to initiate considerations as to the improvements/changes/consumption reductions etc. that might be introduced for that product. A number of these products are sold in such large quantities that even a relatively small improvement would have great influence compared to many of the lower ranked products.

It is emphasized that during the final evaluation of the results brought forward in this project, it is of course necessary to observe that the ranking does not take all the environmental impacts connected to the industrial products into consideration. In other words, when finding the final priority of the products it would be relevant to include knowledge about emissions of chemical substances during manufacturing processes in Denmark, and at the same time take the industrial products that contain especially environmentally hazardous materials into consideration.

In this way industrial products that are only sold in very small quantities, and therefore are ranked very low on the list, can demand attention due to a content of environmentally hazardous materials or pollution during manufacturing.

Uncertainties

Aside from this, it is emphasized that the ranking naturally contains elements of uncertainty, since all the data that go into the calculations can only be determined within a certain degree. In some cases errors were made at estimating the material composition, material data etc. As is noted in section 2.2 it is estimated that the loss of resources calculations should be considered to have a degree of uncertainty that typically ranges from -42% to +61%, whereas the calculations of energy consumption range from -50% to +76%.

These uncertainties indicate that it makes no sense to claim that the commodity group ranked as number 30 has a greater environmental impact than the commodity group ranked as number 35, or to single out number 250 instead of number 300. It does however make sense to emphasize commodity groups ranked 1 - 50 instead of numbers 100 - 200 and so on. In other words it is the greater perspectives that should be noticed.

Data base

Apart from the ranking, which was the primary goal of this project, the project also fulfilled the goal of providing essential knowledge of industrial products and the materials used in these. This knowledge is as described in section 3.2 expected to be of use in connection with material flow analyses and other

environmental studies concerning industrial products. All the data that were retrieved through this project along with the documentation of this data were organised in a data base installed in the computer system of the Danish Environmental Protection Agency (Miljøstyrelsen). Although this data base is today only equipped to carry out the calculations that were necessary in connection with this project, the data base could relatively easily be extended to carry out a number of other calculations. This project can therefore be said to have laid the cornerstone for a data base on industrial products and materials, which will hopefully be of great value in the future environmental work in Denmark.

It is emphasized that the extent and time limit of this project naturally resulted in a data base that is far from perfect and in many ways is improvable. The data found in this data base should therefore not be considered the ultimate truth, but rather a basis that can be useful for making overall estimates, and which can be improved, as more precise data are made available.

1 Method description

1.1 Principles and philosophy

1.1.1 Background

Pilot project

This project is based on the considerations of the pilot project called "Environmental impact of industrial products" ("Industriprodukters Miljøbelastning") (cf. /2/). The objective of this pilot project was to develop a methodology to estimate the environmental impact by industrial products to enable identification of the type of products causing the most serious environmental impact through their entire life cycle.

The pilot project and thus also this project are an attempt to concretize the thoughts expressed in the action plan for cleaner technology of the Ministry of the Environment /1/. Whereas up till now the environmental measures taken have focused primarily on the pollution from manufacture activities, the future measures will be more focused on industrial products and the environmental impact related to the entire life cycle of industrial products, i.e. from extraction of raw materials to disposal of discarded products.

The efforts taken to identify a method for ranking industrial products based on their environmental impact are based on the fact that the funds available in the Danish society are not unlimited. It is consequently both necessary and appropriate to focus the measures to be taken on the types of industrial products that are especially harmful to the environment.

The pilot project included an assessment of relevant environmental relations of an industrial product throughout its life cycle (cf. fig. 1.1) and the possibilities of obtaining data on these environmental relations and the related measures. A proposal for various methods of ranking industrial products was made.

It was estimated (cf. /2/) that the possible ranking methods can be divided in three levels that are clearly different as to the method accuracy/information value and the workload required by applying the method. These levels are as follows:

Level 1: Quantities only. A ranking of industrial products can be carried out based exclusively on the quantities (in weight) of the products consumed or produced in Denmark. This level can only be considered an indication of the actual environmental problems. The criterion will be inaccurate and unreasonable, as e.g. foodstuffs, paper and wood-based products will rank highly, even though these products exclusively or mostly consist of renewable materials. Furthermore, it is not possible to consider the energy consumption of the industrial products during their use phase, even though this consumption has a crucial importance to the total energy consumption of products using energy in their use phase. The required work to be performed

applying this method was estimated at 2.5 to 3.5 man months excluding computer activities.

Level 2: Loss of resources and energy consumption. A better ranking is achieved by estimating the loss of resources and the energy consumption of industrial products. The loss of resources is a goal for consumption of the natural resources, but also indirectly an expression of an environmental impact (diffuse pollution etc.) The energy consumption will be an indicator of the greenhouse effect and the acidification, as these environmental impacts are mainly emissions to the air at energy transformation (e.g. coal to electricity). Other environmental problems will however not be included in the ranking. The required work to be performed by applying the method was estimated at 40 to 61 man months excluding computer activities.

Level 3: All environmental problems. At this level efforts are made to achieve detailed knowledge of the life cycle of all materials contained in industrial products. It should thus be possible to estimate loss of resources and energy consumption, as well as other environmental impacts, such as greenhouse effect, ozone depletion, acidification, eutrophication, dispersion of heavy metals and persistent organic matters and other local impacts (dust, noise, carcinogenic substances etc.) The ranking is possible by means of a scoring system or various ways of quantification. The workload was assessed considerable (100 man months as a minimum) and of a level only justifiable, if for other reasons there is a need for developing actual environmental profiles for specific materials.

The project described in this report has applied the above ranking method designated "level 2". This level is considered the optimal level based on a balancing of accuracy/information value versus workload of a method to include all industrial products (finished goods) sold in Denmark.

1.1.2 Philosophy

Definition of an industrial product

An industrial product is here defined as "an article that has been through a working-up process characterised as a mass production, and the further use of which does not involve additional industrial joining or processing".

Thus, articles like crude oil, iron bars, potatoes, electronic components and gravel are not considered industrial products, whereas petrol, machines, ready-made casseroles, computers and concrete elements are.

Defined in this way industrial products correspond to finished goods, whereas raw materials and semi-manufactures are not considered industrial products. The reasonability of this definition is based on the view that measures to reduce the environmental impact of industrial products must be based on the finished goods - not on the raw materials and semi-manufactures that are merely production stages of the finished goods. It must be admitted however that the definition is not unambiguous, as many articles can be used as semi-manufactures as well as finished goods.

It should be noted that the definition also excludes finished goods made as handicraft. This is considered acceptable, as the quantities produced of those articles are very modest compared to industrial products. Therefore the environmental impact of the handicraft is considered marginal compared to that of industrial products.

Problem elaboration

Also it should be noted that in this project report the designation industrial product means the product including packaging, spare parts and working means, if any, used during the entire life cycle of the product.

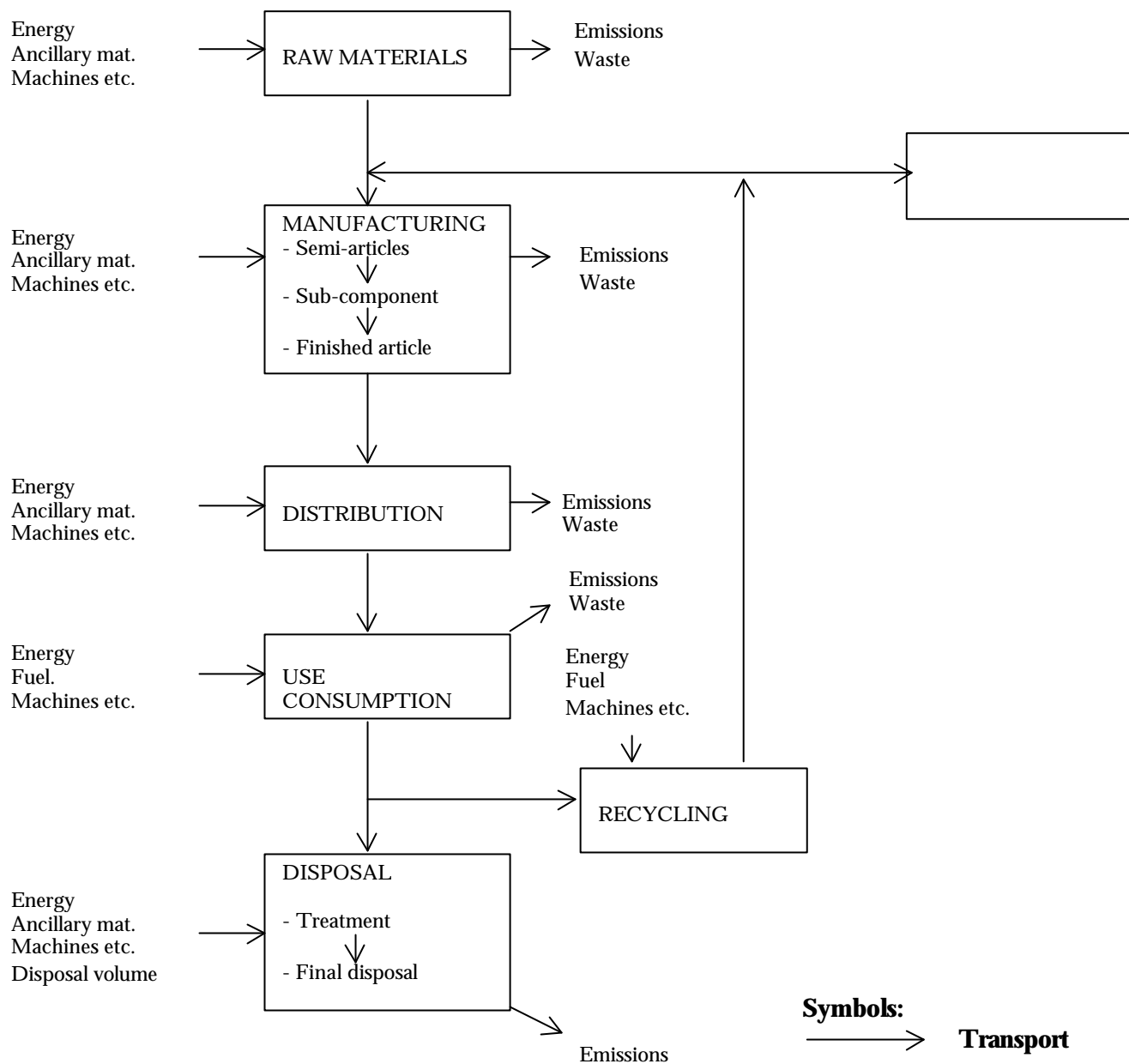


Fig. 1.1 Environmental relations of an industrial product during its life cycle (principle)

The grounds for this choice are that packaging, working means and spare parts are actually an integrated part of the industrial product and consequently must be included to enable a just comparison of various industrial products.

In practice the term industrial product covers a very large quantity of different articles. The commodity statistics of Statistics Denmark based on the commodity tariff of the Central Customs and Tax Administration /3/ include approx. 10,000 tariff numbers. As most of these tariff numbers include many different types of goods, the categorization of the statistics in itself is a significant simplification of reality.

Furthermore, there is the large number of environmental relations (cf. fig. 1.1) occurring in the life cycle of an industrial product and the complexity of such life cycles. Although it is theoretically possible to analyse the life cycles and all the environmental relations of all industrial products, this would practically be an overwhelming task.

These conditions mean that any method to estimate the environmental impact of all industrial products during their life cycles must necessarily simplify reality and focus on indicator parameters in preference to covering the total environmental impact. This is considered acceptable, as the purpose of the ranking of industrial products is to identify the types of industrial products for which there is a need for further measures to be taken, including additional investigations. This ranking is not to be considered a final evaluation.

Philosophy

The principal philosophy behind the method applied in this project is as follows:

- 1) All industrial products are composed of a relatively modest amount of materials, and the environmental impact of industrial products is to a wide extent determined by these materials.
- 2) The material composition of industrial products with the same function will be rather similar (as a main rule - it is of course possible to find exceptions from this rule).
- 3) It is consequently possible and appropriate to divide industrial products in commodity groups and estimate the material composition of each commodity group by estimating the composition of an "average product".
- 4) By combining the estimated material composition with information of the amount of industrial products sold in the society in question, it is possible to determine the amount of materials utilised within each commodity group.
- 5) By choosing and estimating certain characteristics (indicator parameters) of each material - that can be considered a measurement of the environmental impact by the use of this material - a quantitative estimate of the environmental impact of a specific commodity group is obtainable.

Materials

As it appears the term material is a key element of this project. This term is chosen as an expression of the "building stones" of which industrial products are composed. Actually materials are an intermediate stage between substances and products - an intermediate stage, which cannot be defined unambiguously, but is meaningful all the same.

There are two reasons why the term materials cannot be defined unambiguously. One is that materials normally cover material compounds that are not unambiguously defined chemically. As a commercial product, e.g. iron is not a chemically clean material, but a mixture of several substances, of which some have been added deliberately (alloy components), whereas other substances are natural impurities. Thus the material low alloy carbon steel covers a long series of material compounds with the common characteristics that the dominant component of the material is iron. Correspondingly, the material PVC - besides the PVC molecules - will normally also contain many different additives, such as dyes, flame retardants, UV stabilizers etc. to a varying extent.

The other reason is that in several cases it is difficult to distinguish between materials and industrial products. Parallel to the comments on semi-manufactures versus finished goods (see above) several materials can be considered industrial products themselves. This applies especially to chemical products like paint, solvents etc., but also to materials like glass and paper etc. In section 1.4 is stated the materials applied in this project and the considerations behind the choices made.

That the environmental impact of the industrial products to a wide extent is related to the materials contained in the products, is due to the following

- ? that materials can be considered a resource
- ? that energy is used for manufacture of materials apart from the fact that many materials contain energy (latent energy)
- ? that manufacture, use and recycling of materials in many ways result in release of chemical substances, which stresses the environment.

Naturally industrial products also cause environmental impacts that are related to the product rather than the applied materials. This is mainly about the energy consumption and the consumption of various chemical substances for the use of the industrial product, but also the environmental impact made in connection with the disposal/recycling of the product.

In this project is focused on loss of resources and energy consumption as indicator parameters of the total environmental impact. The choice of these indicator parameters was made, because they are considered representative of a significant part of the total environmental impact - combined with the assessment that it is relatively easy to estimate these parameters for all industrial products. **It is emphasised that this choice is not an indication that the other environmental impacts are considered insignificant.** It is just relatively difficult and requires therefore a considerable workload to estimate data of these aspects. For a more detailed discussion of this issue reference is made to /2/.

In the following the chosen indicator parameters are described briefly:

Loss of resources

Each material can be considered a resource in itself. This resource is used for manufacturing of industrial products. Throughout the life cycle of an industrial product the resource will be lost entirely or partly: The material ends up in landfill sites, is spread diffusely in the surroundings or transformed. Consequently it is relevant to talk of a loss of resources. This loss of resources varies from one material to another and will to a certain extent also be dependent on the industrial product the material is part of.

In all phases of the life cycle of an industrial product waste will be produced and thus there will be a loss of resources (cf. fig. 1.1). Here is only the loss of resources occurring in the distribution, consumption and recycling/disposal phases estimated - thus the loss of resources through the raw material and production phases and the loss of resources related to infrastructure, manufacture of production equipment etc. are ignored (cf. /2/).

The reason for this choice is that the loss of resources in the distribution, consumption and recycling/disposal phases can relatively easily be calculated by estimating the part of the individual materials in an industrial product that will be collected for recycling (only recycling of materials is included - not recycling of products, cf. 1.5.1). On the other hand it would be difficult and a large workload to collect data of the loss of resources in the raw material and production phases. Unfortunately no knowledge is available today that would enable a precise assessment of the importance of this choice. In the pilot project /2/ it is assessed (a rough assessment) that the loss of resources throughout the distribution, consumption and recycling/disposal phases represents 30 - 70% of the total loss of resources.

These assessments are to be understood as follows: The lower limit of 30% corresponds to valuable materials (e.g. heavy metals) with a high degree of recycling, whereas the upper limit corresponds to materials that are non-recyclable (e.g. thermoset plastics). The choice of only including the loss of resources throughout the distribution, consumption and recycling/disposal phases (rather than including the loss of resources throughout the entire life cycle) means that industrial products with a low content of recyclable materials are ranked higher here (i.e. achieve a relatively larger loss of resources compared to other products) than would be the case, if the calculation of the loss of resources were based on the total loss of resources throughout the entire life cycle. Contrary to that, industrial products with a large part of recyclable materials would here be ranked lower than would be the case, if the calculation of the loss of resources were based on the total loss of resources throughout the entire life cycle. This systematic error in connection with the ranking method is however not of any decisive importance - taking the other uncertainties of the ranking into consideration (cf. 2.2).

At the assessment of the loss of resources it was distinguished whether the material was renewable or non-renewable. A renewable material is a material that is recreated naturally within the measurable future. A definition of the measurable future is disputable. In this report all vegetable and animal materials and water are considered renewable materials, whereas all mineral and oil based materials, i.e. materials based on geological resources are considered non-renewable.

The relevance of distinguishing between renewable and non-renewable materials is of course that a non-renewable material in principle can be used up, and thus is a resource that in the interest of the community is worth economizing on - more than a renewable material.

An objection to this is e.g. that iron ending up in landfill sites or is spread diffusely in nature and here is considered a loss of resources, in fact is not lost, but recoverable, which means that it should be appropriate to consider iron a renewable material. This argument is however only partially correct. It is correct that e.g. iron will never be lost completely. In principle it is possible to recover iron from seawater or other parts of nature, where it ends. The related energy consumption is however significantly larger than the energy consumption related to production of iron today.

The discussion is introduced here to stress the close connection between the state of the material of being renewable/non-renewable and the process of manufacture - and the related energy consumption - of the material. That a material like iron is assessed to be non-renewable is an expression of the fact that the present manufacture of pig iron is based on geological occurrences that are non-restorable within the measurable future.

As a parallel it can be noted that in this project plastic materials are assessed to be non-renewable materials, as the manufacture of plastic materials is today based on crude oil or natural gas that are geological resources that are non-restorable within the measurable future. In principle it would however not be difficult to manufacture plastic materials (and other petrochemical products) from vegetable raw materials. Such production does not take place today, as it would be too expensive and require too much energy. If - or rather when - the production of plastic materials is changed and becomes based on vegetable raw materials, the state of these materials would change to becoming renewable.

Unfortunately even renewable materials can be used up by heavy exploitation. This question is today primarily relevant to tropical tree species, fish and similar marine products. The principle point of view adopted in this project is that a renewable material that is not recreated concurrently with its use should be handled with the same care as non-renewable materials by the community.

In connection with non-renewable materials it would be relevant to continuously supervise the reserves of the resource, estimate when they will come to an end, how easily they are replaceable and thus the social value of the resource. These aspects of the resource problematic are not assessed in this project, partly because there is no clear definition of when a resource is exhausted (such a definition requires a decision of the acceptable energy consumption for extraction of the material from other sources), and partly because the necessary workload to estimate this aspect for all materials would be considerable. By the ranking, the same value has thus been assigned to all materials. In connection with the assessment of the results of the project, it must of course be evaluated whether the loss of a ton of sand and gravel should be considered just as important as the loss of a ton of copper.

Energy consumption

There is energy consumption throughout the entire life cycle of an industrial product, both at extraction and manufacture of materials, at processing of

these materials, at the use of the industrial product (only certain products) and by the recycling/disposal of the industrial product.

In itself energy is one of the most important resources of the community. Other things being equal it is therefore in the interest of the community to minimise the consumption of energy for industrial products. Besides this, the energy consumption could be regarded as a measure of a series of other essential environmental problems, such as acidification and greenhouse effect that are in a very high degree related to the acid gasses and CO₂ released in connection with the use of fossil fuels.

Based on an assessment of how easy it is to procure/estimate data of the various parts of the energy consumption and the importance of the various parts of the total consumption (cf. /2), the energy consumption in this project calculated as follows:

- ? The sum of the energy consumption for extraction, manufacture, processing and transportation of materials and the consumption in connection with the use of industrial products
- ? Minus the energy in the materials that is utilised, when the materials ending up as combustible waste are treated in incineration plants.

The elements of the total energy consumption throughout the life cycle of an industrial product that are not included, are the consumption through the distribution, recycling and the disposal phases and the energy consumption related to infrastructure and manufacture of production equipment. Furthermore, the energy consumption of the final assembly and finish of the finished goods will only be included to the extent the consumption is included in the estimates of the energy consumption for extraction, manufacture and processing of the materials that are available.

On the basis of the available data the exact importance of these choices is not possible to assess. In the pilot project /2/ it is roughly estimated that the energy consumption for extraction, manufacture and processing of materials together with the energy consumption during the use phase of industrial products are 70 - 90% of the total energy consumption. It should be noted that the calculations made during the EDIP project (Environmental Design of Industrial Products) have shown that for industrial products requiring energy by its use, this energy consumption will typically be decisive for the size of the total energy consumption /2/.

Furthermore it should be noted at the calculation of the energy consumption for extraction, manufacture and processing of combustible materials also includes energy content of the materials. The argument of this choice is that the combustible materials used for industrial products alternatively could have been used as an energy source. As they are used for manufacture of industrial products, energy is occupied and consumed.

1.1.3 Assessment principle

Ranking method

The ranking method used in this project divides the industrial products in commodity groups. Loss of resources and energy consumption are calculated for each commodity group. Then all commodity groups are ranked both to loss of resources and to energy consumption. The contents of these two ranking lists are finally collected in one list, in which the average ranking of

each commodity group is calculated. By calculation of the final ranking, the two parameters are balanced evenly (no arguments justifying that one of the parameters is more important than the other, are known).

The loss of resources is in this context (cf. the previous section) defined as the quantity of materials in a commodity group that is not recycled, because the materials end up as waste that is disposed of or incinerated, or because the materials during their use are spread diffusely to the surroundings as a result of wear, corrosion or the like. Loss of renewable materials that are recreated concurrently with their use is however not included in the loss of resources.

The energy consumption is correspondingly - in this context - defined as the energy consumption used for extraction, manufacture and processing of the materials in the commodity group, plus the energy latent in these materials (if relevant), plus the energy consumption during the use phase (if relevant), minus the amount of energy recovered by incineration of the loss of resources.

The calculation of the loss of resources for each commodity group presupposes knowledge of the quantities of each commodity group sold annually in Denmark and knowledge of the composition of the materials in each commodity group. The calculation principle is summarized in box 1.1.

Correction factor

It should be noted that information of quantities in principle is based on information from Statistics Denmark (cf. 1.2). This information includes exclusively the net weight of industrial products, i.e. excluding any kind of packaging. As the composition of the commodity group is calculated as the composition during the life cycle of the products, i.e. including packaging, working means and spare parts, it has in connection with the calculations been necessary to define a special correction factor (K) for each commodity group. This correction factor has been identified as the relation between the weight of the industrial products including packaging/working means/spare parts and the weight of the industrial products alone.

Assessment of results

At the final assessment of the results of this ranking it is important to be aware that the ranking does not consider all environmental impacts related to industrial products. At the final ranking of industrial products it would be relevant to include the knowledge available of the release of chemical substances to the environment in connection with production activities in Denmark and also consider to what extent the different industrial products contain especially environmentally harmful substances. A consideration of such conditions might of course at some points result in a deviation of the final ranking compared to the ranking of this project.

Environmentally harmful substances

With a view to these ranking considerations it is found relevant within the scope of this project to assess and state whether the individual commodity groups contain selected, particularly environmentally harmful substances. The principles and the scope of this assessment are described in detail in section 1.6.

Box 1.1 Calculation principles

Total ranking

The total ranking of a commodity group is determined by the following sum, as the commodity group obtaining the lowest sum will be ranked as the highest (no. 1), the group obtaining the second lowest will be ranked as the second highest (no. 2) etc.:

$$P_R + P_E$$

where

P_R = Ranking compared to loss of resources

P_E = Ranking compared to energy consumption

Loss of resources

The loss of resources of the commodity group is determined by the following expression, as the commodity group obtaining the highest value will be ranked as the highest (no. 1), the commodity group obtaining the second highest value will be ranked as the second highest (no. 2) etc.:

$$R = M \times K \times S (S_X \times R_X)$$

where

R = Total loss of resources of the materials in the commodity group (in tonnes)

M = The amount of industrial products in the commodity group sold in Denmark (in tonnes)

K = Correction factor taking into account that "Statistics Denmark's" data of production and supply do not include packaging and consumption of working means and spare parts throughout the life cycle of the products

S_X = Share of the material x in the commodity group (in % - assessed average of all industrial products in the commodity group)

R_X = Loss of resources of the material x in the commodity group (in % - the loss of materials that are renewable and recreated concurrently with the use are not included)

Energy consumption

The energy consumption of the commodity group is determined by the following expression, as the commodity group obtaining the highest value will be ranked as the highest (no. 1), the commodity group obtaining the second highest value will be ranked as the second highest (no. 2) etc.

$$E = \frac{E_p - E_1 + E_D}{A \times A_E + M/V_G \times E_{DV}} = M \times K \times S (S_X \times (E_{PX} + E_{1X})) - M \times K \times S (S_X \times R_X \times E_{1X}) \times$$

where

M , K , S_X and R_X are as defined above

E_p = Energy consumption for extraction, manufacture and processing of the materials contained in the products of the commodity group plus the energy content of these materials

E_1 = The energy content in the commodity group utilised at incineration of the loss of resources

E_D = Energy consumption during the use phase of the products of the commodity group

E_{PX} = Energy consumption for manufacture and processing of the material x in the commodity group (in GJ/ton)

E_{1X} = Energy content of the material x in the commodity group (in GJ/ton)

A = Share of combustible waste that is disposed of by incineration (in %)

A_E = Energy efficiency of waste incinerators (in %)

V_G = Average weight of industrial products in the commodity group (in tonnes)

E_{DV} = Energy consumption during the use phase of an average product throughout the life cycle of the product (in GJ/each).

1.2 Division of industrial products in commodity groups

Supply statistics

The division of industrial products into commodity groups was made on the basis of "Statistics Denmark's" commodity supply statistics. These statistics are prepared by Statistics Denmark by combining the foreign trade statistics with commodity statistics for the Danish industry. With a few exceptions the tariff numbers applied in the supply statistics correspond to the tariff numbers applied in the foreign trade statistics and the goods statistics for industry. The exceptions in question concern the following commodities/industrial products:

- ? Monetary gold and confidential consignments: The supply statistics do not include the tariff numbers of these goods, which is considered acceptable in this connection
- ? Goods of concrete and wires/cables: For these industrial products the foreign trade statistics and the goods statistics for industry do not apply the same division. In the supply statistics special tariff numbers (not included in the other statistics) for these industrial products have been created.

The supply statistics are not published, but extracts are obtainable from Statistics Denmark. In connection with this project Statistics Denmark have supplied extracts of the statistics - data of production, exports, imports and supply for all tariff numbers in the statistics based on 1992-data. These extracts are the basis for the division of tariff numbers in commodity groups described in the following.

Division procedure and rules

The supply statistics contain in total 30,376 tariff numbers (version May 1993) divided in 97 commodity chapters. These tariff numbers were treated as follows:

Tariff numbers assessed to include only raw materials, semi-manufactures or handicrafts were as a principal rule sorted out (cf. 1.1). Examples of handicraft are jewellery and basketwork. 3,729 tariff numbers in total were sorted out in this basis.

However many semi-manufactures are also to rather a wide extent used as finished goods (e.g. materials for construction; in this project construction is not considered an industrial process). Additionally there is environmental focus on a series of semi-manufactures (e.g. tyres). Consequently it was decided to keep many semi-manufactures in the ranking system. The assessment criterion here was whether the semi-manufactured article in question was considered having a certain importance as an individual article. It was a calculated choice to rather sort out too little than too much.

The disadvantage of this method is of course that certain materials are included in more than one commodity group. For example copper wire might be included as pure copper wire, as copper in an electromotor and as copper in the machine in which the electromotor is installed. This disadvantage is considered acceptable here.

Tariff numbers that have not been sorted out are hereafter divided in commodity groups according to the following rules:

1) **Maintain the systematics of the statistics**

Tariff numbers in different commodity chapters must not be collected in the same commodity groups.

2) **Commodity groups must be homogeneous**

Other tariff numbers are collected in commodity groups, the aim being homogeneity as regards the function, the materials and the energy consumption of the industrial products during their use phase.

Homogeneity as regards function means that industrial products in the same commodity group must have a certain coherence that makes it reasonable to consider them collectively and provide them with a common name. This coherence might be common characteristics (e.g. electro-motors) or common use (e.g. machines for textile processing).

Homogeneity as regards materials means that industrial products in the same commodity group if possible should be composed of the same kind of materials. In many cases however this requirement cannot be fulfilled, as even under the same tariff number there are in some cases industrial products manufactured from quite different materials (example: Vacuum jugs and textiles).

Homogeneity as regards energy consumption in the use phase means that the energy consumption of the goods must be of the same size, so that it makes sense to talk of an average energy consumption for the industrial products in the same commodity group. It makes thus no sense to mix small motor boats and cargo vessels or cars and lorries.

3) **Minimise the problem of confidentiality**

Tariff numbers, of which data of quantity with Statistics Denmark are confidential, are to the widest possible extent grouped under consideration of rules no. 1 and 2 in such a way that there are at least 3 confidential tariff numbers in the same commodity group. Hereby the confidentiality as to the sum of the quantity information of the tariff numbers in question is lifted (cf. 1.3).

4) **Threshold values**

In each commodity chapter a special commodity group named "miscellaneous" can be established. All tariff numbers, in which the production in Denmark as well as the supply in 1992 were less than 100 t/year in 1992, are grouped in this commodity group, unless these tariff numbers belong naturally together with other commodity groups in the commodity chapter. If - after the division - a few tariff numbers still remain, of which the production as well as the supply in Denmark in 1992 were less than 200 t and which do not belong naturally together with other commodity groups, so that a special commodity group for each of these tariff numbers should be established, then these numbers may also be placed in "miscellaneous".

5) **Environmentally harmful substances**

Tariff numbers including industrial products with a substantial content of especially environmentally harmful substances (e.g. mercury cells) must irrespective of rule no. 4 remain in special commodity groups. Thus, special commodity groups for e.g. thermometers, mercury cells, nickel-cadmium accumulators, pesticides and wood preservatives have been established.

6) **Minimise the number of commodity groups**

It is important - under consideration of the other rules - to aim at minimising the number of commodity groups, as this - other things being equal - will reduce the required workload to carry out the project.

In total 966 commodity groups with 6,647 tariff numbers were established. Of these "miscellaneous-groups" include in total 66 commodity groups with 1,532 tariff numbers in total. Table 1.1 provides an overview of the division of tariff numbers in the individual commodity chapters.

The precise division appears from appendices 3 and 4. Appendix 3 is a systematic list of all tariff numbers in the supply statistics, in which the related commodity group is stated off each individual tariff number, or it is informed whether the number alternatively has been sorted out as raw material/semi-manufactured article etc. Appendix 4 is a systematic list of all commodity groups, in which the tariff numbers related to each individual commodity group are stated.

Assessment of division

It is stressed that the actual division of a series of groups appears to be a compromise between the stated rules, and especially between the rules 2, 3 and 6. Confidential tariff numbers are thus deliberately grouped in a few commodity groups, irrespective of the fact that they do not meet the requirements of homogeneity.

As the division appears today (cf. appendices 3 and 4), it is the assessment of the author that it is useful for this project, but not necessarily optimal in all details.

Threshold values

As to the rule of threshold values (rule no. 4) it should be noted that this rule was made on the basis of the awareness that many industrial products are sold in quantities so modest that it can be immediately assessed that the ranking of these products will be very low. On the basis of information from Statistics Denmark /3/ it is known that the average supply in 1992 of all tariff numbers in the supply statistics exceeds 5,300 t, whereas the supply of at least 24% of all the tariff numbers in 1992 did not exceed 100 t.

Many industrial products that are only sold in modest quantities are special products that are difficult to group together with other products sold in large quantities and consequently to a wide extent must be placed in their own commodity groups. Without a kind of threshold value it would be an unreasonably large share of the total workload invested in this project that would be used to clarify the material composition of commodity groups, the environmental impact of which is relatively modest.

Table 1.1 Overview of the division of commodity numbers in the individual commodity chapters *1)

Com-commodity
chapter

No.

Title

Number of tariff numbers in total
 Number of tariff numbers in commodity groups
 Number of tariff numbers sorted out
 Number of tariff numbers in misc. group
 Number of commodity groups

1

Live animals

40

0

40

0

0

2

Meat and edible offal

264

195

69

0

6

3

Fish and crustacean

308

235

73

0

4

4

Milk and dairy products

154

101

53

3

11

5

Misc. products of animal origin

26

0

26

0

0

6

Live trees and other plants

61

0

61
0
0

7
Edible vegetables
119
25
94
0
2

8
Edible fruits and nuts
133
14
119
0
2

9
Coffee, tea and spices
54
9
45
5
3

10
Corn
57
28
29
0
1

11
Milling products; malt, starch etc.
76
34
42
2
3

12
Oilseed and oily fruit
101
4
97
0
1

13
Plant juices and extracts; shellac, natural resin etc.
17
0
17
0
0

14
Vegetable materials for basketwork etc.

11
0
11
0
0

15
Animal and vegetable oils and fats
137
24
113
13
4

16
Refined articles of meat, fish and crustacean
107
107
0
13
14

17
Sugar and sweets
47
21
26
1
9

18
Cocoa and articles prepared of cocoa
26
11
15
0
5

19
Articles prepared of corn, flour etc., cakes and biscuits
48
44
4
5
14

20
Articles of vegetables, fruit, nuts etc.
263
225
38
58
13

21
Misc. products from the foodstuff industry
44
40
4
6
17

22	Beverages, ethanole, vinegar
110	
110	
0	
4	
16	
23	Residues and waste products from the foodstuff industry
68	
68	
0	
6	
10	
24	Tobacco and manufactured tobacco substitutes
30	
8	
22	
1	
4	
25	Salt, sulphur, soil and stone types, typsum, lime, cement etc.
98	
38	
60	
2	
12	
26	Ores, slag and ashes
51	
0	
51	
0	
0	
27	Mineral fuel, mineral oils etc.
102	
53	
49	
7	
14	
28	Inorganic chemicals etc.
258	
36	
222	
7	
16	

Table 1.1 Overview of the division of commodity numbers in the individual commodity chapters (continued) *1)

Com-modity
chapter

No.

Title

Number of tariff numbers in total
Number of tariff numbers in commodity groups
Number of tariff numbers sorted out
Number of tariff numbers in misc. group
Number of commodity groups

29

Organic chemicals

458

55

403

3

6

30

Pharmaceutical products

70

49

21

34

10

31

Fertilizers

40

40

0

1

6

32

Tanning and dye extracts

75

27

48

0

6

33

Volatile vegetable oils; perfumery and cosmetics

56

21

35

6

10

34

Soap, detergents, cleaning materials, lubricants etc.

33

29

4

0

9

35

Proteins, starch, glue, paste and enzymes

34
3
31
0
2

36
Gunpowder and other explosives
10
10
0
6
5

37
Photographic and cinematographic goods
65
65
0
1
4

38
Miscellaneous chemical products
98
46
52
6
28

39
Plastic and articles thereof
259
171
88
2
37

40
Rubber and articles thereof
98
61
37
9
20

41
Hide, skin and leather
64
0
64
0
0

42
Leather articles, upholstery etc.
43
43
0
20
8

43
Fur and fur articles
44
4
40
4
1

44
Wood and wooden articles
171
133
38
8
27

45
Cork and cork articles
8
6
2
0
2

46
Basketwork and other articles of weave materials
13
0
13
0
0

47
Pulp of wood etc.; paper and cardboard waste
23
0
23
0
0

48
Paper, cardboard and articles thereof
205
173
32
0
18

49
Books, papers, pictures and other printed matters
28
28
0
9
6

50
Real silk
25
17
8
17

1	
51	Wool and fine and coarse animal hair
71	
30	
41	
16	
3	
52	Cotton
178	
120	
58	
1	
6	
53	Other vegetable textile fibres
51	
13	
38	
13	
1	
54	Endless chemical fibres
106	
52	
54	
12	
8	
55	Short chemical fibres
168	
102	
66	
49	
11	
56	Cotton, felt, fibre cloth; twine, rope and cordage
60	
59	
1	
28	
14	
57	Carpets and other textile flooring
47	
47	
0	
10	
12	

Table 1.1 Overview of the division of commodity numbers in the individual commodity chapters (continued) *1)

Com-modity
chapter

No.

Title

Number of tariff numbers in total
Number of tariff numbers in commodity groups
Number of tariff numbers sorted out
Number of tariff numbers in misc. group
Number of commodity groups

58
Special, woven fabrics; laces, embroideries etc.
57
21
36
21
1

59
Impregnated and coated textiles
46
15
31
9
5

60
Knitted fabric
55
55
0
17
6

61
Clothes of knitted fabric
175
175
0
112
18

62
Clothes of other than knitted fabric
225
225
0
156
22

63
Other factory-tailored textiles
88
83
5
42
12

64
Footwear, spats etc. and accessories

84
80
4
19
10

65
Headgear and accessories

18
15
3
13
2

66
Umbrellas, parasols, sticks, whips etc.

8
5
3
1
3

67
Processed feathers and downs, artificial flowers etc.

8
6
2
4
2

68
Articles of stone, gipsum, cement, asbestos and similar materials

68
68
0
8
18

69
Ceramics

52
52
0
0
10

70
Glass and glassware

158
102
56
0
11

71
Natural or cultured pearls, precious stones and metals etc.

71
26
45

26
1

72
Iron and steel
482
147
335
18
17

73
Articles of iron and steel
278
278
0
27
25

74
Copper and articles thereof
78
53
25
0
7

75
Nickel and articles thereof
18
11
7
0
1

76
Aluminium and articles thereof
72
64
8
0
8

78
Lead and articles thereof
14
6
8
1
2

79
Zinc and articles thereof
15
7
8
0
2

80
Tin and articles thereof
9

5
4
0
1
81
Other base metals, ceramic metals and articles thereof
65
29
36
1
5
82
Tools, cutlery of base metals
126
126
0
34
11
83
Miscellaneous articles of base metals
52
44
8
9
17
84
Nuclear reactors, steam boilers, machines and apparatus
1008
803
205
148
107

Table 1.1 Overview of the division of commodity numbers in the individual commodity chapters (continued) *1).

Commodity
chapter

No.

Title
Number of tariff numbers in total
Number of tariff numbers in commodity groups
Number of tariff numbers sorted out
Number of tariff numbers in misc. group
Number of commodity groups

85

Electrical machines and apparatus

640
470
170
88
68

86

Engines, carriages, goods wagons and other railway material

45
18
27
4
9

87

Vehicles and parts for them

193
113
80
12
17

88

Aircrafts, space crafts and parts for them

30
21
9
19
2

89

Ships, boats and floating material

45
44
1
5
13

90

Optical, photographic instruments and apparatus

278
276
2
191
27

91

Watches and parts for them

72
72
0
72
1

92

Musical instruments, parts and accessories

34
34
0
33
2

93	Weapons, ammunition, parts and accessories
37	
37	
0	
25	
4	
94	Furniture, bedding, lamps and lighting accessories
95	
76	
19	
5	
20	
95	Toys, games and sports equipment
79	
76	
3	
24	
23	
96	Miscellaneous articles and products
77	
75	
2	
0	
14	
97	Works of art, collector's items, antiques
7	
0	
7	
0	
0	
99	Confidential consignments, returns
3	
0	
3	
0	
0	
Sum	
10376	
6647	
3729	
1532	
966	

Note:

- 1) Commodity chapter number and title refer to the division of tariff numbers in commodity chapters applied in the consumption tariff and misc. commodity statistics prepared by Statistics Denmark. It should be noted that the commodity chapter numbers 77 and 98 are not applied at the moment. Titles are abbreviated.

Tariff numbers sorted out are deemed to be exclusively raw materials, semi-manufactures or handicraft.

As to the column "number of tariff numbers in misc. group" it should be noted that a special "misc." commodity group has been established for each commodity chapter, in which the tariff numbers within the defined threshold value are included (cf. text).

It is therefore considered acceptable in this project to introduce threshold values and include tariff numbers within the stated threshold values in special "misc." commodity groups, the composition of which is not investigated in this project (cf. 1.4). This procedure has the advantage that the tariff numbers in question are still part of the ranking system, and that it is consequently relatively easy to make a more precise assessment of the industrial products in question, if it is considered relevant at a later time.

The choice of threshold value was determined on the basis of an assessment of data from Statistics Denmark - an assessment of the share of the total goods volume (production or import - 1992 data) that will end up in a "miscellaneous" commodity group at various threshold values. At this assessment, threshold values of 50, 100 and 500 tonnes were estimated. The result of this investigation was that at a threshold value of 100 t, 8 commodity chapters would be affected so much that 50% of the total goods volume (production or imports) would end up in the "misc." group. For a further 31 commodity chapters between 10 and 50% of the total goods volume would end up in the "misc." group, whereas less than 10% of the total goods volume would be affected in connection with the other goods articles.

The commodity chapters that are affected considerably (>50% of the goods volume in the "misc." group) are chapter 43 (fur), chapter 50 (real silk), chapter 53 (other vegetable textile fibres than cotton), chapter 71 (pearls, precious stones and metals) and chapter 90-93 (optical and photographic instruments, watches, musical instruments and weapons). It is common for these chapters that they include many different industrial products that are only sold in modest quantities.

Numbering of commodity groups

All commodity groups have been assigned a five-figure number. The two first figures correspond to the number of the commodity chapter in questions, whereas the three last figures are a serial number within the chapter in question. If a "misc." group has been established in a commodity chapter, this group will always be assigned the number "xx001" in which xx may vary from number 01 to 97. In the applied systematic the number "xx001" is only used for "misc." Thus, this number is not applied in commodity chapters in which no "misc." group has been established.

1.3 Quantity data

As stated in section 1.1 the calculations of both loss of resources and energy consumption of the individual commodity groups are based on the quantity of products measured in tonnes/year sold in Denmark.

In practice it has been chosen to base the calculations (cf. appendices 1a and 2) on the mean value of production and supply in Denmark, as the supply is defined as production plus imports minus exports.

It is to be seen as a pragmatic way of solving the problem that the impact of the various industrial products on the environment is quite different. Denmark is a large-scale exporter of certain industrial products, i.e. that the Danish production is significantly larger than the imports to the Danish market. This applies to e.g. refrigerators, district heating pipes, chewing gum, plastic toys etc. From this type of industrial product the environmental impact may be much more serious in the production phase than during the consumption and disposal phases.

On the contrary, there are industrial products that by and large are not manufactured in Denmark, but imported. A typical example is cars. For this type of products the impact on the Danish environment is alone related to the use and disposal of these products (presupposed that transboundary water and air pollution is not taken into consideration).

Additionally, calculations based on supply data alone (cf. appendix 1b) have however been made. The result of these calculations shows that the ranking of commodity groups is not changed significantly, when it is based on supply data solely instead of the mean value of production and supply.

Information about production and supply of all commodity groups was procured mainly from Statistics Denmark, as mean data of the years 1990 to 1992 have been applied in order to avoid incidental variations in production and supply. Statistics Denmark have calculated the mean value of production and supply for each tariff number and subsequently summed up the figures within each commodity group. The statistic information known and applied in this project is thus in principle limited to the sum of production and supply of all tariff numbers within a commodity group. It should be noted that mean values during three years are not likely to eliminate incidental variations of industrial products like ships, trains and aircrafts. In connection with these types of products, incidental variations can only be balanced by applying average data of 10 years. This has not been done in this project, and quantity data of these types of industrial products are consequently subject to a higher uncertainty than the other commodity groups.

In connection with a small part of the tariff numbers the process encountered some technical problems that made it necessary to introduce special procedures or special rules. This was necessary in the following cases:

- 1) **The calculated supply of a tariff number is negative**
In some cases the supply of a tariff number is negative. This was observed in connection with several tariff numbers in the supply statistics for 1992. A clarification of the cause for each tariff number was not attempted, but it is judged that in principle there may be the following causes:

- a) Production and/or imports are entirely or partly registered with other tariff numbers than exports
- b) Production and/or imports are entirely or partly registered in another year than exports.

As to cause a) it is assessed that it is a kind of "statistical confusion" caused by the reporting procedure of the statistical data that cannot be avoided. As regards cause b) these are natural variations, which are probably to a wide extent eliminated in this project, because the calculation of production and supply data is based on mean values for 3 years.

Regardless of the actual cause that the supply is negative, the following rule is applied: If the supply of a tariff number - used as a mean value during the period of 1990 to 1992 - is negative, the supply is put as zero in the calculation. Thus it is avoided that "statistical confusion" and natural variations of a tariff number affect the quantity data of other tariff number in the same commodity group.

- 2) **Production data are not informed in tonnes, but only in value (DKK) and other measures (numbers, litres, square metres, pairs or the like)**
 This is the case in connection with a series of tariff numbers dealing with industrial products, for which another measure than weight is used traditionally. Examples are tyres, bags, shoes, acetic acid, furniture etc.

In these cases the information in the foreign trade statistics of quantities in tonnes - besides information of value and other measures - has been utilised. By assuming that the weight per value unit or other measure is the same for Danish production and imports/exports, the weight of the Danish production can be estimated. The estimation of these data has been carried out by Statistics Denmark, as data of the value of exports have been used for estimation of the Danish production primarily.

For a few industrial products it has however not been possible to apply this procedure, as no imports/exports of one or more of the years 1990 to 1992 have been registered for these products. The product types and commodity groups in question are the following:

- Group 49001, tariff 4911.00.00.0: Photosensitive paper and cardboard
- Group 85003, tariff 8502.12.10.0: Generator sets for civil aircrafts
- Group 86004, tariff 8603.10.00.0: Self-propelling carriages etc.
- Group 89001, tariff 8906.00.10.0: Naval vessels
- Group 89003, tariff 8901.90.10.5: Containerships

For these tariff numbers the quantities have been estimated to the same principles as stated for confidential quantity information (cf. point 3).

It should be noted that as regards naval vessels and photosensitive paper, these are quantities of a size that should not have been included in "misc." groups. Unfortunately the precise information was not available until at a time, when it was no longer possible to adjust the commodity group division.

3) **Information of quantity, value and other measures of production and/or imports and/or exports is confidential**

For a series of tariff numbers the information of Danish production, imports or exports are entirely confidential. This confidentiality can be achieved by a Danish enterprise by contacting Statistics Denmark and applying for it, if the applying enterprise holds an essential part of the trade within the tariff number in question.

In this project it has been necessary to procure information of Danish production and supply for all tariff numbers, as these quantity data are included in the calculations.

At the composition of commodity groups it was strived at gathering confidential tariff numbers to the widest possible extent, so that at least three confidential tariff numbers are included in a commodity group. In this way the confidentiality of the sum of the quantity information of the tariff numbers in question is lifted in principle, as it is impossible for outsiders to calculate the value of an individual tariff number on the basis of these sums.

In some cases it was however only possible to include 1 or 2 confidential tariff numbers in the same commodity group. In those cases the information of the other tariff numbers in the commodity group was procured from Statistics Denmark, whereas for the confidential number an assessment of production and supply was made.

These assessments are based partly on information from the Danish enterprises trading within the tariff numbers in question, and partly on data from literature or statistical information combined with common sense.

Table 1.2 Commodity groups containing tariff numbers in connection with which it has been necessary to assess the quantity data

Commodity group		Commodity group	
No.	Name	No.	Name
04006	Whey	73023	Household articles of iron/steel
17007	Chewing gum containing sugar	76009	Profiles, sheets, pipes etc. of aluminium
20011	Fruit preserved without sugar	82001	Misc. tools, cutlery etc.
21014	Composite/ready-made foodstuff	82006	Cutting tools w/active parts of cemented carbide
23003	Bran etc. vegetable residues of corn	84006	Hydraulic and pneumatic machines
27013	Crude oil coke	84008	Submersible and circulating pumps
38004	Pesticides	84081	Printing machines
39020	Lavatory seats and lids of plastic	84084	Washing machines
39026	Other packaging/transp. art. of plastic	84285	Machines for textile processing
40007	Belts and belt conveyors	85023	Electrical water heaters and immersion heaters
44009	Parquet blocks	85047	Radio and telephone receivers
48019	Other articles of cardboard and paper	85050	Television sets and video machines
56015	Fishing nets of polyamide	85255	Relays for electrical circuits
60001	Misc. knitted fabric	90001	Misc. optical or photographic instruments etc.
61001	Misc. clothing of knitted fabric	90016	Thermometers

63008	Sacks and bags for packaging	90022	Electricity meters
68001	Misc. articles of stone, gypsum etc.	90024	Thermostats
68017	Articles of peat	90026	Instruments for aut. reg. except thermostats
69004	Moler-based products	93004	Ammunition for military purposes
70008	Laboratory and quarts glass	95004	Constructional toys
70010	Articles of glass fibres and glass cloth		

It is stressed that the purpose of these assessments was to establish a likely order of magnitude (e.g. <1,000 t/year, 1,000 - 5,000 t/year, 5,000 - 10,000 t/year) of the information in question to ensure a reasonably correct ranking of the commodity group in question. Deliberately it was not intended to achieve very precise assessments. Even in cases where the relevant enterprise provided precise information, this information was deliberately blurred in respect of the enterprises' need for confidentiality.

Generally the assessments are conservative, i.e. higher than the real values. This choice is based on the argument that the fact that the information is confidential does not mean that the environmental impact of the industrial products in question is underestimated. However there is deliberately no particular systematic as to how much the values have been increased compared to the real ones. Thus it should not be possible to estimate the true figures for a confidential tariff number on the basis of the quantity data stated in this project.

Especially it should be noted that in cases in which information of exports is confidential, and it has not been possible relatively easily to assess the size of these exports, the exports were conservatively stated as being zero.

Table 1.2 shows the commodity groups including confidential tariff numbers, for which it was necessary to assess the quantity data.

Table 1.3 Tariff numbers of which production and supply are based on 1992 data only

	Commodity group	Tariff number		
No.	Name			
62001	Misc. clothing except of knitted fabric	621132410	621132420	621133410
		621133420	621142310	621142410
		621142420	621143310	621143410
		621143420	621143420	
62003	Wind jackets, anoraks and the like	620192009	620193009	620292009
		620293009		
62009	Costumes for women	620422800	620423800	
62013	Trousers, knickers, overalls for women	620462390	620463180	620469180
72005	Chromium-coated sheets of iron/unalloyed steel	721070310		
72008	Painted/lacquered/plastic-coated iron/steel sheets	721070390		
73001	Misc. articles of iron and steel	731700400		
73018	Screws, nails, sprigs etc. of iron/steel	731700200	731700690	
73019	Galvanized nails etc. of iron/steel wire	731700610		
85001	Misc. electrical machines and apparatus	850619310	850619350	850619390
		850620300	850620400	850620500
		850620900		
85009	Manganese dioxide batteries	850620110	850620190	850620200
85010	Zinc-carbon	850619910	850619950	850619990
85057	Sockets and plugs	853669100	853669100	853669900
		853690100		
90001	Misc. optical or photographic instruments etc.	902580100	902580910	902580990
90016	Thermometers	902519100	902519910	902519990

4) **Statistical information for 1992 is more detailed than for 1990 and 1991**

It has not been possible to calculate mean values of the period 1990 to 1992 for a series of tariff numbers. This concerns the tariff numbers in connection with which Statistics Denmark have applied another and/or more detailed division in 1992 than in 1990 and 1991, and in connection with which the tariff number at the commodity group division in this project were distributed into different commodity groups.

The reason for the problem is that the commodity division was made based on the supply statistics for 1992 and thus has not allowed for the changes in the use of tariff numbers that were made from 1990 and 1991 to 1992. The optimal solution of the problem would therefore be an adjustment of the commodity group division.

For temporal and other practical reasons it was chosen to base the calculations for the tariff number in question on 1992 data exclusively. Table 1.3 shows a list of the tariff numbers concerned.

1.4 Assessment of the composition of the commodity groups

As mentioned in section 1.1.2 the composition of an "average product" for the commodity group in question was estimated, as packaging and consumption of working means and spare parts throughout the life cycle of the product are considered an integrated part of the product.

These estimates were made on the basis of information from Danish manufacturers and importers, centres of research and knowledge, literature etc. combined with own assessments and measurements. The basis for the estimates as well as the applied information sources for each commodity group is stated in appendix 5.

Assessment of material composition

The typical process in connection with assessment of material composition was as follows:

- ? Based on the Kompass Guide of Trade and other sources of information the dominant manufacturer(s)/importer(s) of the type of industrial products in question is/are identified.
- ? In cooperation with this/these manufacturer(s)/importer(s) one or more industrial products considered typical for the commodity group is/are identified.
- ? Subsequently the material composition and the weight of the industrial product(s) in question are estimated based on information the manufacturers and importers.
- ? Then the weight and the material composition of packaging and weight, quantity and composition of working means and spare parts throughout the life cycle of the product are estimated.
- ? On this basis the material composition throughout the life cycle of the product is calculated.

In the cases, in which the commodity groups is not homogeneous, i.e. the group is composed by different products of different material composition, or in which the same product in practice is produced from different materials, the material composition of typical examples of the different product types is estimated. Thereafter the material composition of an "average product" was calculated by weighting the product types in question in relation to their estimated market share.

It was aimed to achieve information of the material composition of industrial products within a commodity group from at least two independent sources, e.g. two manufacturers. In the cases in which the market is dominated by one manufacturer only, and it was possible to obtain information from this manufacturer, one reference was however considered sufficient. It is stressed that in these cases the obtained information was the manufacturer's opinion of the material composition of an "average product" of the commodity group, which is not necessarily identical with the manufacturer's own products.

Own measurements and assessments might have been used to clarify the composition of consumer goods (e.g. the weight of buttons on a shirt) or the composition and weight of packaging compared to the real product. The share of surface treatment materials (e.g. paint, galvanisation) might be based on an estimate of the area that is treated multiplied by the typical layer/thickness of such surfaces.

At the listing of the material composition it was distinguished between the materials listed in table 1.5. The assessed material composition of each commodity group was stated in appendix 2 as well as appendix 5. As an example of these data table 1.4 states the estimated composition of the commodity group 85014 (vacuum cleaners). As it appears, the contents of all materials are stated as percentages, rounded off to whole numbers.

Threshold values

The contents of materials each constituting less than 1% of the total material weight of the product, was not attempted estimated. This threshold value was introduced as a consequence of the fact that many industrial products are composed of a very large amount of different materials, of which many are used only in very small quantities in the product. Without such a threshold a survey of the composition of industrial products would be an overwhelming task. Besides, materials in such small quantities do in reality not affect the total loss of resources or the energy consumption of the product.

For packaging materials a limit of 5% was in principle applied, based on experience from the pilot project (cf. /2/) that it should be avoided to make disproportionate efforts to survey packaging materials, if these have no significant importance for the total result. In practice it was possible to estimate also packaging materials of many commodity groups down to the level of 1%.

The total share of materials that are each below the threshold value will vary considerably from one commodity group to another. In order to avoid that a considerable part of the materials in a commodity group is not included at the ranking, it was chosen to define a fictive material ("D500 Other") to represent the sum of all the materials below the threshold value.

The material "D500 Other" was deliberately added resource and energy data that must be considered conservative compared to those of the majority of other materials (cf. table 1.5).

Table 1.4 Estimated material composition of the commodity group 85014
- vacuum cleaners

Material code and name		Contents in %
J010	Cast iron/soft steel	11
M050	Aluminium	4
M053	Copper	3
P362	Polystyrene	12
P361	Polypropylene	9
P365	PVC, soft	9
P350	ABS	9
P356	Nylon	4
X603	Paper	32
X604	Cardboard	5
D500	Other	2
P359	Polyethylene	0
P366	PVC, hard	0
U305	Nitrile rubber	0
K452	Petrochemical liquids, oil	0
J012	Soft steel, high-alloyed	0
M059	Brass	0
P355	Thermoplastic polyester	0

It should be noted that for commodity groups, which are in reality exclusively consisting of renewable materials that are recreated concurrently with the use (e.g. foodstuffs), the loss of resources could be considerably overestimated, if conservatively the packaging share is estimated at 5%, and only the material "D500 Other" is used to describe this packaging share. By means of a special check of composition data it was attempted to avoid such an overestimated loss of resources. At this check it was especially focused on commodity groups that could be foreseen to become ranked highly because of large quantities.

Materials that are individually below the threshold value were - to the extent they were known - included in the material composition with a contents percentage of 0. Thus it was achieved that the information that these materials are constituent parts of the product is not lost.

Miscellaneous groups

The material composition of "misc." groups (cf. section 1.2), is defined as 100% of the material "D500 Other". The result is that the ranking of "misc." groups will sooner be overestimated rather than the opposite.

Packaging

Packaging material reused directly for the same purpose (e.g. soft drink bottles, milk cases, euro pallets etc.) is written off with the product it is used for. As an example a beer bottle reused approx. 50 times is registered with only 2% of its weight. For certain types of transport packaging, e.g. tank wagons, ships etc. it can immediately be estimated that the packaging is reused so many times that it - as regards weight - is of no importance to the finished article.

Material list

The material list (cf. table 1.5) is to be considered a pragmatic attempt to identify the most used materials in industrial products. At the development of this list the following criteria were applied:

- ? It was distinguished between materials that are/are considered substantially different as regards resource, energy and environmental conditions
- ? It must be possible to identify the material in industrial products
- ? It was aimed at limiting the amount of different materials as much as possible.

These criteria means that under the same name materials are grouped that on the basis of other criteria would be separated. Thus the characters of many of these materials are sooner material groups than specific materials. This was considered acceptable, as the differences between the individual materials can be considered of no importance in this connection. As an example, it was considered unimportant to distinguish between low-/unalloyed cast iron and low-/unalloyed soft steel, as the difference between these materials are primarily based on the content of carbon and the applied processing techniques, which are in this connection considered insignificant.

It must be admitted though that part of the materials mentioned here (especially chemical materials) is in reality groups covering rather a large amount of materials with significantly different characteristics. An example is the material "K459 Pesticides/preservatives" covering a series of substances/materials that is significantly different - both as concerns energy consumption for manufacture and the environmental impact. It must be recognized that within the scope of this project it was not possible to distinguish more precisely between the relevant substances/materials covered by this material group. In this case the criterion "that is must be possible to identify the material in industrial products" was decisive.

Secondary materials

For a few materials in the material list a secondary material was defined (e.g. "g101 Packing glass" and "x609 packing glass"). Secondary materials are here defined as materials containing a substantial part of recycled materials. The purpose of including secondary materials is to credit the industrial products containing secondary materials with the energy gains achieved, as the secondary materials are typically cheaper than primary materials as regards energy. In practice secondary materials (except the material "x608 Crushed concrete" are normally based on a mixture of recycled (secondary) materials and primary raw materials - with significantly varying mixture proportions. There are but few secondary materials based 100% on recycled materials. All secondary materials connected to materials in the material list are defined as mixtures containing a substantial part of recycled materials. The corresponding "primary" material is accordingly defined as based exclusively or predominantly on primary raw materials.

Secondary versus primary material

There were special considerations in connection with the use of secondary versus primary materials, as manufacturers and importers normally do not know whether the materials contained in industrial products are secondary or primary. Comments on the most important secondary materials are as follows:

Cast iron/soft steel (low-alloyed)

On the basis of information from /6, 7/ the secondary and primary materials can be divided approximately as follows:

- ? Applications like iron bars (round bars, angle iron, channel iron etc.), steel sheets and products thereof (e.g. welded pipes and pipe profiles) and cast iron are predominantly (75-100%) secondary materials. For such applications solely the material "x600" is used.
- ? Large oil and gas pipes and other applications subject to heavy safety demands are exclusively primary materials. For such applications is here solely used the material "j010".
- ? Beams (e.g. I profiles) are approximately 50% secondary and 50% primary materials. For such applications is here solely used the material "x600".
- ? Other low-alloy steel is predominantly (50 - 100%) secondary materials. For such applications is here solely used the material "x600".

Aluminium

On the basis of information from /8, 9, 10, 11, 12/ it is estimated that the division between secondary and primary materials is approximately as follows:

- ? Cables, foils and construction materials meeting heavy strength demands are exclusively primary materials. For such applications is here solely used the material "m050".
- ? Castings, façade sheets and similar mass applications with limited strength demands are predominantly (75%) secondary materials. For such applications are here solely used the material "x601".
- ? Other applications are predominantly (90 - 100%) primary materials. For such applications are here solely used the material "m050".

Copper

On the basis of information from /13, 14/ it is assessed that the division between secondary and primary materials are approximately as follows:

- ? Cables and electrolyte copper are exclusively primary materials. For such applications are here solely used the material "m053".
- ? Other purposes, including alloys are predominantly secondary materials. For such applications are here solely used the material "x602".

Packing glass

According to information from Holmegaards Glasværk (glassworks) all packing glass manufactured in Denmark contains waste glass in varying quantities. Therefore packing glass manufactured in Denmark is in this report considered a secondary material. As Danish products packed in glass on the whole dominate the market, it was chosen to consider all packing glass secondary material.

Cardboard and paper

Cardboard is a material based on secondary materials to a wide extent. In this project all wrapping cardboard is considered secondary material. As regards paper, products like egg trays, kitchen rolls and toilet paper are secondary materials, whereas other paper products conservatively are considered primary materials.

Working means

Working means are in this project considered related to the machine where they are used - not to the product processed in the machine. In this way, detergents, softeners and water are counted among the materials belonging to a washing machine, and not included in the material composition of textiles. It is stressed that the products (e.g. textiles) treated in the machine are not included in the working means.

The material drinking water as a working means

The sum of all materials in an industrial product will of course always be 100%. In connection with one individual material - drinking water - it was however found appropriate to depart from this rule. The reason is that as regards the industrial products in connection with which water is a working means (e.g. washing machines, dish washers, textile processing machines etc.) the consumption of water throughout the life cycle of the product is normally so large that the relative contents of all other materials will be far below 1% (i.e. the machine is in practice composed exclusively of drinking water). As drinking water is considered a renewable material that is recreated concurrently with its use, this would mean that the loss of resources for the machines in question would be calculated as zero. This of course would be an absurd result which would be due to the chosen calculation procedure exclusively. In order to avoid this result, it was chosen to decide the composition in such a way that the sum of all materials other than water will be 100% for the industrial products including water as a working means. Then the relative contents of water is calculated, the result of which might be several thousand percent.

Shortcomings of the material list

It was necessary to prepare the material list at an early stage of the project. For various reasons - time or other practical causes - it was not possible later on to correct the material list, even though it turned out to be incomplete and inappropriate. Some of the recognized material list problems are as follows:

- ? The material "s161 China" covers both sanitary china and tableware china which are apparently (cf. material data in appendix 6) substantially different as regards energy consumption for the manufacturing process.
- ? In reality there is no reason for distinguishing between the materials "u308 Urethane rubber" and "p364 Polyurethane". Material data for these two materials are identical (cf. appendix 6).
- ? The material "s156 Concrete elements" is not a material, but an industrial product.
- ? The list should have included more secondary materials, because stainless steel, high-alloyed soft steel and a series of other metals are to a wide extent used as secondary materials also.

- ? A material named "vegetable residual products" covering residual products from the manufacturing of vegetable oils, sugar, beer etc. is missing.
- ? In some cases it would be appropriate to be able to distinguish whether the material "d500 Other" is renewable or non-renewable.
- ? Materials to describe low-value fuels like lignite and peat are missing. Lignite is in this project described by the material "k 450 Carbon", whose resource and energy data are based on pit-coal, whereas peat is described as "v227 Other vegetable materials", whose resource and energy data were calculated as an average of the other vegetable materials.

The material division is thus in no way to be considered the final and optimal division, but rather a qualified estimate considered useful in connection with this project. This implies of course that the errors caused by the shortcomings of the material list are taken into consideration at the assessment of the project results.

1.5 Resource and energy data

1.5.1 Resource data

The assessment of the loss of resources for commodity groups is based on an estimated loss of resources for each individual material in the commodity group. At the same time it was decided whether the material was considered renewable, and if renewable materials were recreated concurrently with their use.

Loss of resources

The loss of resources of each individual material was determined on the basis of the size of the part of the material in the finished industrial product that will not be recycled in the end. At the assessment the following kinds of loss were in principle considered:

- ? Wear and corrosion in the distribution, consumption and recycling/disposal phases (at transport of the product from factory to consumers, at the use of the product and at collection, treatment and sorting of discarded products and the contained materials).
- ? Loss to waste (the product ends as waste that is disposed of and incinerated instead of being recycled).

These losses are here mainly assessed to be dependent on the material in question. Consequently it is here considered meaningful to talk of "an average material-dependent loss of resources" indicating the part of the material that will normally be lost, irrespective of the industrial product in which it is used. E.g. it was calculated that the average loss of resources of the material "j010 Cast iron/soft steel (unalloyed/low-alloyed)" will be 10%. This means that as an average approx. 10% of all the low-alloyed iron and steel introduced to the Danish community with industrial products are lost and approx. 90% are recycled.

Table 1.5 shows the average loss of resources of each material. The loss of resources was determined on the basis of knowledge available in literature, information from experts, including the recycling trade in Denmark, and

common sense. The stated loss of resources is considered covering the situation in Denmark in the early nineties. The precise arguments for the loss of resources are stated in appendix 6.

For certain industrial products the loss of resources of the materials will deviate from the average loss of resources. This applies especially to products that are not likely to be recycled. E.g. a wrist watch or a ballpoint pen of stainless steel that is discarded must be expected to end up in the rubbish bin together with the refuse instead of being collected with scrap iron. The real loss of resources of stainless steel in the wrist watch/ballpoint pen is consequently closer to 100% rather than the 3% estimated to be the average loss of resources for stainless steel (cf. table 1.5).

To avoid this problem an estimate was made for all commodity groups of whether the loss of resources for one or more materials in the commodity group in question would deviate from the average loss of resources. Then the calculation value was estimated and determined. The precise estimates and actual data of each commodity group appear from appendix 5.

It is stressed that by calculating the loss of resources in this way, it was not considered that there is a considerable recycling of certain products in the use phase. As examples are mentioned used car doors taken out from ramshackle cars and resold; old timber beams cut out for other purposes and used bricks from demolished buildings used for new buildings. This kind of recycling is not considered at the calculation of the loss of resources for materials. This kind of recycling is however indirectly included in the calculations, as in reality the life cycles of the industrial products are extended resulting in a decreased consumption of new industrial products. In this way the influence of this kind of recycling means a decreased quantity of industrial products calculated.

Renewable materials

As mentioned in section 1.1.2 it was in this project chosen to consider all materials based on geological resources to be non-renewable materials, whereas vegetable and animal materials were considered renewable materials. Additionally there is however a long series of other materials estimated to be renewable.

Thus are gases recovered from the air - and sooner or later will escape to the air again - considered renewable materials. Carbon dioxide mainly produced by burning of fossil fuels is however because of the production method estimated a non-renewable material.

Table 1.5 Material list *1)

Material code	Name	Average loss of resources %	Renewable resource Yes/No	Recreation of resource Yes/No	ASC GJ/tonne	Processing supplement GJ/tonne	Energy GJ/tonne
j	Iron and steel						
j010	Cast iron, soft steel (low-all.)	10	N	N	23	22	0
j011	Cast iron (high-alloyed) *2)	10	N	N	26	22	0
j012	Soft steel (high-alloyed) *2)	10	N	N	95	22	0
j013	Stainl. steel (min. 12% Cr) *3)	5	N	N	95	22	0
j014	Magnet steel	5	N	N	200	0	0
j015	Sintered steel (powderpressed)	10	N	N	20	0	0
m	Other metals *4)						
m050	Aluminium	20	N	N	190	22	0
m051	Lead	25	N	N	29	0	0
m052	Cadmium	85	N	N	55	0	0
m053	Copper	10	N	N	75	22	0
m054	Mercury	95	N	N	15	0	0
m055	Nickel	25	N	N	330	0	0
m056	Silver	35	N	N	110	0	0
m057	Tin	10	N	N	70	0	0
m058	Zinc	20	N	N	55	0	0
m059	Brass (Cu/Zn)	10	N	N	70	22	0
m060	Solder alloys (Pb/Sn)	100	N	N	55	0	0
m061	Nickel-copper alloys *5)	10	N	N	200	22	0
m062	Zinc-aluminium alloys	10	N	N	120	22	0
m063	Copper-tin alloys * 6)	10	N	N	75	22	0
m064	Hard metals (C/Cr/W/Co/Fe)	15	N	N	290	0	0
m065	Other metals	30	N	N	120	0	0
g	Glass						
g100	Flat glass (float glass)	90	N	N	8	1	0
g101	Packing glass (cast glass)	70	N	N	7	0	0
g102	Borosilicate glass (lab. glass)	100	N	N	11	0	0
g103	Lead crystal	100	N	N	11	0	0
g104	Quartz glass	100	N	N	30	0	0
g105	Glass cloth/glass fibres	100	N	N	12	0	0
g106	Glass wool	100	N	N	27	0	0
s	Stone materials						
s150	Granite	30	N	N	0,7	1	0
s151	Marble	100	N	N	0,7	1	0
s152	Lime, pulverised	100	N	N	0,5	0	0
s153	Lime clinkers	100	N	N	6	0	0
s154	Sand and gravel	100	N	N	0,06	0	0

Table 1.5 Material list (continued) *1)

Material code	Name	Average loss of resources %	Renewable resource Yes/No	Recreation of resource Yes/No	ASC GJ/tonne	Processing supplement GJ/tonne	Energy GJ/tonne
s	Stone materials (continued)						
s155	Cement/concrete	100	N	N	7	0	0
s156	Concrete elements	30	N	N	2	0	0
s157	Burnt clay (tile etc.)	40	N	N	2	3	0
s158	Gypsum board	100	N	N	7	0	0
s159	Rock wool	100	N	N	13	0	0
s160	Ceramics/fireproof articles	100	N	N	60	0	0
s161	China	100	N	N	45	0	0
s162	Other stone materials	100	N	N	12	0	0
v	Vegetable materials						
v200	Soft wood, raw-processed	100	Y	Y	4	6	17
v201	Hard wood, raw-processed	100	Y	Y	6	8	20
v202	Pressure creosoted wood	100	Y	Y	6	0	17
v203	Vacuum-impregnated wood	100	Y	Y	6	6	17
v204	Precious woods (tropical)	100	Y	N	9	8	20
v205	Woody reeds (rattan, cane)	100	Y	Y	11	0	15
v206	Veneer	100	Y	Y	17	0	20
v207	Cellulose fibres	100	Y	Y	13	13	15
v208	Wood chip boards	100	Y	Y	6	0	17
v209	Wood fibreboards	100	Y	Y	12	0	18
v210	Paper	55	Y	Y	30	0	13
v211	Cardboard	60	Y	Y	30	0	21
v212	Cork	100	Y	Y	10	3	29
v213	Cotton	100	Y	Y	110	30	16
v214	Other vegetable fibres *7)	100	Y	Y	75	60	16
v215	Fruit	100	Y	Y	2	4	1
v216	Vegetables	100	Y	Y	4	4	0
v217	Cereals	100	Y	Y	5	6	14
v218	Vegetable oils *8)	100	Y	Y	40	0	38
v219	Sugar	100	Y	Y	10	16	17
v220	Honey	100	Y	Y	2	0	14
v221	Coffee	100	Y	Y	6	0	15
v222	Cocoa	100	Y	Y	4	3	21
v223	Beer and wine, incl. dessert wine	100	Y	Y	4	0	0
v224	Spirits	100	Y	Y	55	0	8
v225	Protein (vegetable)	100	Y	Y	23	0	17
v226	Starch	100	Y	Y	5	0	17
v227	Other vegetable materials	100	Y	Y	18	0	16

Table 1.5 Material list (continued) *1)

Material code	Name	Average loss of resources %	Renewable resource Yes/No	Recreation of resource Yes/No	ASC GJ/tonne	Processing supplement GJ/tonne	Energy GJ/tonne
a	Animal materials						
a250	Meat from mammals	100	Y	Y	35	13	10
a251	Meat from poultry	100	Y	Y	29	2	4
a252	Fish and shellfish	100	Y	Y	9	8	3
a253	Milk (butter, cheese, icecr. etc.)	100	Y	Y	4	25	1
a254	Eggs	100	Y	Y	23	70	5
a255	Fat (animal)	100	Y	Y	2	0	38
a256	Leather (chrome-tanned)	100	Y	Y	100	0	18
a257	Leather (vegetable-tanned)	100	Y	Y	95	0	18
a258	Wool and other animal hair	100	Y	Y	45	18	21
a259	Protein (animal)	100	Y	Y	6	0	17
a261	Feathers and down	100	Y	Y	29	0	21
a262	Other animal materials	100	Y	Y	35	0	14
u	Rubber materials						
u300	Natural rubber	80	Y	Y	40	0	45
u301	Butyl rubber	100	N	N	190	0	45
u302	Chloroprene rubber (CR)	100	N	N	120	0	40
u303	Ethylenpropylene rubber (EPDM)	100	N	N	160	0	45
u304	Isoprene rubber (IR)	100	N	N	180	0	45
u305	Nitrile rubber (NBR)	100	N	N	140	0	40
u306	Silicone (Q)	100	N	N	300	0	21
u307	Butadiene rubber (BR)	80	N	N	140	0	45
u308	Urethane rubber (PUR)	100	N	N	75	0	26
u309	Andre rubber materials	100	N	N	140	0	45
p	Plastic materials						
p350	Acrylnitrile-butad.-styrene (ABS)	100	N	N	50	0	35
p351	Acrylic plastic (PMMA)	100	N	N	70	18	26
p352	Epoxy (EP)	100	N	N	75	0	33
p353	Melamine plastic (MF)	100	N	N	70	0	16
p354	Phenol plastic (PF)	100	N	N	40	0	27
p355	Termopl. polyester (PET,PBT)	95	N	N	55	22	30
p356	Polyamide (nylon) (PA)	100	N	N	130	11	29
p357	Polycarbonate (PC)	100	N	N	85	0	29
p358	Unsaturated polyester (UP)	100	N	N	50	0	30
p359	Polyethylene (PE)	95	N	N	28	0	45
p360	Polyoxymethylene plastic (POM)	100	N	N	100	0	16
p361	Polypropylene (PP)	100	N	N	30	0	45
p362	Polystyrene (PS)	100	N	N	40	0	40

Table 1.5 Material list (continued) *1)

Material code	Name	Average loss of resources %	Renewable resource Yes/No	Recreation of resource Yes/No	ASC GJ/tonne	Processing supplement GJ/tonne	Energy GJ/tonne
p	Plastic materials (continued)						
p363	Polytetrafluorethylene (PTFE)	100	N	N	60	0	5
p364	Polyurethane (PUR)	100	N	N	75	0	26
p365	Polyvinylchloride (PVC), soft	100	N	N	40	0	17
p366	Polyvinylchloride (PVC), hard	100	N	N	40	0	17
p367	Urea plastic (UF)	100	N	N	30	0	14
p368	Other plastic materials	100	N	N	60	0	27
o	Surface materials						
o400	Paint & lacquer, water-based	100	N	N	24	0	5
o401	Paint & lacquer, solvent-based	100	N	N	14	0	30
o402	Paint & lacquer, 2-komp. /reactive *9)	100	N	N	40	0	20
o403	Paint & lacquer, water-based	100	N	N	22	0	9
o404	Dextrin & casein glue, water-b.	100	Y	Y	9	0	1
o405	Glue, solvent-based	100	N	N	12	0	40
o406	Glue, reactive	100	N	N	40	0	28
o407	Melt glue	100	N	N	65	0	27
o408	Printing ink, water-based	100	N	N	35	0	7
o409	Printing ink, solvent-based	100	N	N	20	0	26
o410	Printing ink, reactive	100	N	N	50	0	35
o411	Enamel	100	N	N	240	0	0
o412	Chromating *10)	100	N	N	3800	0	0
o413	Phosphatizing *10)	100	N	N	7900	0	0
o414	Chromium surface	100	N	N	710	0	0
o415	Nickel surface	100	N	N	710	0	0
o416	Zinc surface, hot-galvanized	100	N	N	85	0	0
o417	Zinc surface, electro-galvanized	100	N	N	200	0	0
o418	Tin-plating	100	N	N	600	0	0
o419	Anodizing *10)	100	N	N	1600	0	0
o420	Other surfaces	100	N	N	170	0	0
k	Chemical materials						
k450	Carbon	100	N	N	4	0	30
k451	Petrochemical gasses(butane etc)	100	N	N	3	0	45
k452	Petrochemical liquids (oils etc.)	100	N	N	4	0	40
k453	Oxygen-containing solvents (ethanol etc.)	100	N	N	50	0	27
k454	Other solvents (chlorinated etc.)	100	N	N	55	0	3
k455	Wax types	100	N	N	26	0	45

Table 1.5 Material list (continued) *1)

Material code	Name	Average loss of resources %	Renewable resource Yes/No	Recreation of resource Yes/No	ASC GJ/tonne	Processing supplement GJ/tonne	Energy GJ/tonne
k	Chemical materials (continued)						
k456	Bitumen	10	N	N	10	0	40
k457	Photographic chemicals	100	Y	Y	2	0	0
k458	Tensides	100	N	N	30	0	29
k459	Pesticides/preservatives	100	N	N	60	0	20
k460	Active medical substances	100	N	N	1500	0	25
k461	Nitrogen	100	Y	Y	8	0	2
k462	Oxygen	100	Y	Y	7	0	0
k463	Argon & other inactive gases	100	Y	Y	6	0	0
k464	Carbon-dioxide, liquid	100	N	N	12	0	0
k465	Ammonia, liquid	100	N	N	35	0	25
k466	Heat-transmitt. means, others	100	N	N	60	0	1
k467	Chlorine	100	Y	Y	11	0	2
k468	Acids, inorganic	100	N	N	5	0	0
k469	Acids, organic	100	N	N	20	0	12
k470	Bases	100	Y	Y	22	0	0
k471	Salts	100	Y	Y	9	0	3
k472	Water	100	Y	Y	0,004	0	0
k473	Water, ion exchanged	100	Y	Y	0,009	0	0
k474	Water, sterile	100	Y	Y	0,4	0	0
k475	Nitrogenous fertilizer	100	N	N	25	0	0
k476	Phosphorous fertilizer	100	N	N	2	0	0
k477	Potassium fertilizer	100	N	N	3	0	0
k478	Mix-fertilizer	100	N	N	11	0	0
k479	Other chemical materials	100	N	N	21	0	0
d	Miscellaneous						
d500	"Other"	100	N	N	100	0	0
x	Secondary materials						
x600	Cast iron, soft steel (low-alloy)	10	N	N	12	22	0
x601	Aluminium	20	N	N	10	22	0
x602	Copper	10	N	N	8	22	0
x603	Paper	55	Y	Y	16	0	13
x604	Cardboard	60	Y	Y	18	0	21
x605	Polyethylene (PE)	95	N	N	14	0	45
x607	Asphalt	5	N	N	0,9	0	2
x608	Crushed concrete	100	N	N	0,03	0	0
x609	Packing glass	40	N	N	6	0	0
x610	Rubber (tyres)	80	N	N	65	0	30

Notes for table 1.5:

- *1 Data stated in this list are derived from appendix 6. As regards definition of headings, reference is made to section 1.5 in the text.
- *2 High-alloy soft steel and cast iron are defined as steel and iron with more than 5% alloy components.
- *3 Stainless steel is defined as steel with more than 12% chromium. Some steel types can be categorized as either j012 or j013. The category considered the most natural based on the application was chosen
- *4 Alloys are categorised according to their dominant metal, unless they belong with one of the alloys specifically mentioned.
- *5 Nickel-copper alloys are all alloys with essential contents of copper and nickel, including German silver (copper-zinc-nickel) and aluminium bronze (copper-aluminium-nickel). The aluminium bronze is the bronze alloy to be applied, when bronze is to meet heavy demands on strength (cf. tin bronze).
- *6 Copper-tin alloys are all alloys containing copper and tin, including red bronze (copper-tin-lead-zinc) and tin bronze (copper-tin). Tin bronze is considered typically used for decoration purposes (figures etc.) and as bearing material in machines/motors. Tin bronze often contains a little lead and is then called lead bronze).
- *7 This material is fibres of sisal (agave), coconut, jute, flax etc.
- *8 This material is both vegetable oils for cooking and linseed oil etc.
- *9 Includes also UV-hardening paints and lacquers.
- *10 Chromating, phosphating and anodizing are methods for surface treatment of metals - methods that in principle are based on oxidation of the surface leading to formation of corrosion products that protect against further oxidation. Anodizing is used for aluminium only.
It should be noted that at the computer calculations of the energy consumption the ASC values are stated as zero. The reason is that an upper limit of the ASC values of 3,000 GJ/tonne was entered in the computer system. Due to the very layers developed by chromating and phosphating this will however have no significant influence on the calculated results.

There are special considerations in connection with salt (NaCl) and products manufactured on the basis of salt. As sea salt, salt is a renewable resource, as the greater part of the salt quantity used in the Danish community must be anticipated returned to the sea. This takes place partly as salt discharged to the sea with wastewater and rainwater, and partly indirectly because of the chemical compounds sodium and chlorine that are extracted from salt are spread in the community and the environment, but sooner or later combine again thus generating salt. In this way there is a constant cycle of sea salt. It is however different with rock salt, which is a geological occurrence that must be considered a non-renewable resource.

Generally the principle used in this project is that today's dominant resource and process of manufacture decide whether a certain material is assessed to be renewable or non-renewable. As regards salt, the situation is that in Denmark the production is exclusively based on rock salt, whereas sea salt internationally by and large has similar - or maybe even higher importance. For that reason it was in this project chosen to consider salt and all products manufactured on the basis of salt (including chlorine, salts and bases, of which sodium compounds are the chief part of the consumption) as renewable resources.

It should be noted that the material "k457 Photographic chemicals" are assessed to be renewable, as this material is dominated by sulphur and sodium compounds, which are considered renewable.

The principle that the dominant resource and process manufacture are decisive for the assessment of the material in question became important to a series of chemical materials that actually include many different substances, of which some are based on renewable resources and others on non-renewable resources. This is not dealt with in detail here, but it should be mentioned that it was necessary to make a choice in connection with several materials, and it might of course be discussed whether this choice was appropriate.

Is the resource recreated concurrently with its use?

For all renewable materials it was assessed whether the resource is recreated concurrently with its present use. As regards the all-important part of the renewable materials there was no doubt that a sufficient recreation is in fact taking place. As an example it can be mentioned that the resource of wood - and thus the dominant resource of cardboard, paper and many other materials - at least in Northern Europe - is growing. The only materials that caused special considerations were "v204 Precious woods - tropical" and "a252 Fish and shellfish".

It was chosen here to consider the material "v204 Precious woods - tropical" as a material that is not recreated concurrently with its use, as this was considered the case as regards the dominant part of tropical wood. This assessment was considered as not being contrary to the fact that certain types of wood, e.g. teak, are predominantly based on working of plantations and consequently should be recreated to a sufficient extent. Contrary to that, it was assessed that the resource "a252 Fish & shellfish" is recreated concurrently with its use. This assessment presupposes that the specified catch quota ensure that the resource is not exploited excessively.

It is stressed that in connection with the assessment as to whether a renewable resource is recreated concurrently with its use, it was not considered whether the resource was manufactured in a sustainable way. Such an assessment that considers the impact by the manufacture on the environment (e.g. the correlation between the agricultural meat production, the manure and the nitrogen impact on the marine environment and the resulting consequences) is far more complex and of an extent that was impossible to fit into the scope of this project.

1.5.2 Energy data

For all materials in this project data of the following were estimated:

- ? Energy consumption for extraction and manufacture (normally named ASC = the Accumulated material Specific energy Consumption)
- ? Energy consumption for processing
- ? Energy content (also called latent energy) of the material.

Additionally, for certain commodity groups - if relevant - the energy consumption during the use of the industrial products was estimated.

It should be noted that E_p (energy consumption for extraction, manufacture and processing of materials plus the energy of these materials - cf. table 1.1) was calculated as the sum of ASC + processing supplement (if relevant) + energy content (if relevant).

ASC (= Accumulated material-Specific energy Consumption)

At the calculation of the energy consumption for extraction and manufacture (ASC) of materials, the energy consumption for the following purposes is in principle included, as the aim was to establish a realistic estimate of the energy consumption:

- ? Extraction of raw materials
- ? Processing of raw materials
- ? Heating, lighting and securing of environment and working environment at places of manufacture
- ? Transport of raw materials and materials (only included to the extent that the energy consumption for transportation is significant compared to energy consumption for other purposes)
- ? Conversion and refining of energy.

Information of ASC was collected from all available sources, including literature, centres for research and knowledge, experts, foreign databases as well as Danish enterprises. In certain cases it was necessary to estimate the ASC on the basis of enthalpy calculations (i.e. by calculating the difference in the chemical energy contents of the raw materials compared to the end product - the enthalpy = the chemical energy contents; the enthalpy of a

chemical material depends on the position of electrons in relation to the nuclei of the atoms.

For a few materials the energy consumption was established based on a comparison to other materials. Table 1.5 shows the estimated data of ASC for all materials. The precise preconditions and calculations of each material appear from appendix 6.

Literature was the preferred data source to the extent that information was at all available. Data from literature vary however considerably because of differences of technology levels and the age of the data in question.

It was attempted to compensate for differences of age (e.g. data from 1970 versus data from 1980) by projecting all information of ASC to 1990. Thus an immediate comparison between literature data and current data provided by enterprises was achieved.

The projecting of old data to 1990 is in all cases based on the development of energy efficiency within the relevant trades in Denmark. In this connection the Danish research institution RISØ provided assistance. On the basis of Statistics Denmark's input-output statistics RISØ calculated the energy efficiency measured as energy consumption (in TJ) in relation to production value (in million DKK) for all trades in Denmark for all years during the period of 1970 to 1989 /16/. These figures show that certain trades, e.g. the metal industry, have a significant development in the form of higher energy efficiency, whereas the picture of other trades is rather confusing, which is probably indicating structural changes within the trades in question - rather than varying energy efficiency. Here it was chosen to carry out projecting for only the trades showing a distinct development. This development was subsequently considered to apply to Danish as well as foreign production processes.

In this project it was not possible to relate data from different sources to different technology levels. For materials for which several data of ASC values were available, the ASC value was in practice established as the mean value of the available data. Data that were considered less reliable or less representative were however neglected.

All ASC values (and other energy data) were recalculated to consumption of primary energy, i.e. it was compensated for loss of energy at refining of oil and at conversion of primary fuels to electricity. The recalculation was made by defining the energy efficiency of the most important energy sources used in manufacture and transport processes. The following energy efficiency values were applied:

Electricity (used for heating and process energy):	35%
Oil and oil products (used for transport, heating and process energy):	90%
Natural gas and coal (used for heating and process energy):	100%

These energy efficiency values are in practice used in such a way that e.g. the energy consumption in the form of electricity was divided by 35% = $35/100 = 0.35$ to achieve the ASC value.

To the extent that a material is created as a by-product at the manufacture of another material, only the energy consumption for the further processing was included at the calculation of the ASC value of the by-product. E.g. wool, leather and feather are considered by-products of meat production. Therefore, energy consumption for breeding of animals is included under meat products and not under wool, leather and feather. The correctness of this assumption can of course be discussed, especially in connection with by-products, such as wool that has a real commercial value.

The energy consumption for transport is generally a comparatively small part of the total ASC value and typically less than 1 GJ/tonne. In some cases, e.g. carriage by sea from other continents, the transport contribution may increase to 1 - 3 GJ/tonne. The transport contribution was estimated and included in the ASC value in the cases in which this contribution was considered significant compared to the energy consumption for other purposes. The unit values stated in table 1.6 were used at the calculation of the transport contribution.

Table 1.6 Energy consumption for transport - unit values

Means of transportation		Energy consumption	Reference
Lorry	Lorry, neighbourhood transport	2.70 MJ/tonne/km	/17/
	Lorry, long-distance transport	0.85 MJ/tonne/km	/18/
Goods train	Goods train, electric	0.12 MJ/tonne/km	/18/
	Goods train, diesel	1.15 MJ/tonne/km	/19/
Ship	Coaster	0.47 MJ/tonne/km	/18/
	Cargo vessel	0.20 MJ/tonne/km	/18/
	Tanker	0.11 MJ/tonne/km	/18/

Enthalpy calculations

For a series of materials it was not possible to procure data of ASC values from literature, centres of research and knowledge or Danish enterprises. For some of these materials it was in this project chosen to carry out enthalpy calculations (i.e. calculation of the difference in the chemical energy contents of the raw materials compared to the end product). These calculations were carried out for synthetic rubber materials and chemical compounds.

The enthalpy calculations are based on the raw materials used for manufacture of the chemical compounds. Naturally it was necessary to look at the raw materials of which ASC values are available. Then the process stages - that the raw materials are to pass to become chemical compounds - are assessed. Each stage is characterised by certain chemical intermediate products, each representing an energy level (enthalpy = the chemical energy contents of chemical substances). On the basis of the composition of chemical compounds and intermediate products it can be assessed whether each process stage requires supply of energy or develops energy and the energy quantity per tonne of chemical compound. By adding these energy quantities it was possible to calculate the total energy quantity (i.e. process energy quantity) necessary to convert the raw materials to the required chemical compounds. It is stressed that it is possible to estimate the minimum energy requirement during the process from raw material to finished article by this calculation. The calculation does not consider comfort energy, transport etc.

For the materials in connection with which this calculation was made it was chosen here to only include the process stages requiring supply of energy. Further it was chosen to establish the ASC value as being the calculated minimum energy need plus 100%, thus including comfort energy, transport etc. Such a calculation is of course subject to some uncertainty, but is nevertheless assessed to result in a realistic ASC value.

As enthalpy calculations represent rather a heavy workload, it was not possible to make such calculations for all materials for which information of ASC was not available in literature etc. For certain materials it was therefore considered acceptable to make a qualified estimate based on knowledge of other materials. As an example, the ASC value of cadmium was established to be corresponding to the value of zinc, as cadmium exclusively is extracted as a by-product at zinc production. Correspondingly the ASC value of the material "k454 Other solvents (chlorinated etc.)" was estimated on the basis of knowledge of the energy consumption at the manufacture of oxygen containing solvents and the energy consumption at the manufacture of pesticides.

Finally it should be noted that for materials that are in reality material groups (especially chemical materials) the same rule as for loss of resources was used, that is to say that the ASC value was established on the basis of the dominant materials. Thus the ASC value of the material "k470 bases" determined on the basis of the ASC value of NaOH, which is the overall dominant technical base.

Processing supplement

The ASC value as described above will only to a limited extent include the energy consumption throughout all the processing stages of the industrial product. An example is that the ASC value of steel and other metals normally only covers typical commercial products from metal works like bars, beams and sheets, whereas the material of the finished goods might turn out to be in special forms and dimensions after having undergone a series of adaptation, hardening and polishing processes. Correspondingly the ASC values of foodstuffs and other vegetable and animal products cover only the materials as raw (fresh, cut out meat, rough timber), whereas the character of the finished article might be e.g. ready-made casseroles and furniture. For a series of materials there might thus be significant energy consumption in the further processing.

Here it was chosen to allow for this additional energy consumption by defining a special processing supplement. This processing supplement reflects the additional energy consumption typically required at the further processing of materials that can also be used unprocessed. Table 1.5 shows the processing supplement for materials to which such a supplement seems relevant.

Whether the processing supplement of a material should be included in the calculation was decided on the basis of an assessment of the material composition of each individual commodity group (cf. appendix 5). For all materials stated as being included in a commodity group it was considered whether to add processing supplement to the material in question or not. If in the column of processing supplement a Y for yes is stated, a processing supplement has been added at the calculation of the energy consumption of

the material in question (i.e. E_p (cf. table 1.1) was calculated as ASC + processing supplement + energy content (if relevant)). If an N for no is stated, no processing supplement has been added (i.e. E_p was calculated as ASC + energy content (if relevant)).

Thus it was chosen to consider the question of processing supplement for the individual materials in an industrial product as a question of either/or, which is of course a drastic simplification of reality. In practice the energy consumption for processing of materials varies from one product to another within wide limits. Consequently it would be much more appropriate to apply a graded scale. Roughly estimated, a scale with a range of 10 and 200% of the processing supplements stated here would be needed. The problem is however that the knowledge required for creating such a scale, let alone judging precisely where on the scale each individual material of industrial product is to be placed is not available. Such scales may be developed within the coming 10 years, but the task would in any case be enormous. The choice made in this project - to treat the processing supplement as an either/or - must consequently be considered the only realistic method for systematically taking the energy consumption related to further processing of a certain material under consideration.

Processing supplement - when?

It was not possible to make precise definitions of when a processing supplement should be added. Guidelines were however provided, which were the basis for the decisions made for each individual commodity group. A short resume of these guidelines appears from table 1.7 below.

Table 1.7 Guidelines for adding of processing supplement

Material	Processing supplement - when
Metals	When the material is adapted to small or special dimensions and forms, or the material is subjected to hardening or polishing
Wool, cotton, cellulose fibres, other vegetable fibres and plastic materials	When the material is used as textiles (covering dyeing etc.)
Wood	When wood is used for manufacture of furniture
Flat glass	When flat glass is used for manufacture of safety glass
Meat, fish and shellfish, fruit and vegetables	When the material is deep-frozen, processed into tinned food, mash or other corresponding processing, including manufacture of slices of meat and ready-made food)
Milk	At manufacture of butter, cheese, milk powder etc.
Eggs	At manufacture of egg powder
Sugar and cocoa	At manufacture of sweets, including toffee and chocolate
Cereals	At manufacture of bread
Burnt clay	When the material is glazed

When processing supplements have not been added to a series of materials, this is due to the following:

- ? The material is assessed to mainly being used as it is without any further processing (applies to e.g. a series of chemical materials)

- ? The material corresponds in processed condition to another material included in the list (applies to e.g. pulverised lime, which in processed condition corresponds to lime clinkers)
- ? The material is in practice always processed into its final form at once, and the processing supplement is therefore included in the ASC value (applies to e.g. rubber and plastic materials)
- ? The processing supplement is considered insignificant (applies to e.g. paint and printing ink, to which a processing supplement should have been added to cover industrial use of these products; this supplement is however considered insignificant considering the systematic error that the ASC value of the material considers both dry matters and solvents, whereas in the material composition only the dry matters contained in the finished article are considered; this error is found acceptable, because paint and printing ink are always but a marginal part of the finished article).

The data used for the estimation of the processing supplement were derived partly from Danish enterprises, partly from literature. All data were converted to primary energy to the same principle as used at the calculation of ASC values. To the extent that data from literature are old, these have been projected to approx. 1990 in the same way as described in connection with ASC values. The precise preconditions of the stated ASC values are for each material described in appendix 6.

Energy content

The energy content of the materials stated in table 1.5 is the net calorific value calculated as the calorific value of the dry matter contents minus the energy quantity needed to heat the water contents from 20°C to 100° C and convert this water contents to steam.

Information of the energy content of the various materials is to a wide extent found in literature. In certain cases it was however necessary to estimate the calorific value of the dry matter content and then subsequently calculate the net calorific value. The precise preconditions of each material appear from appendix 6.

The energy content is among other things used to calculate the energy of each commodity group expected to be recovered, if the entire material quantity ending up as loss of resources is collected with combustible waste. The preconditions of this calculation are that 75% of all combustible waste ends up in solid waste incineration plants, and that the average energy efficiency of such plants is approx. 80%. This corresponds fairly to the present situation, as the presumed energy efficiency among other things allows for the fact that it will only be possible to utilise part of the produced waste-generated heat during the summer period.

It should be noted that this calculation of certain commodity groups is not quite precise, as it presupposes that the loss of resources (more precisely 75% hereof) is always brought to incineration plants. Thus it is not allowed for the fact that certain commodity groups (e.g. foodstuffs) the loss of resources will never - or only to a modest extent - end up in incineration plants. As regards other commodity groups (e.g. coal) the loss of resources will be incinerated all

right, but the energy exploitation will be different than the one in an incineration plant.

As far as it can be assessed, the inaccuracy of the resulting calculated data will be within the general uncertainties of the calculation results. Thus it has no significant importance to the ranking of the commodity groups.

Energy consumption during use

The energy consumption during use was in principle calculated as the total energy consumption during the use phase/throughout the life of the industrial product. This calculation was normally based on information of the energy consumption per working hour of a typical product in the commodity group combined with an estimate of the total quantity of working hours throughout the life of the product. In this way the total energy consumption throughout the life for each product of the commodity group was estimated. At this estimate all types of energy consumption were converted to primary energy to the same principles used at the calculation of ASC values.

In order to determine the total energy consumption in the working phase of the commodity group it was necessary to know the amount of products in the commodity group. This amount was here calculated on the same quantitative basis as is generally used in the calculations (cf. section 1.3), as an average weight of industrial products in the commodity group was estimated.

Data of energy consumption per working hour and average weight are to a wide extent based on information provided by Danish enterprises and importers. The average weight was alternatively calculated on the basis of information in the foreign trade statistics. The estimated energy consumption and average weight for each commodity group are together with the precise preconditions stated in appendix 5.

1.6 Environmentally harmful substances

As stated in section 1.1.3 it was assessed for each individual commodity group whether it contained environmentally harmful substances. At this assessment in this project the focus was exclusively on the environmentally harmful substances cadmium, lead, nickel, copper and phthalates.

The background for the choice of these substances is that the substances in question and their applications are today only partly regulated, and in the author's opinion it is considered likely that some day some kind of regulation will be introduced (or the regulation in force will become more stringent), as it is known that the substances and applications in different ways cause environmental problems.

It was found unnecessary to focus on substances already regulated (examples: PCB, pentachlorophenol, cadmium in plastic etc.), or of which regulation is immediately forthcoming (mercury), as the applications of these substances are known in detail.

It should be noted that industrial products contain many other environmentally harmful chemical substances than the ones mentioned here. The amount of environmentally harmful chemical substances that could and should be included at the assessment of the environmental impact related to industrial products, are in reality considerably large. That only the substances

cadmium, lead, nickel, copper and phthalates are considered in this project, is primarily due to the time and resource limits this project was subject to. An extension of the list of environmentally harmful chemical substances in industrial products established here might consequently be needed.

It should be stressed however that as the occurrence of certain environmentally harmful substances to a wide extent is related to the use of certain materials, far more environmentally harmful substances than the five substances/substance groups focused on in this section have been identified in this project. Thus the occurrence of PAH compounds is mainly related to petrochemical liquids, bitumen and asphalt, whereas e.g. the occurrence of chromium is mainly related to iron and steel alloys, chromium surfaces (chromium-plating) and leather (chrome-tanned).

Comments on the chosen substances/substance groups especially focused on in this section are as follows:

Cadmium is generally accepted as one of the most important environmental poisons. A number of the most essential applications of cadmium has already been regulated, and the use of cadmium for most purposes has ceased or is decreasing. NiCd batteries are an exception to this development. These batteries are used in more and more contexts, and the consumption has been increasing considerably for a number of years. The use of these batteries is today partly regulated, as they are attempted collected and reused. The collection results do however not live up to the goals determined /23/, and it is assessed that there is a need for further measures or regulations.

Lead is also identified as one of the most important environmental poisons. Only the most problematic uses (lead shots, lead additives for petrol etc.) have so far been regulated. It is however the objective of the Danish Environmental Protection Agency that the use of lead for most purposes should cease in the long term /22/.

Nickel is especially known in relation with nickel allergy, and in this connection a regulation has been introduced. New investigations have however revealed that nickel is also a problem in connection with use and disposal of slag from solid waste incineration plants /20/. It is assessed here that nickel will be one of the heavy metals that the Danish EPA will focus on in the years to come.

Copper is simultaneously an essential nutritious matter and an important ingredient in a number of pesticides. Recent investigations have shown that copper poses a problem in connection with use and disposal of slag from solid waste incineration plants /20/. It is assessed here that copper will be one of the heavy metals that the Danish EPA will focus on in the years to come.

Phthalates are a substance group that has drawn a lot of attention for many years (risk of cancer etc.) At a recent investigation of environmentally harmful substances in residual products and emissions from solid waste treatment facilities the phthalates DEHP and DBP are ranked as the two organic compounds in such residual products and emissions resulting in the most severe environmental impact /21/. It is assessed here that phthalates are a substance group for which substitution considerations will be initiated in the years to come.

In table 1.8 the included uses of the individual substances are stated. It is stressed that as regards nickel, copper and phthalates no detailed investigation of the application pattern in Denmark has so far been carried out. The applications of the substances in question mentioned in table 1.8 are consequently to be considered fingertip knowledge and far from a complete overview.

Table 1.8 Applications of environmentally harmful substances included

Substance	Applications
Cadmium (Cd)	Nickel-Cadmium batteries - both open and closed. All applications in which such batteries are an integrated part of the industrial product.
Lead (Pb)	All intentional applications, except the use of lead compounds as siccative in paint, as it is unclear to what extent it still occurs in Denmark.
Nickel (Ni)	All applications as pure metal, metal alloys and surface treatment (nickel-plating) except solder alloys (the use of nickel for this purpose is unclear). Not applications as chemical compounds and natural/artificial contaminant
Copper (Cu)	All applications as pure metal, metal alloys, surface treatment and pesticides. Other applications like chemical compounds are only partly covered, whereas applications like natural/artificial contaminant are not.
Phthalates (Pht)	Application like softener in soft PVC. Applications like softener in water-based paints, glue, printing ink and active substance in mosquito repellent are not included.

2 Results

2.1 Assessment of calculation results

The result of the calculations appears from appendices 1a and 1b. The calculations in appendix 1a are based on the mean value of volumes of production and supply, whereas the calculations in appendix 1b are based on volumes of supply only. In both appendices 1a and 1b all commodity groups are stated according to their final weighted ranking, which allows for both loss of resources and energy consumption. Additionally the following information is given for all commodity groups:

- ? Quantitative basis, i.e. the quantitative data used in the calculations
- ? Calculated loss of resources and ranking after loss of resources
- ? Calculated energy consumption and ranking after energy consumption
- ? The environmentally harmful substances included in the products of the commodity group (cf. section 1.6).

It should be noted that more commodity groups may have the same ranking, and further that appendix 1a includes all commodity groups, whereas in appendix 1b only the approx. 200 highest ranked commodity groups - to save space - are included.

Below the results of the most interesting of the approx. 50 highest ranked commodity groups are commented on:

As regards the 50 highest ranked commodity groups there is only a small difference in the lists in appendices 1a and 1b. In practice 44 repetitions can be registered. The six commodity groups from appendix 1a, which are not included in the 50 first groups in appendix 1b, can be found among no. 50 to 82 in appendix 1b. As regards the upper 50 commodity groups there is thus no significant difference as to whether the ranking is based on volumes of supply exclusively or on the mean value of volumes of production and supply. In reality these are products, which are sold in very large quantities or in other ways involve a loss of resources and/or energy consumption so high that this will be perceptible in both cases.

Even though the upper 50 commodity groups represent many different types of industrial products and in reality also semi-manufactures and raw materials, there is a fairly clear picture of the sectors of society that are interesting, when the topic is loss of resources and energy consumption.

The energy sector

The first sector that leaps to the eye is the energy sector. This sector is among the 50 upper commodity groups represented by the following groups:

27003	Pit coal
27009	Oil for combustion
27008	Petrol and kerosene
27011	Crude oil gas and natural gas
27013	Crude oil coke

It can be discussed whether these goods should be considered industrial products or semi-manufactures/raw materials. As they are included here, it is natural that they are placed at the top of this list because of the large quantities used and consumed (i.e. are lost). Even though the calculation of the energy consumption for these commodity groups is not accurate (in the calculation it is assessed that 60% of the energy content is utilised, whereas the real figures are 40% for pit coal and 80 - 90% for other fuels), the results reflect nevertheless the fact that a significant part of the energy of these fuels is not utilised. The greater part of the calculated energy consumption reflects in reality the energy that is lost.

The transport sector

The next sector appearing is the transport sector. This sector is among the 50 upper commodity groups represented by the following groups:

89003	Oceangoing cargo vessels
84004	Refrigerator ships
87004	Passenger cars
86005	Trains
87006	Lorries and vans
89002	Passenger ships

The above are all industrial products of long life and considerable energy consumption during their use phase. The loss of resources of these products is however not insignificant. For ships that are predominantly made of iron and steel (which are recyclable without any problems), lubricating oils and other system liquids for motors etc. are the dominant part of the loss of resources. Cars and trains have relatively larger contents of plastic and other materials that are not - or only to a limited extent - reusable. Generally it should be noted that the results show that the transport sector is one of the most significant energy consumers, which is due to the heavy transportation demands in the Danish community as it is organised today. The extent to which the energy consumption for carrier vessels and refrigerator ships can rightfully be considered harmful to the Danish community and environment could of course be a subject of discussion, as these ships are mainly used in international trade, and their use therefore is not related especially to the Danish community. As to cars, it should be considered how the energy consumption could be reduced (lightweight materials, more energy-efficient motors?) simultaneously with an increase of the share of recyclable materials.

Agriculture

A third important sector is agriculture and related industries, among others the fertilizer and the food industries. This sector is among the 50 upper commodity groups represented by the following groups:

31006	Mixed fertilizers
31003	Nitrogenous fertilizers
28006	Ammonia
23006	Oilcakes and similar residual products
02002	Fresh, refrigerated meat of mammals
23002	Meat meal, bone meal, fishmeal and similar animal feeding stuff
16006	Ready-made meat and slices of meat
04009	Cheese
23009	Animal feed except for cats and dogs

Generally these goods are included, because they are sold in very large quantities. As regards fertilizers, these are based on raw materials, which are here considered non-renewable resources. Phosphorous minerals are in themselves a geological resource, whereas ammonia, which is also the basis material of the greater part of the nitrogenous fertilizers - is considered a non-renewable resource, as the hydrogen contained in ammonia is today produced from fossil fuels. If the hydrogen were instead manufactured by electrolytic dissociation of water, the ammonia would be considered a renewable resource.

The energy consumption for manufacture of meat can predominantly (cf. material data in appendix 6 for the material "a250 Meat from mammals") be traced back to agriculture's consumption of energy for feeding stuff, heating, ventilation etc.

The high ranking of so many products related to agriculture draws focus to agriculture's nitrogen balances (nitrogenous fertilizers as well as manure), but also to the fact that agriculture's entire meat production in reality involves a significant loss of energy, when energy in vegetable raw materials is converted to meat products.

Building and civil trade

The building and civil trade is represented among the upper 50 commodity groups by the following products:

25011	Cement
27014	Asphalt and similar bitumen-containing mixtures
68014	Products of concrete or artificial stone
38013	Ready-mixed concrete and mortar
68012	Gypsum goods
73011	Iron and steel structures
68008	Rock wool and similar products
72019	Steel reinforcement

The high ranking of these products is primarily due to the fact that they are sold in very large quantities. Some of these products (cement and steel reinforcement) are in reality predominantly semi-manufactures, e.g. used for manufacture of concrete goods. At the calculation of loss of resources for concrete it was taken into consideration that 70% (cf. appendix 6) is estimated to be reused, substituting new gravel and stone/gravel aggregates for road building. It might of course be a subject of discussion whether gravel and stone are a resource that the community should be just as concerned about as other resources. On the other hand it must be assessed that the loss of resources in any case represents a considerable need for landfill capacity that should be minimised in the interest of the society. An overall assessment is that the result points in the direction that a continued improvement of the

reuse of concrete, and a minimisation of the energy consumption at the manufacture of cement and concrete should be given high priority. Because of the comprehensive quantities concerned even minor improvements would be of great importance in relation to many other products.

Goods of gypsum and rock wool are high-ranked, partly because of the large quantities and partly because there is no recycling of these goods meaning that the entire consumption in reality represents a loss of resources.

Asphalt and bitumen-containing mixtures cover predominantly asphalt layers for roads. In the calculation the significant reuse of old asphalt occurring today was taken into consideration. In spite of that, the loss of resources and the energy consumption are however still considerable. That means - as in connection with concrete - that even minor improvements would be of great importance in relation to many other products.

The consumption sector

Industrial products for households and ordinary consumption are represented among the upper 50 commodity groups by the following groups:

84021	Refrigerators, upright and home freezers
84084	Washing machines
85050	Televisions and video machines
94008	Furniture of wood-fibre boards and the like
49004	Papers and magazines
22005	Bottled beer
39022	Carrier bags, sacks and the like of plastic materials
76003	Aluminium foil and articles hereof
94020	Lighting accessories (for incandescent lamps)
94013	Lighting accessories (not for incandescent lamps)

The high ranking of refrigerators, washing machines, television etc. is first and foremost due to the energy consumption during use. The result shows that there is every reason to continue the present efforts to promote the development and the use of low-energy equipment. For washing machines the loss of resources has however also a relatively high importance. Measured throughout the life of a washing machine, detergents and softeners account for 86% of the total material quantity for a washing machine, whereas the machine and the belonging packaging are only 14%. It is thus evident that possible efforts in connection with washing machines should focus on the function of the machine (i.e. consumption of soap etc.) rather than on the materials, of which the machine is composed.

Furniture of wood-fibre boards and similar products (includes all types of furniture based on chipboards and wood-fibre boards), papers and magazines and bottled beer are high-ranked primarily because of the large quantities. For papers and magazines the calculated loss of resources is solely related to the printing ink. For bottled beer the loss of resources is related to the cap and the small share of beer bottles that is not reused, neither as bottle nor material. For furniture the picture is much more diffuse, as besides the wood-fibre and chipboards a wide selection of renewable as well as non-renewable materials - including various veneer, plastic and metal materials, paints and lacquers for surface treatment, edges etc. - are used. It should be evaluated whether there are reasons to consider how the share of renewable materials could be increased (can e.g. printing ink be produced exclusively from renewable

materials?), and whether it would be possible to reduce the energy consumption for the manufacture processes.

Carrier bags etc. of plastic materials as well as aluminium foil are transport and packaging articles used for a series of purposes. The high ranking provides a reason to consider - among other things - whether recycling arrangements for the materials included in these commodity groups should be established.

Lighting accessories (lamps, fittings) are high-ranked, because the energy consumption of the incandescent lamps, fluorescent tubes etc. for the entire life of the lamp/fittings is included. Thus the focus is directed to the role of the lamp/fittings as light source and to the means (reflectors, energy-saving light bulbs etc.) available for optimization of the energy utilization.

Machines and engines

The last sector to be underlined here is machines and engines for industrial processes etc. Among the upper 50 commodity groups are the following:

- 84005 Engines with compression ignition (i.e. diesel motors)
- 84285 Machines for textile processing
- 84087 Casting machines
- 84105 Vending machines

The reason for the underlining of these commodity groups is the common characteristics that even though the quantity of the industrial product itself is quite modest, the commodity groups are nevertheless high-ranked as regards both loss of resources and energy consumption. In any case these are industrial products of a considerable consumption of working means and energy during use.

Motors are high-ranked on the list partly because of considerable energy consumption, partly because of a large consumption of lubricating oil for the continuous maintenance. The result shows that an improvement of the efficiency of the motors should generally be given high priority.

Textile processing machines include machines for washing, bleaching, dyeing, rolling up, cramping, starching, impregnation and other finishing treatment of textiles. Except machines for rolling up and cramping, these machines all have large consumption of water and various chemical substances. The weighted composition of this commodity group is estimated to 99% chemical substances and 1% other, which in this connection covers the iron etc. of which the machines are made. In practice the result places focus on the fact that textile production is an area with a large consumption of chemicals, water and energy.

The result for casting machines shows correspondingly that casting processes require a very large consumption of moulding sand and energy, whereas vending machines (with primarily beverages) are high-ranked because of a large consumption of disposable drinking cups and the energy consumption for heating/cooling of beverages.

The remaining commodity groups

Among the first mentioned 50 commodity groups it is relatively easy to identify the most important sectors. The picture is however more dim

concerning the commodity groups further down the list. Actually products from different sectors are listed, depending on quantities and characteristics of each commodity group. As already registered for the 50 upper commodity groups the characteristics placing a commodity group high on the list will be as follows:

- ? An active consumption of energy during use
- ? Use of working means during use
- ? The product is sold in large quantities and consists especially of non-renewable materials.

It should be noted however that also products predominantly consisting of renewable materials (e.g. foodstuffs) can be high-ranked on the list. When this is the case, it is mainly due to packaging of non-renewable materials (e.g. plastic materials and metal), and that the product is sold in so huge quantities that even a modest packaging share of a few percentage of the total weight of the product results in considerable amounts of non-renewable resources. As it appears from the following section the calculated result of the loss of resources of such products must however be considered very uncertain.

2.2 Uncertainties of results

The ranking of commodities is subject to uncertainty, because all the data applied for the estimates of loss of resources and energy consumption are to some extent uncertain. In this section an assessment of the uncertainties and their importance to the ranking is made.

Initially it should be stressed that all assessments of uncertainties made here are based on an estimate, as the true and real data are not available.

The uncertainty calculation made in the following is based on the assumption that for almost all types of data (e.g. volume of production, correction factor, loss of resources of materials) the predominant part of the data quantity was determined with a relatively modest uncertainty, whereas a minor part of the data quantity had a high degree of uncertainty, sometimes even considerably high. As an example it can be mentioned that it is assessed here that the uncertainty of the ASC values (energy consumption for extraction and manufacture of materials) is dividable as follows:

- ? Approx. 75% of all ASC values were determined with an uncertainty of $\pm 20\%$
- ? Approx. 20% of all ASC values were determined with an uncertainty of $\pm 100\%$
- ? Approx. 5% of all ASC values were determined with an uncertainty of -100% to +500%.

The above division expresses that for most materials (roughly estimated 75%) many studies for determination of ASC values have already been carried out, and even though these data are old, and it was necessary to project these, the uncertainty can generally be considered limited. The uncertainty degree is

highest at the data estimated by enthalpy calculations, or estimated by analogy to other data, or covers material groups in reality consisting of many different materials with widely different ASC values. Additionally there are the uncertainties based on the fact that the material list lacks defined materials covering the materials of which the industrial product actually consists. Here it was chosen to grade these uncertainties by assessing that for 20% of the materials the value will be very uncertain ($\pm 100\%$), whereas the remaining 5% of the materials is quite wrong, which is here expressed by an uncertainty interval of -100% to $+500\%$, as the ASC value cannot become negative.

Irrespective of the precise reasons for uncertainty of the individual ASC values, it is difficult to make an absolute and positive estimate of the uncertainty of the individual value. For ASC values based on studies in literature it is as mentioned assessed that the uncertainty generally is limited. This does not mean however the uncertainty of all data of this type is limited. It can be expected that the majority of such values do not deviate significantly from the truth (i.e. a low uncertainty), whereas a minority will deviate much (i.e. high uncertainty). The situation is the contrary for data based on enthalpy calculations, conclusion by analogy etc. Here the majority of data must be expected to deviate much from the truth (i.e. high uncertainty), whereas a minority will deviate a little (i.e. low uncertainty).

This means that the only quite safe way to evaluate uncertainties is for each ASC value to evaluate and tabulate a statistical distributional function describing the uncertainty of precisely this value and thereafter find a method for assessing the resulting uncertainties. This procedure would involve a workload of the same size as the one already invested in this project.

An alternative might be to carry out sensitivity calculations on the results by changing selected values. Because of the many different data included in this project, such sensitivity calculations might seem of accidental character (what data should be changed?) or alternatively result in a calculation practice of an enormous scope with results that would actually be difficult to interpret.

In this project it was chosen to consider all ASC values a group of data, about which there are some uncertainties describable through a statistical distributional function. The assessments of uncertainties given above are thus interpreted as follows:

- ? It is assumed that there is a 75% probability that the ASC value in each individual case is correct within an uncertainty of 20%
- ? It is assumed that there is a 20% probability that the ASF value in each individual case is correct within an uncertainty of 100%
- ? It is assumed that there is a 5% probability that the ASC value in each individual case is correct within an uncertainty of -100% to -500% .

By studying the other data included in the calculations in the same way and carry out a computer simulation of uncertainties of a series of selected commodity groups, it is considered possible to achieve a realistic impression of the average uncertainties of the calculation results.

It is emphasized that this way of assessing the uncertainties provides the impression of the average uncertainties rather than the maximum

uncertainties, as in reality an equalizing of the uncertainties within a certain data type takes place. The ASC values, based on studies from literature and of a relatively low uncertainty, are affected by the high uncertainty of the ASC values based on enthalpy values etc. and vice versa. Thus the assessment method will not intercept the worst possible cases, which is here considered acceptable, as the aim is to achieve an assessment of the general sustainability of the calculation results (when should the ranking of two commodity groups be considered identical and different respectively) and not the definitive truth of each commodity group.

For the computer simulation a special computer program "RISK", which is a superstructure of the spreadsheet program Excel, was applied. RISK has the property that a fixed value (a figure in a cell of the spreadsheet) is replaceable by a set of values, which fulfil a given statistical distributional function. In the present case each of the data included in the calculation of loss of resources and energy consumption will be replaced by a statistical distributional function. In other respects the programme functions in such a way that a considerable number of calculations of both loss of resources and energy consumption are carried out. At each calculation, a ransom figure, which is in accordance with the chosen statistical distributional function, will be generated for each data. After completed calculations the mean values, the frequency distribution and the standard deviations of the results were calculated.

These uncertainty calculations were based on the calculated expressions of the loss of resources and the energy consumption respectively indicated in box 1.1. For quantity data it was taken into consideration that the calculations in reality are based on the mean value of production and supply, i.e. that actually two quantity data are included in the calculations - and not just one quantity data as is shown in box 1.1. For energy consumption for extraction, manufacture and processing of materials (E_{px}) it was correspondingly taken into consideration that this energy consumption is composed of ASC + processing supplement.

The uncertainty of data types is basically defined as described above for the ASC values (i.e. as a step distribution). At the actual uncertainty calculations it was however chosen to replace the step distribution by a logarithmic normal distribution (lognormal). This choice was made, because a continuous distribution must be expected to reflect reality better than a step distribution. The logarithmic normal distribution is moreover characterised by its natural zero (data values cannot be negative) and by its behaviour like the normal distribution in connection with high data values.

The conversion of step distribution to lognormal distribution was done by choosing a lognormal distribution, which is - based on the standard deviation - was the best possible approximation to the step distribution. All lognormal distributions used in the calculations were identified by the standard deviation (which was here assumed determined by the data type) and the mean value (which is the figure used in the ordinary calculation). The lognormal distribution for the ASC material "m050 Aluminium" was thus unambiguously determined as lognormal (190, 40) where 190 is the estimated ASC value of the material (cf. table 1.5) and 40 is the estimated standard deviation of the ASC values generally (cf. table 2.1).

For each type of data included in the calculations table 2.1 shows partly the assumed step distribution of uncertainties and partly the lognormal distribution (identified by the standard deviation), which is assumed to correspond most accurately to the step distribution. The rationale behind assumed step distributions is described in the following:

Quantity data

According to information from Statistics Denmark /24/ quantity data for approx. 75% of all tariff numbers are available directly from Statistics Denmark, as data for production, imports and exports are reported in tonnes and not subject to confidentiality. These data are normally considered the best and thus in principle true. Empirically even those data will be uncertain because of statistical threshold values, use of incorrect tariff numbers, imprecise quantity data, inclusion of retail packaging in the net weight etc. No certain knowledge of the size of these errors is available - not with Statistics Denmark /24/ either. Here it was consequently assumed that the predominant part (approx. 90%, corresponding to approx. 65% of all tariff numbers) of these data holds a relatively modest uncertainty (5%), whereas a minor part (ca. 10%, corresponding to approx. 10% of all tariff numbers) is holding a significant uncertainty (50%).

The remaining 25% of all tariff numbers includes the numbers for which it was necessary to estimate the quantity data by recalculation on the basis of the foreign trade statistics and the numbers subject to confidentiality or for which it was necessary to estimate the quantity data for some other reason. The tariff numbers, the quantities of which were found by calculation on the basis of the foreign trade statistics, include approx. 22% of all tariff numbers. The precise uncertainty of these data is not known, but is assumed to be 25%.

The tariff numbers, of which the quantity data were estimated (3% of all numbers) were here conservatively assumed to hold an uncertainty of 100%. It was estimated here that the uncertainty was much lower in many cases, but a few data were deliberately estimated very conservatively.

These uncertainty estimates were based on the uncertainty of the individual tariff numbers, thus disregarding an actual equalizing of the uncertainties taking place when the tariff numbers were collected in commodity groups. As this effect lacked clarity, the uncertainty of the tariff numbers was here chosen as the basis of the assessment.

Correction factor

The correction factor is uncertain because of uncertain estimates of the quantity of working means, spare parts and packaging compared to the weight of the industrial product; i.e. that at these points the uncertainty of the estimated material composition will affect the correction factor. The correction factor might also be misjudged because the quantity information includes packaging. This type of uncertainty was included in the quantity data, but not in the correction factor.

An overall estimate is that working means and spare parts have only importance to approx. 20% of the total amount of commodity groups. For the cases in which the correction factor is limited to the importance of packaging, the correction factor will normally be modest (< 1.05) and the uncertainty consequently low ($< 5\%$). For the remaining 20% of the commodity groups the uncertainty of the correction factor will be substantial to significant. It was

assumed her that for 15% of the commodity groups the uncertainty was 20%, whereas it was estimated at 50% for the remaining 5%.

Contents of material

This concerns the contents of the individual material in the commodity group, i.e. the material composition. These contents are stated as a percentage value, which can be between 0 and 100. From the initiation of this project it was estimated that this percentage value was to be determined with an absolute uncertainty of 5%. This means that for a material, the contents of which is stated as 75%, the true value will be within the interval of 70 and 80%, whereas the true value of a material, the contents of which are stated as 5%, will be within the interval of 0 to 10%. This uncertainty reflects that the contents value of the dominant materials of a commodity group is fairly accurate, whereas the value of the materials of smaller shares is very uncertain. At the calculations it was secured that the sum of all contents values (except for water as a working means) is always 100.

Loss of resources for materials

Here it was determined that for all non-recyclable materials, thus with a loss of resources of 100%, this value was established with an uncertainty of 0%. This was the case for approx. 75% of all materials of the material list (cf. table 1.5). For the other materials it is estimated that the uncertainty generally is limited, but that some misjudgements might have happened for a few commodity groups. It was consequently estimated that 15% of the total estimates of loss of resources has an uncertainty of 20%, whereas the remaining 10% has an uncertainty of 100%.

ASC

Reference is made to comments in the above text.

Energy content

It is assumed that for all materials, in which the energy content is 0 (applies to approx. 40% of all materials), this value was determined without any uncertainty. For the remaining materials it is assumed that the value because of many investigations is determined fairly precisely, but that for material groups consisting of many different materials the stated values might be considerably uncertain. Additionally, there are the situations in which the material list does not include a material corresponding precisely to the material in the commodity group. Here it was assumed that for 50% of all materials there is an uncertainty of 20%, whereas for the remaining 10% an uncertainty of 100% was assumed.

Processing supplement

For 80% of all materials no processing supplement was defined. For these materials it was assumed that the supplement was determined with the uncertainty of 0 (in these cases the uncertainty was in principle included in the ASC value). For materials, for which a processing supplement had been defined, it was estimated that the uncertainty of the size of this supplement is generally high. Here it was assumed that the processing supplement for 10% of all materials was determined with an uncertainty of 50%, whereas for the remaining 10% the uncertainty was 100%.

Energy consumption during the life cycle

Uncertainties of the estimates of the energy consumption during the life cycle are related to conditions as e.g.:

- ? Are the industrial products used as the basis for the calculations a true average of all the products in the commodity group?
- ? Are the assumptions of the average energy consumption per operation/use hour and the number of operation/use hours correct?

It is assessed that the estimates made are seldom completely correct, but seldom quite incorrect either. It cannot be excluded however that a few incidents of substantial misjudgements have taken place. Consequently it was assumed that for 80% of the estimates the uncertainty was 20%, for 15% of the estimates 50%, and for the remaining 5% the uncertainty was 100%.

Table 2.1 Calculation preconditions for assessment of uncertainties *1)

Data type	Assumed distribution of uncertainty		Assumed statistical distributional function
	Data quantity %	Assumed uncertainty %	
Quantity data	65 22 10 3	±5 ±25 ±50 ±100	Lognormal with standard deviation of 25%
Correction factor	80 15 5	±5 ±20 ±50	Lognormal with standard deviation of 20%
Contents of material	100	±5	Lognormal with standard deviation of 5% (absolute). Sum of contents of all materials in commodity group fixed at 100
Loss of resources of materials	75 15 10	0 ±20 ±100	An uncertainty of 0% was used for values of 100%. In other cases lognormal with a standard deviation of 40% was applied
ASC	75 20 5	±20 ±100 -100, +500	Lognormal with standard deviation of 40%
Energy content	40 50 10	0 ±20 ±100	An uncertainty value of 0% for an energy of 0 was applied. In other cases a lognormal with a standard deviation of 30% was applied
Processing supplement	80 10 10	0 ±50 ±100	An uncertainty of 0% was applied for materials not added a processing supplement. In other cases a lognormal with a standard deviation of 40% was applied
Energy consumption during use	80 15 5	±20 ±50 ±100	Lognormal with standard deviation of 35%
Average weight of products in the commodity group	80 20	±10 ±50	Lognormal with standard deviation of 25%
Share of combustible waste for incineration	80 20	±20 ±100	Lognormal distribution with standard deviation of 25%, laterally reversed so that it has zero around 100% and subsides towards the value of 0%. Negative values were set at 0%
Energy efficiency at solid waste incineration	80 20	±10 ±50	Lognormal with standard deviation of 25%, laterally reversed so that it has zero at the value 100% and subsides towards the value of 0%. Values below 20% were fixed at 20%

Notes: ') For explanation of the stated data, see the text

Average weight of products in the commodity group

Estimates of the average weight of products in the commodity group are uncertain related to whether the products in question, on which the estimate is based, are a true average of all the products in the commodity group. This estimate is however in many cases based on information from the statistics (total number/total weight), which is assessed to hold a relatively low uncertainty. It was therefore assumed that 80% of all estimates hold a relatively low uncertainty (10%), whereas the remaining 20% has an uncertainty of 50%.

Share of waste that is combusted

The precondition of the calculations was that on average 75% of all combustible waste in Denmark is taken to solid waste incineration plants. Seen in relation to the individual commodity groups this precondition must be considered uncertain. Even though the majority of the loss of resources in all probability will end up in solid waste incineration plants, it is far from certain that the share is precisely 75%. Furthermore, of the individual commodity groups (e.g. foodstuffs, feedstuff etc.) the predominant part of the loss of resources will be utilized in another way - and only to a very limited extent end up in solid waste incineration plants. It was consequently assumed that in 80% of all cases the precondition held an uncertainty of 20%, whereas in the remaining cases the uncertainty was 100%.

Energy efficiency of solid waste incineration plants

At the calculations an energy efficiency of 80% was assumed. This assumption will probably be almost correct in most cases, as the capacity of each incineration plant is adapted to the waste available, and by and large all incineration plants must expect that the waste-generated heating cannot be utilised in full during the summer period. The assumption is however also used for commodity groups such as pit coal, for which the energy efficiency is typically considerably lower. Here it is therefore considered correct to assess that in 80% of all cases the assumption holds an uncertainty of 20%, whereas the remaining cases hold an uncertainty of 50%.

Results

The results of the uncertainty calculation appear from table 2.2. Besides the calculated mean values of the loss of resources and the energy consumption the table shows also the standard deviation of the calculation results and the interval, within which 90% of all the results is.

Energy consumption

As it appears from the results of the energy consumption, the interval - within which 90% of the results are - is typically within the range of -50 to +76% of the mean value. This result is to be interpreted in such a way that all the results of energy consumption stated in appendix 1 should be considered an interval determined by the result -50% and +76% respectively. Intervals, which do not overlap each other, represent in all probability energy consumption values that are in reality different. Contrary to that, intervals that to a greater or smaller extent overlap each other represent energy consumption values, which are almost likely to be identical.

Table 2.2 Uncertainty calculation - results *1)

Commodity group		Loss of resources				Energy consumption			
		Mean tonnes	Standard deviation %	5% quantile (% of mean)	95% quantile (% of mean)	Mean GJ	Standard deviation %	5% quantile (% of mean)	95% quantile (% of mean)
No.	Name								
02005	Frozen meat of poultry	1405	188	-96	390	2.578.813	40	-51	76
19011	Rye bread	1126	336	-99	410	1.144.463	34	-43	62
22008	Wine in containers < 2 l	6115	47	-57	88	230.291	41	-49	73
39022	Carrier bags, sacks etc. of plastic materials	56031	18	-27	32	2.560.019	35	-46	65
40002	Threads and strings of rubber	11	45	-55	91	3.366	41	-51	76
42007	Bags, rucksacks etc. of textiles	699	25	-35	45	79.922	31	-41	58
49004	Papers and magazines	10927	138	-92	340	14.936.656	37	-47	68
62021	Smocks and aprons for women	83	45	-55	86	25.018	29	-39	53
73019	Galvanized nails of iron/steel wire	15872	19	-28	33	348.371	47	-52	80
84036	Automatic dishwashers	5640	32	-44	59	4.603.375	48	-56	91
85008	Permanent magnets	62	52	-56	95	84.799	45	-54	84
85050	Television sets and video machines	10668	20	-30	36	12.848.246	47	-56	88
87004	Cars and vans <3500 kg	23399	37	-47	69	31.166.372	49	-57	94
89004	Refrigerator ships	62262	23	-33	42	261.745.664	48	-56	89
Mean of groups 02005, 19001 and 49004 *2)			221	-96	380				
Mean of other commodity groups *3)			33	-42	61				
Mean value of all commodity groups							41	-50	76

Notes:

- *1) For all the commodity groups the results were based on 10,000 simulations. The percentage figures in the columns "5% quantile" and "95% quantile" indicate the limits within which 90% of the achieved results is, calculated relatively in relation to the mean value. For the commodity group 02005 90% of the calculated results of the loss of resources be within an interval determined by the mean value

minus 96% and the mean value plus 390%. The stated mean values of loss of resources and energy consumption are the values determined at the uncertainty calculation. Consequently there might be minor deviations compared to the values stated in appendix 1a.

- *2) These commodity groups include predominantly renewable materials, which are recreated concurrently with their use. The loss of resources is therefore in any case connected to modest contents of non-renewable materials (packing, printing ink etc.), which are determined with high uncertainty.
- *3) Each of these commodity groups consist predominantly of non-renewable materials.

On the basis of the ranking result of the energy consumption in appendix 1 it can for example be estimated

- ? that the commodity group, which on the basis of its energy consumption was ranked as no. 1, in all probability should not be ranked as no. 3 or lower
- ? that the commodity group, which on the basis of its energy consumption was ranked as no. 10, in all probability should not be ranked higher than no. 6 or lower than no. 39
- ? that the commodity group, which on the basis of its energy consumption was ranked as no. 50, in all probability should not be ranked higher than no. 19 or lower than no. 102
- ? that the commodity group, which on the basis of its energy consumption was ranked as no. 100, in all probability should not be ranked higher than no. 47 or lower than no. 200
- ? that the commodity group, which on the basis of its energy consumption was ranked as no. 300, in all probability should not be ranked higher than no. 145 or lower than no. 473
- ? that the commodity group, which on the basis of its energy consumption was ranked as no. 500, in all probability should not be ranked higher than no. 315 or lower than no. 705.

Loss of resources

For loss of resources the results were characterized by large deviations. It is clear however that the commodity groups, the results of which hold a high uncertainty, are all characterised by being composed of renewable materials, which are recreated concurrently with their use.

The loss of resources, which is calculated, forms therefore only the modest part of the materials of the commodity group that is non-renewable, that is to say packaging, printing ink and the like.

It should be no matter for surprise that the uncertainty of the loss of resources of such commodity groups is generally characterised by the fact that the dominant materials were determined with a low uncertainty, whereas the marginal materials were decided with high uncertainty. This uncertainty was incorporated in the assessment method applied in this project (cf. section 1.4 Threshold values).

For commodity groups, consisting predominantly of renewable materials it was concluded that the uncertainty of the loss of resources can be so

significant that establishing general criteria for it makes no sense. In practice the result must be assessed in detail in each individual case.

For commodity groups, which have some share of non-renewable materials, it was assessed meaningful to talk of a typical uncertainty. Parallel to the assessments of energy consumption it was - based on the results in table 2.2 - assessed that the interval - within which 90% of the results are - is typically of the size of -42 to +61% of the mean value, meaning that all results of loss of resources stated in appendix 1 should be considered an interval determined by the result -42% and +61% respectively. With this as a starting point and based on the ranking results of loss of resources in appendix 1 the following assessments can be made:

- ? that the commodity group, which on the basis of its loss of resources was ranked as no. 1, in all probability should not be ranked as no. 5 or lower
- ? that the commodity group, which on the basis of its loss of resources, was ranked as no. 10, in all probability should not be ranked higher than no. 6 or lower than no. 16
- ? that the commodity group, which on the basis of its loss of resources was ranked as no. 50, in all probability should not be ranked higher than no. 27 or lower than no. 109
- ? that the commodity group, which on the basis of its loss of resources was ranked as no. 100, in all probability should not be ranked higher than no. 50 or lower than no. 200
- ? that the commodity group, which on the basis of its loss of resources was ranked as no. 300, in all probability should not be ranked higher than no. 191 or lower than no. 443
- ? that the commodity group, which on the basis of its loss of resources was ranked as no. 500, in all probability should not be ranked higher than no. 355 or lower than no. 617.

These uncertainty considerations show that even though the calculation results hold uncertainty and thus correspondingly also the ranking of the different commodity groups in relation to each other, the stated ranking will nevertheless could be used as a clear indication of the attention that should be given to the various commodity groups. Except for the commodity groups that predominantly consist of renewable materials, and in connection with which the loss of resources must be estimated in detail in each individual case, it is beyond doubt that the commodity groups with high ranking on the list are the groups resulting in the most significant loss of resources and energy consumption.

2.3 Overall assessment

Ranking

The ranking of industrial products carried out in this project shows that the properties of industrial products that will typically indicate that products have a large loss of resources and/or energy consumption and thus have a high ranking, are the following:

- ? An active energy consumption during use
- ? A large consumption of working means during use
- ? The product is sold in large quantities and has substantial contents of non-renewable materials.

It is hardly surprising that especially the industrial products appearing at the top of the ranking list are products and goods related to the energy sector, transport sector, agriculture and building and civil sectors.

Especially the sectors energy, agriculture and building/civil are characterised by the fact that substantial quantities of quite few articles are consumed/manufactured. Contrary to that, means of transport, such as ships, trains and cars, are characterised by a very large consumption of energy as well as working means (lubricating oil, tyres etc.) during use. For comparison the production and consumption within other sectors are distributed on many different articles, meaning that individually they do not carry great weight in the total accounts.

There are however also a series of consumer goods competing for high ranking on the list. These are typically products requiring energy or working means during use, such as refrigerators and freezers, washing machines, television and lighting accessories - or products sold in very large quantities, such as furniture, beer, papers and magazines.

A series of commodity group topping the ranking list must incidentally be considered semi-manufactures rather than finished goods. This applies to e.g. goods like pit coal, oil, natural gas, diesel motors, feedstuffs, cement and packing articles. This does not mean however that they are uninteresting. An example is that the efficiency of engines in reality has decisive importance for the energy consumption of means of transport.

Especially interesting are commodity groups like machines for textile processing, vending machines and casting machines, which are high-ranking because of the large consumption of working means (chemicals, disposable drinking cups, moulding sand) besides energy consumption throughout the entire life cycle.

It should be stressed that the ranking made here does not consider the utility value of the industrial products in the community or the contents of environmentally harmful substances etc. Thus it does in no way mean that a product is especially "poor or environmentally harmful", if it is at the top of the list.

That a product is ranked at the top of the list means however in actual fact that a very large loss of resources and/or energy consumption are connected to it. It might therefore be in the interest of the community to assess possible improvements/changes/consumption reductions etc. that should be initiated for this specific product.

The interest of the community in initiating improvements is not necessarily limited to the products ranked at the top. It might be relevant to focus on products ranked further down the list, e.g. motivated by the contents of

environmentally harmful substances, pollution during the phase of production etc.

Method

It is assessed that the method for ranking of industrial products applied in this project has proved useful for the purpose. The main basis for this assessment is that the result achieved (the ranking) must be considered logical and well-founded.

When this has been said, it must be recognized though that the method as well as the data in many ways could and should be improved. Neither the commodity group division nor the collected data of commodity groups and materials can be considered optimal and impeccable. The calculation of the energy quantity that can be reclaimed from the loss of resources is not optimal either.

Uncertainties

This means as assessed in section 2.2 that all calculation results including the ranking are naturally uncertain. These uncertainties imply that it makes no sense to assert that the commodity group ranked as no. 30 is more environmentally harmful than the commodity group ranked as no. 35, or to emphasize no 250 in preference to no. 300. Contrary to that, it makes sense to consider the commodity groups ranked as no. 1 to approx. 50 as having more environmental impact than the commodity groups ranked as no. 100 to 200 etc. As it appears, the focus should be on the general lines.

Besides the uncertainties pointed out in section 2.2, the uncertainty related to the division of industrial products into commodity groups should also be stressed. The larger quantities a commodity group includes, the higher it will be ranked. Splitting up a commodity group into more groups is consequently an efficient way of reducing the importance of certain industrial products in a ranking system like this. In this project it was deliberately attempted to minimise the amount of commodity groups, thus gathering various industrial products in the same group to the extent considered at all appropriate. It is obvious that the division can always be discussed, and that some of the choices made after careful consideration will turn out to be wrong.

Accumulation of knowledge

It is assessed that the knowledge of industrial products and materials achieved during this project - all uncertainties considered - has enabled an identification of the types of industrial products to which the focus should be directed in the future environmental efforts, as well as it will be available for utilisation in other connections as described in the following section. During this project an actual accumulation of knowledge within the field of products and materials took place.

It should be emphasized that the knowledge presented in this main report including appendices 1a and 1b could be considered the top of the iceberg, when compared to the knowledge available in the database and the other appendices.

3 The established data base

The data collected and utilised in this project were organised in a data base placed in the computer system of the Danish Environmental Protection Agency. It has not been clarified yet how these data can become available to the public. The structure and the possibilities of application, extension and improvement are described briefly in the following.

3.1 The structure of the data base

The data base was established as a so-called relational data base, which means that it is possible to combine the individual data in different ways and to extend the data base by new data, dependent of the actual needs.

Data as well as calculation results are organised in a series of data base tables. At the completion of this project the data base includes the following tables:

- ? Positionsnummer (TariffNumber)
- ? Vareposition (CommodityTariff)
- ? Varegruppe (CommodityGroup)
- ? Miljøstoffer (EnvironmentSubstances)
- ? KodelisteMilstof (CodeListEnvSubst)
- ? S sammensat (Composed)
- ? Materiale (Material)
- ? Simuleringsoplysninger (SimulationData)
- ? DetaljeretResultat (DetailedResult)
- ? PrioriteretResultat (RankedResult)

In the following the contents of these data base tables are briefly described.

Positionsnummer (TariffNumber)

This table includes all the tariff numbers in Statistics Denmark's supply statistics (version May 1993 - cf. appendix 3). These tariff numbers are considered the allowed tariff numbers of the system. In the table it is stated whether a tariff number is related/not related to a commodity group. The table is used to control that no tariff numbers are "forgotten" in case of adjustment of the commodity group division.

Vareposition (CommodityTariff)

This table states the tariff numbers related to the commodity group (cf. appendix 4). One tariff number can only be related to one commodity group. In this way the table defines an unambiguous connection between Statistics Denmark's supply statistics and the division in commodity groups made in this project.

Varegruppe (CommodityGroup)

The table called "CommodityGroup" contains one record for each commodity group. This record contains the following information (cf. appendix 5):

- ? Number of the commodity group

- ? Name of the commodity group
- ? Total Danish production of the commodity group (tonnes/year)
- ? Total Danish consumption/supply (production + imports - exports) of the commodity group
- ? Energy consumption during the use phase/throughout the life cycle of an average product of the commodity group
- ? Weight of an average product of the commodity group (tonnes - only stated for the products with an energy consumption during their use phase)
- ? Correction factor
- ? Environmentally harmful substances indicated by their chemical abbreviations or the like (this is a text field making it possible to list the environmentally harmful substances of the commodity group in the result list - cf. appendix 1).

It should be noted that the information of the weight of an average product is used for automatic calculation of the number of products in the commodity group (on the basis of information of production and consumption/supply for the commodity group) and thus to calculate the total energy consumption during use for the commodity group.

Miljøstoffer (EnvironmentSubstances)

This table indicates the environmentally harmful substances of the commodity group registered. Each substance is defined by a 4-figure code (the "standat" code - see below). This table is used to search for specific commodity groups containing specific environmentally harmful substances. At this time the table only include selected applications of cadmium, lead, copper, nickel and phthalates (cf. section 1.6).

KodelisteMilstof (CodeListEnvSubst)

This table includes an extract of the Danish EPA's list of environmentally harmful substances - the so-called "standat" list. This list contains all the substances that the EPA normally focuses on in various connections. Each substance is defined by a 4-figure code and the name of the substance. The table only includes code and name of the substances (cadmium, lead, nickel, copper and phthalates) that are so far identified as included in commodity groups.

Sammensat (Composed)

This table states the materials assessed included in the commodity group. The following is stated for each material in each commodity group (cf. appendix 5):

- ? Contents (in %)
- ? Loss of resources (in %)
- ? Processing supplement (is processing supplement included for the material in this group? - yes/no)

It should be noted that the field "loss of resources" is only filled in, if the loss of resources of the material in question in the commodity group in question is considered different (substantially) from the average loss of resources stated for each material in the table "Material" (see below). If a figure of loss of resources has been entered in the table "Composed", the figure stated in the table "Material" is automatically used.

Materiale (Material)

This table includes information of all registered materials. For each material a record with the following information (cf. appendix 6) has been established:

- ? Material code (cf. table 1.5 and appendix 6)
- ? Material name (cf. table 1.5 and appendix 6)
- ? Loss of resources (in % - cf. table 1.5)
- ? Whether the material is considered renewable (yes/no - cf. table 1.5)
- ? Whether the material is recreated concurrently with its use (yes/no - cf. table 1.5 - only relevant to renewable materials)
- ? ASC value (GJ/tonne - cf. table 1.5)
- ? Whether a processing supplement has been defined (yes/no)
- ? Processing supplement (GJ/tonne - cf. table 1.5)
- ? Energy content (GJ/tonne - cf. table 1.5)
- ? Simulation number (a figure between 0 and 99)

It should be noted that it is possible to change all data of a given material (except material code and name) without spoiling the original data. For the individual material this is done by defining a special record with a simulation number different from zero (see below). This facility is built into the data base to provide the opportunity of making sensitivity calculations and to enable studies of the consequences of possible recycling initiatives etc.

Simuleringsoplysninger (SimulationData)

In this table a series of basic preconditions of each calculation is stated. The preconditions are the following:

- ? Quantity basis (it is stated whether the calculations are to be built on production data, supply data or mean value of production and supply)
- ? Waste quantity to be combusted (the share of the waste assessed to be combusted is stated - this is important in connection with utilisation of the energy content of the material quantity ending up as loss of resources)
- ? Energy efficiency of solid waste incineration plants (it is stated on which the efficiency calculations are to be based)

- ? Simulation number (the simulation number - cf. material data - on which the calculations are to be based is stated. If no number is stated, the calculations are based on the original data. If a simulation number different from 0 is defined, the calculations are based on the material records holding this simulation number (see above). For the materials, for which there is no record with the current simulation number, the program will automatically use the original data).

DetaljeretResultat (DetailedResult)

This table is a result table showing the detailed calculation of loss of resources and energy consumption of all commodity groups. The information provided by this table corresponds to the information given in appendix 2.

PrioriteretResultat (RankedResult)

This table is a result table showing the ranking of commodity groups. The information provided by this table corresponds to the information provided in appendices 1a and 1b. It is possible to choose prints of the commodity groups based on ranking of loss of resources, energy consumption or the average position in relation to loss of resources and energy consumption (as in appendices 1a and 1b).

The data base - as it looked at the completion of this project - can be considered partly a series of table with various original data (applies to all tables except Simuleringsoplysninger (SimulationData), DetaljeretResultat (DetailedResult) and PrioriteretResultat (RankedResult)), and partly a superstructure designed for making the calculations needed in connection with this project (applies to the tables Simuleringsoplysninger (SimulationData), DetaljeretResultat (DetailedResult) and PrioriteretResultat (RankedResult)).

Additionally, the data base consists of all the documentation files, which explain the basis for the various commodity group data and material data (cf. appendices 5 and 6). These documentation files were included in the data base as WordPerfect documents and can be called up by entering the relevant commodity group number and material code respectively.

For further information of the structure of the data bases it is referred to the system description (cf. /4/) and the user's guide of the data base (cf. 15/).

3.2 Possibilities of application

As it appears from the preceding section the data base was designed to carry out the calculations needed in connection with this project, apart from which it was designed to make various simulations of changed calculation preconditions. As stated it is possible to adjust the following:

- ? Material data (loss of resources, renewability, recreation of the resource concurrently with its use, ASC value, processing supplement and energy content
- ? Share of waste for incineration plants
- ? Energy efficiency of incineration plants.

Additionally the data base provides the possibility of searching for the following:

- ? Commodity groups, which include environmentally harmful substances (only the environmentally harmful substances included at the time - i.e. at present only cadmium, lead, nickel, copper and phthalates).
- ? Commodity groups, which include a specific material, the contents percentage and the total quantity calculated on the basis of production as well as supply for the group.

The data base is thus considered to be useful in connection with e.g. the following types of environmental investigations/assessments:

- ? Mass flow analyses of selected materials
By utilising the possibility of searching for selected materials a good overview of the types of industrial products containing the material in question and the quantity of the contents is promptly obtainable. As the same material quantity might be included in various commodity groups, the quantity information from different commodity groups cannot be immediately summarised.
- ? Eco-label assessments/promotion of environmentally more friendly industrial products
The information in the data base and the calculation results of loss of resources and energy consumption provides immediately a good impression of the parameters to be focused on in connection with ecolabel assessments of selected industrial products and development of less polluting industrial products.
- ? Recycling initiatives
On the basis of the information in the data base and the calculation results it is possible to obtain a prompt overview of the materials, for which there might be a need for recycling initiatives, as well as an overview of the consequences of specific objectives measured as quantities of the material ending up as loss of resources.

The design of the data base ensures that it can relatively easily be updated and extended. This of course provides the possibility of further applications. For example, a question of how to identify the industrial products to take measure against in order to reduce the quantity of slag from solid waste incineration plants, can be answered by the following:

- ? Defining a new field "A" for each material, which states the slag/ash share of the material, i.e. the part of the material that can be rediscovered as slag/ash
- ? Defining a field "B", which indicates to what extent the loss of resources is taken to the incineration plant
- ? Programming of a supplementary calculation, in which the calculated loss of resources for each material in the commodity group is multiplied by "A" and "B", added up and finally ranked on the basis of this sum.

These application possibilities are to be considered examples. No attempt was made to systematically point out all conceivable application possibilities. It

should be noted that the material data collected as part of this project are assessed to be useful in many relations, e.g. in connection with assessments of cleaner technology for selected industrial products.

3.3 Possibilities of improvements/extension of the data base

The data base, as it appears at the completion of this project, should be considered the foundation stone of a data base for industrial products and materials rather than a complete data base.

The fact that there is a continuous development of the composition of industrial products as well as the energy consumption for manufacture of the same mean that at intervals there will be a natural need for an update of the data of the data base, if it is to preserve its value on the long view.

Furthermore, the data base - as it appears today and with the data it includes - should be considered "the best obtainable" within the scope of this project. This means that in many ways it is possible to improve the data base and the data included.

In other connections (including projects financed by the National Council for Recycling and Less Polluting Technology) data that are more precise than the data of the data base today will no doubt be collected and accumulated. It would be natural to attempt securing that such data are entered into the data base to replace or supplement the existing data.

Also, an adjustment of the commodity group division could be imagined. It should be noted however that if the commodity group division is adjusted, an adjustment of the quantity data would also be needed (presupposes assistance from Statistics Denmark).

Other possible improvements/extensions of the data base are as follows:

? Refining of the material list

In a series of cases (e.g. sanitary ware versus service china) it should be distinguished more detailed between materials than is the case now.

Furthermore, the material list could advantageously be extended by e.g. low-value fuels and more secondary materials, especially as concerns iron, steel and metals.

? Refining of processing supplement

For many materials it would be obvious to define more than one level of processing supplement. In the data base it is quite simple to operate with several levels of processing supplement, as the various levels are defined under material data, whereas in the commodity group data (the table "composed") under processing supplement the real level is stated (e.g. "1", "2" or "3") instead of a simple "yes" like now.

? More information of environmentally harmful substances

Today the data base includes only information of the occurrence of a few environmentally harmful substances in industrial products. It would be natural to include all substances stated in the Standat list of the Danish EPA. On the long view it could be considered whether the Standat list meets the demand, or whether more substances should be included in this list.

? Recovery of the energy in the loss of resources

The calculation of the energy in the loss of resources, which is recoverable is for some commodity groups rather imprecise, as this calculation is based on an assessment of the quantity of the loss of resources that is on average taken to solid waste incineration plants and the energy efficiency of the incineration plants. For certain commodity groups (e.g. foodstuffs) the loss of resources will never - or only partly - end up in incineration plants. For other commodity groups (e.g. pit coal) the loss of resources will be incinerated all right, but the energy utilisation will be different than in an incineration plant.

If this calculation is wanted more precise, it would be necessary to define transportation to incineration plants and energy efficiency as parameters for both materials and commodity groups.

? Value of non-renewable resources

As mentioned in section 1.1.2 there is in the calculation model no possibility of allowing for differences in the value of non-renewable resources. At the calculations the loss of one tonne of sand or gravel is weighted as high as the loss of a tonne of copper. It would of course be relevant to develop methods and knowledge to include these differences in the data base and the calculations that are made.

Finally it is emphasized that the proposals for improvements stated here are exclusively based on considerations made in connection with this project. During the use of this data base a series of other points - by which the data base can be improved or extended profitably - will probably be identified.

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- /24/ Personlig oplysning: Jørgen Morsø Jørgensen, Danmarks Statistik, København oktober 1993 (Personal information: Jørgen Morsø Jørgensen, Statistics Denmark, Copenhagen, October 1993).

Appendix 1a

Ranking of industrial products as to energy and resources

Based on mean value of production and supply quantities

Introduction

In this appendix the commodity groups are listed according to the average ranking in relation to loss of resources and energy consumption.

The calculation of loss of resources and energy consumption is based on the mean value of production and supply quantities, cf. section 1.3 (page 29) in the main report.

The table includes all 966 commodity groups.

Explanation of the table:

In the table the following information is provided:

First column:

The number and title of the commodity group

Second column

The environmentally harmful substances contained in the products of the commodity group (cf. section 1.6). The substances are stated as the following abbreviations: Cu (copper), Pb (lead), Cd (cadmium), Ni (nickel), Pht (phthalates).

Third column:

Uncorrected commodity quantities in tonnes, i.e. quantities have not been multiplied by correction factor. The quantities stated represent the mean value of the production and supply quantities of each commodity group.

Fourth column:

Calculated loss of resources in tonnes
Ranking according to loss of resources exclusively.

Fifth column:

Calculated energy consumption in GJ (Gigajoule)
Ranking according to energy consumption exclusively.

Sixth column:

Final ranking calculated on the basis of the sum of ranking according to loss of resources and ranking according to energy consumption.

It should be noted that more than one commodity group can have the same ranking. The detailed calculations of each commodity group are shown in Appendix 2. For further information of each commodity group, see Appendices 4 and 5.

It is also noted, that the ranking presented in this translation of the original report deviates slightly from the original ranking. In fact the final ranking for a number of commodity groups differs by 1 position from the original ranking. This difference comes from that the list is based on a recalculation in which the material composition of commodity group 85062 "insulated wires and cables" has been changed. The final ranking (33) for group 85062 has, however, remained unchanged.

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY		LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking		
27003	Coal	5709675	5709675	1	91354792	8	1	
27009	Oil for combustion	5127061	5127061	2	102541210	7	1	
27008	Petrol and petroleum	Pb	2271177	2271177	3	45423530	13	2
27011	Petroleum gas and natural gas		2087119	2087119	4	43829488	14	3
89003	Ocean-going cargo ships	Ni, Cu, Pb, Pht, Cd	250281	96046	21	286109548	3	4
84005	Compression-ignition engines	Cu, Ni, Pb, Pht, Cd	6630	79431	25	752037725	2	5
89004	Refrigerator ships (gas tankers)	Ni, Cu, Pb, Pht, Cd	84973	62567	29	246781215	4	6
84285	Machinery for treatment of textile	Ni, Cu, Pb, Pht, Cd	1791	219426	12	16703272	34	7
25011	Cement	Pb	1642569	1642569	5	11497980	43	8
31006	Mixed fertilizers		885427	885427	7	9739697	50	9
31003	Nitrogenous fertilizers		406911	406911	10	10172763	49	10
87004	Motor cars and vans < 3500 kg	Ni, Cu, Pb, Pht, Cd	46683	23563	51	29103196	20	11
84021	Refrigerators, freezers and other freezing equipment	Cu, Pb, Cd	51526	20310	59	40796957	15	12
28006	Ammonia		156523	153392	15	6902655	60	13
27014	Asphalt and other bituminous mixtures		2375529	118776	18	7252491	58	14
94020	Lighting fittings - incandescent lamps	Ni, Cu, Pb, Pht, Cd	6987	12881	81	188526369	5	15
48019	Other articles of cardboard and paper		418936	21994	58	16752873	33	16
68014	Articles of concrete or artificial stone		1975453	592636	8	3950906	83	16
38013	Ready mixed concrete and mortars	Pb	2387822	940802	6	3688325	91	17
84084	Washing machines	Ni, Cu, Pb	5801	37232	41	6797978	61	18
23006	Oil-cakes and similar residues		1321516	13347	77	15341395	35	19
94013	Other lighting fittings (not incandescent lamps)	Ni, Cu, Pb, Pht, Cd	4309	9415	103	63234008	9	19
2002	Meat of mammals, fresh or chilled		563568	11497	87	23120019	28	20
94008	Furniture of fibreboards		135311	34842	43	4902473	73	21
73006	Other pipes of iron and steel		370841	37084	42	4450086	76	22
49004	Newspapers and periodicals		388266	11648	86	14932983	37	23
76009	Profiles, sheets, pipes etc of aluminium		54288	13281	78	10294633	47	24
48007	Paper and cardboard coated with chalk etc		113485	22403	54	4588610	74	25
84087	Casting machines	Ni, Cu, Pb	84	258300	11	2169901	118	26
85050	Television and video apparatus	Ni, Cu, Pb, Cd, Pht	11595	10578	93	12113530	41	27
39012	Plates, film etc, mainly of PE		55577	54169	33	2827841	103	28
39022	Various bags etc. of plastics		55971	55950	31	2559753	108	29
86005	Diesel-electrical trains (IC3)	Ni, Cu, Pb, Pht, Cd	4366	10145	95	11161157	44	29

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
			Tonnes	Ranking	GJ	Ranking	
34004	Washing and cleaning preparations etc.	151615	67789	28	2442327	113	30
89002	Passenger ships	9432	8837	110	18527069	31	30
76003	Alu-foil and articles thereof	21468	22089	57	3888977	85	31
16004	Other prepared or preserved meat	109118	13443	76	5268347	71	32
85062	Insulated wires and cables	33815	22366	55	3326574	96	33
87006	Motor vehicles for the transport of goods	12743	6785	132	31262144	19	33
68012	Articles of plaster	199306	187347	13	1564947	139	34
73011	Structures of iron and steel	192065	24392	50	2612077	106	35
23002	Flours, meals and pellets of meat or fish etc.	368572	7519	120	13429433	40	36
39037	Other articles of plastics	24594	24594	49	2459350	112	37
84105	Vending machines	2291	15428	68	3496778	93	37
27010	Lubricating oils with more than 70% mineral oil	71056	68285	27	1585676	136	38
39017	Plates, sheets, film etc of other plastics	32634	32602	47	2377842	116	38
22005	Bottled beer	608762	13928	72	3178224	100	39
27013	Petroleum coke	85000	85000	23	1360000	152	40
68008	Rock wool and similar mineral wool	100028	100028	20	1300358	155	40
32003	Paints, not based on water	50572	56134	30	1380905	148	41
68010	Articals of asphalt and similar materials	45013	22732	53	1633719	132	42
21014	Composite food preparations	32444	12237	85	3018418	101	43
4009	Cheese	219057	6966	129	7028514	59	44
39026	Other articles f/conveyance&packing of plastic goods	27452	27428	48	1436148	143	45
72019	Steel reinforcement	107141	53571	34	1285692	157	45
23009	Animal feed - not for cats and dogs	628543	6285	138	8743233	54	46
49002	Brochures, leaflets and printed matters	215698	6471	137	8295896	55	46
57008	Tufted carpets with pile of polyamide	19495	19690	60	1586772	135	47
25007	Broken stone and macadam	1419012	425703	9	993308	189	48
32004	Paints based on water	39459	43800	37	1203610	166	49
69003	Bricks, tiles and gutters etc	456124	182449	14	912247	194	50
85022	Light beam and plasma welding apparatus	2049	6847	131	4428855	77	50
89010	Lightships	1709	4611	166	11828996	42	50
89005	Barges and floating cranes, not selfpropelled	26771	5798	148	5994610	65	51
15002	Cooking oils	74607	6221	139	4279837	79	52
94006	Furniture of metal	43241	10045	97	1882931	125	53

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
23008	Cat and dog food	Pb	75877	8422	113	2471964	110	54
87002	Tractors and similar vehicles	Ni, Cu, Pb, Pht, Cd	7337	4400	171	9424818	52	54
84036	Dish washing machines	Ni, Cu, Pb	2231	5636	149	4355425	78	55
27002	Anthracite		54544	54544	32	872704	198	56
22013	Ethanol		19879	19481	61	1184472	170	57
84104	Machines for manufacture of cement and concrete etc	Ni, Cu, Pb, Cd	12165	2752	221	49298207	10	57
89011	Other floating structures	Ni, Cu, Pb, Pht, Cd	6742	2846	218	38908318	17	58
84102	Data processing machines	Ni, Cu, Pb, Cd	4698	4526	168	5056987	72	59
94003	Seats, whether or not convertible into beds	Ni, Cu	27518	13604	74	1191369	168	60
94005	Furniture of wood		74782	7628	119	1919043	123	60
39033	Windows/Venetian blinds & other equipm of plastics	Ni, Cu, Pb	20039	18638	63	1018222	182	61
83005	Mountings, fittings for windows, doors etc	Ni, Cu, Pb	19171	19363	62	1017677	183	61
4002	Milk and cream, concentrated		545013	5614	150	3253661	97	62
48004	Corrugated paper and cardboard		343440	3328	203	10859538	45	63
68015	Articles of asbestos cement		88295	78583	26	734615	222	63
17002	Sugar		377391	3812	187	6720691	62	64
73022	Ovens, radiators etc	Cd	20823	2739	223	22334726	29	65
70010	Articles of fibre glass and fibre tissue		33088	33088	46	794112	211	66
76004	Structures, door frames etc of aluminium	Ni	13975	6501	136	1947500	122	67
73007	Articles of iron and steel with zinc coating		100723	10072	96	1208670	163	68
4003	Milk and cream, condensed/powder	Pb	43778	7749	118	1429378	144	69
84002	Central heating boilers	Ni, Cu, Pb, Pht	20244	2412	237	23924492	26	70
23010	Vitamin and antibiotic mix for animals		16256	7462	122	1451402	142	71
2003	Meat of mammals, frozen		151944	3100	209	8207894	56	72
44021	Doors and windows of wood		61499	14575	70	897631	195	72
32006	Sealing compounds, painters' fillings etc.	Pb	42127	42551	38	698097	229	73
85028	Stoves and ovens for households	Ni, Cu, Pb, Pht, Cd	7631	2094	248	28471845	21	74
34007	Artificial waxes and prepared waxes		18428	18445	64	812962	210	75
38028	Other products from the chemical industry		33109	33109	45	695279	230	76
85002	Electric motors and generators	Ni, Cu, Pb, Cd	13192	1618	278	1391146028	1	77
95004	Constructional toys of plastics	Ni, Cu, Pht	11674	11230	88	924561	193	78
72012	Profiles of iron/non-alloy steel		90049	9005	106	1080588	176	79
84053	Other handling, loading or unloading	Ni, Cu, Pb, Pht	20951	2493	231	9441428	51	79

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
			Tonnes	Ranking	GJ	Ranking	
machinery							
40008 New tyres of rubber for cars, buses etc	Ni	11600	9813	99	1014655	184	80
84025 Other refrigerator and freezer equipment	Ni, Cu, Pb, Cd	5965	1734	267	40724685	16	80
28009 Inorganic acids		189501	106121	19	530937	265	81
39023 Bulbs, bottles, flasks etc of plastics	Pb	15054	15039	69	744295	219	82
23003 Bran and similar vegetable residues		195522	3989	180	2470563	111	83
94012 Plastic lamps&lighting fittings(not incandescent lamps)	Ni, Cu, Pb, Pht, Cd	920	2314	243	10196410	48	83
84013 Ventilators	Ni, Cu, Pb, Cd	7056	1728	268	25618163	25	84
68009 Expanded clays		237317	94927	22	474633	276	85
73015 Cans, boxes etc of iron/steel	Pb	83547	8354	114	1011571	185	86
39011 Self-adhesive plates, sheets, foils etc of plastics	Pb, Pht	15855	15596	67	687867	233	87
15003 Margarine and other fats and oils		94650	2932	214	3728853	87	88
3002 Fish, fresh or chilled		139334	4096	177	1830519	127	89
39021 Boxes etc of plastics for packing of goods	Pb	13490	13608	73	692545	232	90
44011 Particle boards coated with plastics		104922	4238	175	1676041	131	91
48010 Paper and cardboard treated/coated with plastics		25557	5878	145	1205143	164	92
39006 Inflexible pipes and hoses of plastic & fittings	Pb	14230	14217	71	667394	240	93
44028 Other articles of wood		98425	4921	160	1288377	156	94
39004 Seamless inflexible tubes, pipes & hoses of plastic	Pb	13458	13446	75	642024	245	95
31005 Potassic fertilizers		125581	125581	17	376743	306	96
90005 Apparatus for photographic laboratories	Ni, Cu, Pb, Pht, Cd	951	3562	195	1701859	129	97
39015 Flexible plates, sheets, film etc of PVC	Pb, Pht	13079	13067	79	622192	249	98
70004 Multiple-walled, insulating units of glass	Ni, Cu	41661	37245	40	431607	291	99
28004 Carbon dioxide		33975	34030	44	438726	288	100
39034 Office & school supplies of plastics	Ni, Pb, Pht	16122	11214	89	641238	246	101
70002 Flat glass		50362	45325	36	402892	300	102
94011 Eiderdowns, pillows and similar furnishing		8500	7038	127	814125	209	102
4005 Milk and cream, acidified		183373	3814	186	1370197	151	103
38004 Pesticides	Cu	21758	9824	98	654890	241	104
39007 Inflexible pipes and hoses of plastic, not seamless	Pb	12285	12275	84	580293	255	104

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
16003	Preserved sausages	Pb	34879	5894	144	870207	199	105
85014	Vacuum cleaners	Ni, Cu, Pb, Pht, Cd	1955	1911	256	3716542	89	106
20008	Jams, purées of fruit	Pb	34316	8897	109	678509	238	107
94019	Lighting fittings of plastics - candescent lamps	Ni, Cu, Pb, Pht	743	1533	286	6004445	64	108
21012	Composite sauces		29466	5318	154	872825	197	109
57009	Tufted carpets with pile of PP		11073	11184	90	552004	263	110
72004	Zinc-coated sheets of iron/non-alloy steel		52410	6656	134	743698	220	111
85003	Electr generating sets w/internal combustion engine	Ni, Cu, Pb, Pht, Cd	2679	2525	229	1777506	128	112
69006	Unglazed stoneware		9474	9474	100	568410	259	113
84050	Trucks	Ni, Cu, Pb, Pht, Cd	7914	1821	262	3234049	98	114
27006	Coke and semi-coke		23293	23293	52	372680	309	115
39030	Bowls, buckets and pots of plastics	Pb	10697	10697	92	518677	269	115
84109	Valves	Ni, Cu, Pb	19323	3306	204	1233094	159	116
87013	Trailers and semi-trailers	Ni, Cu, Pb, Pht	23707	5609	151	761662	214	117
73004	Tubes and pipes of cast iron		59185	5919	143	710220	225	118
44015	Plywood		50720	2637	225	1387807	146	119
16006	Preserved fish	Pb, Pht	34758	5129	158	751772	216	120
48012	Towels, napkins for babies, tampons etc of paper		19333	6770	133	654420	243	121
87003	Buses	Ni, Cu, Pb, Pht, Cd	3700	1558	284	3614476	92	121
16005	Preparations of minced meat etc.	Pb	29917	3470	197	1035469	180	122
30010	Other pharmaceutical substances		6548	6548	135	654750	242	122
39013	Plates, film etc, mainly of acrylic pl/PP		8042	8036	115	559825	262	122
72002	Tin-coated sheets of iron/non-alloy steel		53786	5863	146	692758	231	122
25009	Gypsum	Pb	38820	38785	39	290013	339	123
84051	Passenger and goods lifts	Ni, Cu, Pb, Cd	3436	1491	290	3717662	88	123
40012	Retreaded tyres of rubber	Ni	7445	7222	123	576392	256	124
44017	Packing cases, boxes etc of wood	Ni	68152	3408	200	1061800	179	124
73019	Galvanized nails etc of iron/steel wire		15776	15820	66	355393	313	124
84081	Printing machinery	Ni, Cu, Pb, Pht, Cd	1124	3041	213	1164152	171	125
85060	Fluorescent tubes and vapour lamps	Ni, Cu, Pb	813	928	357	23448811	27	125
74002	Rods, sheets, pipes etc of brass	Pb, Ni	21982	2193	245	1561613	140	126
94017	Prefabricated buildings	Ni, Pb, Cu, Cd	18499	9471	101	452745	284	126

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
84045	High-pressure cleaners	Ni, Cu, Pb, Cd	3461	1274	305	4111505	81	127
85041	Magnetic tapes	Ni, Cu, Pb	4641	7983	116	507417	270	127
22006	Beer in containers		234237	2366	240	1386352	147	128
2005	Meat of poultry, frozen		74661	1523	288	2585265	107	129
64008	Footwear - uppers of leather - soles of other material	Pb, Cu	6917	4718	164	683248	235	130
39005	Flexible pipes and hoses of plastics	Pb, Pht	8950	8949	108	427428	293	131
22003	Bottled mineral water containing added sugar	Pht	250729	4649	165	680626	237	132
35003	Glue, paste and other adhesives	Pb	8883	11102	91	356143	312	133
39016	Plates, sheets, film, strip etc of cell plastic	Pb, Pht	7194	7193	124	463708	280	134
94010	Mattresses	Ni	7375	4767	162	642529	244	135
34009	Candles		8680	8767	111	408839	297	136
2006	Meat of mammals, salted		66457	1356	300	2383911	115	137
32007	Printing inks	Pb	9171	9171	105	357340	311	138
27007	Mineral spirits		11220	12455	83	294541	336	139
25006	Granite		277033	83110	24	193923	399	140
94018	Other furniture		5223	5223	157	522250	268	141
19009	Cookies, bisquits and wafers etc.	Pb	40745	1776	265	1230019	161	142
86002	Electrical locomotives etc	Ni, Cu, Pb, Pht, Cd	2028	645	396	19170229	30	142
84097	Machine-tools for working wood, cork etc	Ni, Cu, Pb, Cd	1943	1325	303	1890145	124	143
29003	Organic solvents without halogens		7944	7943	117	353327	314	144
56006	Needle felt of wool and other animal hair		6957	7026	128	380953	305	145
19007	Roasted or swelled cereals etc.		29927	2140	247	1009634	187	146
84022	Cold, frozen food counters and racks	Ni, Cu, Pb, Cd	3832	960	350	3840836	86	147
22014	Spirits in containers < 2 litres	Pb	20201	1649	275	1221581	162	148
11003	Starches		79261	1664	271	1197861	167	149
69010	Statuettes etc	Pb	9219	9449	102	289584	340	150
90004	Photocopying apparatus	Cu, Pb, Pht, Cd	1570	1142	323	2155169	119	150
73018	Screws, nails, tacks, pins etc of iron/steel		16343	16388	65	223165	378	151
84015	Air compressors	Ni, Cu, Pb, Cd	2249	584	412	16953776	32	152
94015	Illuminated signs, illuminated name-plates & similar	Ni, Cu, Pb, Cd	1356	1141	324	2062027	121	153
16002	Sausages and similar products of meat	Pht	33264	1376	299	1378840	149	154
84068	Combine harvesters	Ni, Cu, Pb, Cd	6195	900	364	3894008	84	154

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
			Tonnes	Ranking	GJ	Ranking	
4008	Butter	55986	1187	316	1595204	134	155
84072	Milking machines and dairy machinery	1901	730	383	5486556	68	156
27012	Paraffins and waxes	7132	7132	126	313808	326	157
85059	Halogen and incandescent lamps	635	530	429	27555077	23	157
84016	Ventilating apparatus	3651	559	418	14298385	38	158
89001	Misc. ships, boats and floating structures	4413	4413	170	441300	287	159
48009	Paper and cardboard with glued surface	18150	3087	210	610408	250	160
84107	Miscellaneous other machines	6420	971	348	2194053	117	161
21015	Ice cream	55057	2400	239	702035	227	162
84011	Compressors for refrigerators	1381	437	461	173394968	6	163
84057	Self-propelled shovel loaders	4281	643	398	5447582	69	163
69008	Sanitary articles, tableware etc of porcelain or china	6107	6197	140	303957	330	164
84008	Submersible and circulating pumps etc	12577	2060	250	743149	221	165
69002	Ceramic products	5512	5512	152	330720	320	166
84076	Machinery for the food industry	4379	549	422	9089283	53	167
20003	Preserved vegetables	29462	5233	156	328940	321	168
19011	Rye bread	128778	1248	308	1157732	172	169
69007	Glazed stoneware	5263	5263	155	315750	325	169
84085	Tumblers	2154	605	405	4554279	75	169
3003	Fish, crustaceans, fresh, frozen	89555	927	358	1875369	126	170
76008	Other articles of aluminium	12297	12912	80	187222	405	171
44009	Parquet blocks	33895	1695	269	746697	218	172
32002	Wood preservatives	8077	8964	107	220537	381	173
38011	Organic composite solvents and thinners etc.	5077	5077	159	307514	329	173
76005	Drums, tins etc of aluminium	3472	1927	254	684249	234	173
23005	Mash, dregs and similar residues	106215	1073	333	1233043	160	174
61012	Sweaters, waistcoats, pullovers etc	7551	1209	314	1030289	181	175
62013	Women's trousers, knickers, overalls	3977	3042	212	444124	286	176
85043	Compact discs	691	4563	167	295954	335	177
89006	Fishing vessels and factory ships	1555	669	389	2426920	114	178
44014	Coated fibre boards	31172	1574	283	731682	224	179
73021	Stoves and similar for liquid/solid fuel	2514	690	388	2112502	120	180
85035	Loudspeakers	8765	2082	249	565046	261	181
20002	Vegetables preserved by vinegar	24094	3784	190	325554	322	182

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
72008	Painted/lacquered/plastic-coated sheets	Pb, Pht	25720	3498	196	344442	316	182
22008	Wine in containers < 2 litres	Pb	33895	6159	141	234001	372	183
73013	Insulated sandwich sheets	Pb, Pht	11707	6857	130	219351	383	183
22009	Wine in containers > 2 litres		32818	5963	142	226562	374	184
85023	Electric water heaters or immersion heaters	Ni, Cu, Pb, Pht	1894	405	471	10630908	46	185
87011	Bicycles	Ni, Cu, Pb	5195	2921	215	396364	303	186
21013	Soup and broth		10914	1844	260	566205	260	187
25008	Granulates of marble and granite		153127	49154	35	107189	485	187
84001	Miscellaneous reactors, boilers, machinery		3364	3364	202	336350	318	187
20013	Fruit juice added sugar		58823	1888	259	534003	264	188
84096	Machine-tools for flattening of metal	Ni, Cu, Pb, Cd	4018	848	368	1252816	158	189
39036	Colostomy and urine bags of plastics	Pht	4292	3767	191	292076	337	190
44004	Timber of tropical wood		9361	9361	104	159129	424	190
33004	Hair care preparations, body shampoo etc.		10669	5329	153	223709	376	191
84092	Machine-tools for drilling, boring, milling of metal	Ni, Cu, Pb, Cd	1275	790	375	1318037	154	191
90010	Syringes	Ni	2453	2540	228	400833	302	192
20014	Fruit juice not added sugar		60274	1935	253	464103	279	193
38014	Anti-freezing preparations		3912	4263	173	254175	359	193
16009	Fish eggs	Pb, Pht	7540	4430	169	240359	367	194
84049	Cranes	Ni, Cu, Pb, Cd	7835	1005	343	885179	196	195
33007	Miscellaneous hair care preparations		4660	4747	163	223313	377	196
86009	Containers for transport	Ni, Pb, Cu, Cd	25489	2625	226	346133	315	197
84064	Grass mower	Ni, Cu, Pb, Cd	3869	507	436	2538488	109	198
19012	Pastry with limited sugar content		84365	817	372	1091608	175	199
40003	Sheets, profiles, mats and strips of rubber		3475	3247	205	287023	342	199
90002	Proces-work cameras	Cu, Pb	395	2904	216	301427	331	199
39002	Monofilaments, rods, sticks and profile shapes of plactics	Pb	3542	4001	179	231838	373	200
57007	Tufted carpets with woolen pile		4885	3208	206	279381	346	200
84006	Hydraulic and pneumatic machines	Ni, Cu, Pb, Pht, Cd	1333	1020	339	770843	213	200
84075	Machines for working of cereals	Ni, Cu, Pb	3450	452	457	3374487	95	200
85001	Miscellaneous electrical machinery and equipment		2875	2875	217	287500	341	201
25010	Limestone		158284	147204	16	73646	548	202

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
56015	Fishing nets of polyamide	2247	2247	244	322193	323	203
72017	Rods, wires etc of other alloy steel	8947	895	365	849965	204	204
7002	Vegetables, frozen	57805	1172	319	588084	252	205
39027	Disposable plates of plastics	3774	3800	189	219672	382	205
85036	Electric amplifiers	714	552	421	1374474	150	205
40007	Conveyor or transmission belts of rubber, other than hard rubber	3863	2771	220	265716	353	206
48005	Solid cardboard	32178	650	395	1066340	178	206
84307	Floor cleaning machinery	996	602	406	1191088	169	207
3004	Fish, smoked	14158	1598	281	422969	295	208
38012	Catalytic preparations	4828	3983	181	199134	395	208
85052	Burglar and fire alarms	228	248	543	15212633	36	209
18003	Chocolate, filled	16447	1209	314	529396	266	210
85013	Electro-mechanical tools for working in the hand	798	501	439	1464280	141	210
21017	Fruit juice, concentrate	25403	2744	222	253040	360	211
16011	Foodstuffs of liver	16435	1075	332	590481	251	212
29006	Organic chemicals to be used for decalcification	5837	5837	147	144758	436	212
48003	Toilet and towel tissue, cloths etc of paper	52729	559	418	1204588	165	212
62001	Articles of apparel, not knitted fabric	2555	2555	227	255450	356	212
84027	Industrial drying devices	2113	198	573	46589984	12	213
69011	Other articles of ceramics	12535	12629	82	97806	504	214
39009	Fittings of plastic	3955	3953	184	181874	407	215
44016	Other veneered or laminated wood	18513	1481	293	404759	299	216
23007	Vegetable residues and by-products of fruit etc.	40350	847	369	706350	226	217
85004	Wind turbines	9337	2161	246	271370	349	217
39014	Inflexible plates, sheets, film etc of PVC	3814	3810	188	181446	409	218
73014	Tanks, casks and drums etc of iron/steel	17071	2161	246	261868	354	219
16008	Fish, perishables	12639	1902	257	283166	344	220
84080	Offset machines	349	943	354	640668	247	220
85011	Lead accumulators	6862	3980	182	164850	422	221
90001	Misc optical, photographic apparatus & similar	2406	2406	238	240550	366	221

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
			Tonnes	Ranking	GJ	Ranking	
25004	Slate	8496	8496	112	101946	493	222
85058	Control and distribution boards/panels	4073	2026	251	258750	355	223
16007	Preserved fish, frozen	19928	1105	327	457752	282	224
39025	Lids, caps and other closures of plastics	3433	3431	198	171993	416	225
94009	Furniture of plastics	2991	3081	211	189656	403	225
19014	Cakes, Danish pastry and similar products	24205	783	376	671492	239	226
85007	Static converters	864	165	594	27657381	22	227
40011	New tyres of rubber for tractors etc	3177	2356	241	221893	379	228
20007	Deep-fried vegetables	12238	1020	339	433007	289	229
48006	Composite paper and cardboard	26413	534	426	850221	202	229
86004	S-train and similar self-propelled coaches	505	351	494	1573842	137	230
21007	Inactive yeasts a.o. single-cell micro org.	5298	1516	289	282654	345	231
83016	Wire and electrodes for welding of steel	3617	3689	192	141614	442	231
84044	Irrigation systems etc	6330	2491	232	189769	402	231
84032	Other machinery for processing of materials	979	199	572	6331085	63	232
84004	Spark-ignition engines	582	209	567	5344021	70	233
17009	Sweats, wine gum and similar with sugar	21375	718	385	586606	253	234
56013	Twine and ropes of PE or PP	3253	3176	208	149333	430	234
85027	Microwave ovens for households	1066	318	510	1631681	133	235
85021	Industrial furnaces	219	110	626	35926438	18	236
23004	Beet-pulp and similar residues	41666	437	461	1010772	186	237
84073	Machines for production of animal feed	2070	302	518	1679145	130	238
17007	Chewing gum with sugar	5124	1173	318	300837	332	239
63009	Tarpaulins and sunblinds	2287	1811	263	214923	388	240
84026	Water heaters and heat exchangers	6722	916	361	432666	290	240
85039	Tape recorders & other sound reprod apparatus	1047	722	384	487554	273	241
34003	Surface-active agents	3668	3191	207	133504	451	242
73008	Pipes, cables etc of stainless steel	8963	448	458	851438	201	243
85024	Electr space heating apparatus	484	79	651	47202782	11	244
88002	Passenger planes > 15 t	58	115	623	14019938	39	244
84077	Machinery for manufacture of paper and cardboard	514	95	639	27452043	24	245
84020	Industrial furnaces, non-electric	612	644	397	529274	267	246
63008	Sacks and bags for packing	2912	1796	264	191927	401	247

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
68011	Building materials of mastic etc.	9524	7143	125	75716	542	248
84091	Lathes for metal	835	390	476	948765	192	249
85031	Electro-thermic household appliances	454	348	496	1073343	177	250
44008	Profiled wood except parquet blocks	17464	1235	310	243236	365	251
73002	Sheet piling and profiles of iron and steel	16168	1617	279	194010	398	252
84048	Jacks	4014	705	386	429028	292	253
39020	Toilet seats and covers of plastics	2500	2484	233	135605	447	254
84074	Other agricultural machinery	1477	266	536	1409272	145	255
85061	Electroplating machinery	92	1735	266	173876	415	255
87017	Other vehicles, not mechanically propelled	8735	1659	273	181678	408	255
20010	Fruit preserved by sugar and sweetened cereal	11176	1899	258	150173	428	256
40015	Inner tubes & interchangeable tyre treads of rubber	2467	1831	261	155521	427	257
40006	Textile-reinforced tubes and hoses of rubber	1751	1669	270	167507	421	258
95009	Miscellaneous toys of plastics	2310	2452	235	130495	456	258
31004	Phosphatic fertilizers	22194	22194	56	44387	637	259
84106	Machines for working rubber and plastics	1146	173	588	2682408	105	259
40020	Other articles of rubber	2190	1734	267	146042	435	260
56009	Non-wovens, not coated, covered or laminated	2045	2024	252	133786	450	260
63010	Tents	2120	1453	295	180372	410	261
34006	Lubricating preparations without oil	3800	3417	199	88960	515	262
84043	Spray guns	325	1136	325	208556	391	263
85029	Coffee and tea machines for households	520	414	468	626374	248	263
89009	Tugs and fire-floats	119	319	509	820447	208	264
57011	Tufted carpets with pile of other vegetable fibres	2403	1554	285	147859	433	265
84024	Machinery for manufacture of icecream	427	112	624	3457988	94	265
73005	Oil and gas pipes of iron and steel	9766	977	346	224618	375	266
84103	Other office machines	377	239	548	1131182	173	266
84030	Machinery for heating of foodstuffs	625	69	656	5682988	67	267
30004	Medicaments with insulin	1113	764	378	273727	347	268
69009	Tableware etc of ceramics and stoneware	2362	2421	236	103254	490	269
84034	Purifying machinery for liquids	2293	4264	172	70403	557	270

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
16014	Crustaceans, perishables	Pht	6922	1642	276	131081	455	271
73001	Miscellaneous articles of iron or steel		1442	1442	296	144200	437	272
2004	Meat of poultry, fresh or chilled		14395	445	459	484571	275	273
39010	Floor, wall & ceiling coverings of PVC	Pb, Pht	2507	2507	230	89065	514	274
44002	Wood charcoal and other coal		4130	3841	185	69699	560	275
22004	Non-alcoholic beverages, not soft drink		47980	504	437	370431	310	276
68018	Articles of stone and other minerals		4821	4821	161	57846	592	277
84059	Boring machinery for earth, minerals or ores	Ni, Cu, Pb, Cd	1924	210	566	1001489	188	278
85009	Manganese dioxide batteries	Cu, Pb	1952	1612	280	114445	474	278
68007	Abrasives		2775	1388	298	121823	464	279
70003	Safety glass, except for transport		5028	4230	176	58469	587	280
17008	Liquorice		14566	463	451	332178	319	281
76002	Varnished/coated sheets of aluminium		6153	1655	274	101281	496	281
95020	Paddling pools, playground equipment etc	Ni, Cu, Pb, Pht	3743	1050	337	147255	434	282
72006	Al/Zn-coated sheets of iron/non-alloy steel		9196	1085	329	139404	444	283
17003	Molasses		314507	0	717	7673959	57	284
33008	Preparations for oral and dental hygiene		3321	2823	219	71568	555	284
27004	Lignite and lignite briquettes		3659	3659	193	58536	586	285
85051	Parabolic reflectors	Ni, Cu, Pb, Cd, Pht	1709	471	447	299179	333	286
85063	Optical fibre cables		1384	1410	297	109742	483	286
87008	Crane lorries, fire-fighting vehicles etc	Ni, Cu, Pb, Pht, Cd	864	371	486	409949	296	287
39001	Miscellaneous plastics and articles thereof		1197	1197	315	119650	468	288
44005	Timber of coniferous tree		531285	0	717	5737878	66	288
60006	Knitted fabric with elastic threads		2155	466	449	297349	334	288
84061	Ploughs and similar		5025	657	393	209000	390	288
38002	Activated carbon, activated natural mineral products		3481	3620	194	57924	591	289
84093	Machine-tools for grinding or finishing of metal	Ni, Cu, Pb, Cd	746	414	468	343618	317	289
39032	S Skylights and belonging frames	Pb	1522	986	345	142670	441	290
22016	Vinegar and substitutes		22713	1914	255	79152	534	291
16012	Prepared meat of poultry		12365	344	497	427273	294	292
28005	Nitrogen		86608	177	585	841348	206	292
39028	Tableware etc of plastics, not disposable	Pb	1563	1591	282	95565	509	292
44001	Wood and articles of wood; wood charcoal		1164	1164	320	116400	471	292

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
69005	Glazed ceramics	Pb	10126	4050	178	50630	613	292
84058	Excavators	Ni, Cu, Pb, Pht, Cd	1183	176	586	848841	205	292
85047	Reception apparatus for radio and telephone	Ni, Cu, Pb, Pht, Cd	2309	1197	315	113173	476	292
85056	Electr. apparatus for switching electr. circuits	Cu, Pb	1463	1478	294	100937	497	292
68002	Unpolished, shaped stone		28486	10540	94	29597	701	293
70006	Drinking glasses	Pb	4235	4248	174	48722	621	293
84095	Machine-tools for cutting-off metal	Ni, Cu, Pb, Cd	348	312	513	455384	283	294
27005	Peat (including peat litter)		175002	0	717	4270037	80	295
84019	Ovens, non-electric	Ni, Cu, Pb	200	23	695	2999092	102	295
12002	Oil seeds, misc grains, fodder etc.		240989	0	717	4002345	82	296
30003	Medicaments with antibiotics	Pht	1112	492	442	254438	358	297
62012	Skirts and divided skirts	Pb, Cu	1277	966	349	131904	453	298
84014	Exhaust hoods	Ni, Cu, Pb, Pht	433	175	587	756469	215	298
61011	T-shirt and vests		3924	243	545	570966	258	299
62008	Men's trousers, working clothes	Pb, Cu	1722	542	424	221035	380	300
94002	Swivel chairs		3096	936	356	135039	448	300
84018	Furnaces, non-electric	Cu, Pb	239	268	534	493633	271	301
11002	Cereal flours and grains		348902	0	717	3698356	90	302
29004	Organic solvents with chlorine		1532	1532	287	86070	522	303
61001	Articles of apparel, knitted or crocheted		1099	1099	328	109850	481	303
72007	Al-coated sheets of iron/non-alloy steel		8132	960	350	123281	462	304
85006	Electrical transformers with liquid insulation	Cu, Pb	2660	966	349	121867	463	304
96006	Brushes and brooms for households	Cu, Pb, Ni	1850	1211	312	98996	501	305
84088	Rolling mills and rolls for metal	Ni, Cu, Pb, Cd	758	370	487	310142	328	306
4006	Whey		1834648	0	717	3233383	99	307
85033	Telephone apparatus	Ni, Cu, Pb, Pht, Cd	806	811	373	140816	443	307
61017	Socks and stockings of knitted fabric		1468	518	433	218102	384	308
84035	Purifying machinery for gases	Ni, Cu, Pb	1328	215	564	580344	254	309
78002	Articles of lead	Pb	2827	1076	331	104319	489	310
96001	Miscellaneous manufactured articles		1059	1059	334	105900	486	310
21010	Tomato ketchup		10510	1008	342	110667	479	311
44010	Particle boards		213530	0	717	2733178	104	311
39029	Household article, table cloths etc of plastics	Pb, Pht	2133	1231	311	92189	511	312
84052	Pneumatic lifts etc	Ni, Cu, Pb	1086	119	620	850208	203	313
48014	Carbon paper etc		8412	336	501	317888	324	314

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
68004	Polished, shaped stone	12935	7502	121	28651	704	314
61008	Women's slips of knitted cotton fabric	1529	496	440	215816	386	315
85045	Transmission apparatus for radio-telephony	511	144	605	731766	223	316
68001	Misc. articles of stone, plaster etc	1031	1031	338	103050	491	317
84100	Electrical typewriters	245	389	477	267472	352	317
76007	Kitchenware and household articles of aluminium	909	529	430	192698	400	318
84082	Doubling or twisting machines	174	26	692	1573013	138	318
85025	Hair and hand dryers	136	95	639	959321	191	318
39024	Spools for film, tape etc of plastics	1485	1483	292	75941	539	319
61014	Track suits	1099	638	400	148177	431	319
87010	Mopeds, motor-cycles, scooters	494	405	471	245470	364	320
62007	Men's trousers, knickers, overalls	1648	461	452	216166	385	321
57012	Carpets of felt	1221	1184	317	84731	525	322
94007	Medical, surgical, dental or veterinary furniture	2541	732	382	123509	461	323
69004	Moler-based products	8500	3400	201	42500	643	324
16013	Shrimps, shelled, frozen	16483	493	441	187273	404	325
29005	Organic chemicals as coolants, propellants etc.	1330	1330	301	74746	544	325
63001	Other made-up textile articles	988	988	344	98750	502	326
84039	Packing or wrapping machinery	686	85	646	860751	200	326
24004	Tobacco	3923	966	349	99247	498	327
52003	Woven fabrics of cotton, min. 85 weight% of cotton	5266	98	636	771201	212	328
73023	Household articles of iron/steel	7576	828	371	110190	480	329
84033	Centrifuges	547	45	677	1125107	174	329
85040	Magnetic tape equipment for video recording	743	511	435	168961	419	330
57010	Tufted carpets with pile of other chemical fibres	1290	1302	304	72025	552	331
62015	Men's shirts	1880	349	495	251548	361	331
63003	Bed linen	3120	193	576	461632	281	332
84078	Machinery for making up paper and cardboard	588	79	651	831531	207	333
84090	Machining centres	330	226	557	401307	301	333

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
		Tonnes	Tonnes	Ranking	GJ	Ranking		
62016	Women's blouses and shirts	Pb, Cu	1470	601	407	130282	457	334
74006	Semi-manufactures of refined Cu	Cu	3433	342	498	238312	368	335
83012	Frames and mirrors	Ni, Cu, Pb	2100	1327	302	67387	565	336
19005	Pasta, not cooked or stuffed		8611	452	457	176876	413	337
44006	Timber of Nordic foliferous tree		94405	0	717	1321670	153	337
37003	Offset plates	Cu, Pb	1487	290	523	270114	350	338
40018	Gaskets of rubber, other than hard rubber		1013	943	354	87855	519	338
2007	Meat of mammals, smoked		6034	317	511	246098	363	339
84038	Machinery for filling of bottles	Ni, Cu, Pb	549	85	646	698621	228	339
22002	Bottled water	Pht	62057	1150	322	71837	554	340
24002	Cigarettes		9943	280	527	268783	351	341
34008	Polishes and creams		2298	1661	272	53211	606	341
33006	Hair spray	Pb	967	1210	313	66245	567	342
40005	Metal-reinforced tubes&hoses, other than hard rubber		988	744	380	99081	500	342
83002	Locks	Ni, Cu,Pb	1306	653	394	104897	488	343
87007	Tankers	Ni, Cu, Pb, Pht, Cd	532	177	585	406462	298	344
54007	Woven fabric v/more than 85% synthetic fibres		970	633	401	109011	484	345
74008	Other articles of copper	Cu	3113	310	515	236643	370	345
28002	Oxygen		62193	127	615	492266	272	346
54003	Woven fabric of strips of PE/PP		1256	1268	307	60962	580	346
44018	Wooden frames		2986	1055	335	71853	553	347
30006	Medicaments w/vitamins in packings for retail sale	Pht	1070	574	416	114791	473	348
56001	Miscellaneous wadding, felt, ropes etc		858	858	367	85750	523	349
70007	Tableware, toilet articles etc of glass	Pb	2716	2725	224	36947	667	350
68013	Decorated articles of plaster		3954	3954	183	27675	710	351
62020	Other working clothes for men	Pb, Pht, Cu, Cd	962	624	402	101529	495	352
59003	Linoleum with textile backing		2661	841	370	84323	528	353
18002	Chocolate, not filled		5178	326	508	207876	392	354
39031	Tanks, vats & similar containers of plastics		1272	1271	306	56961	594	354
76006	Aluminium wire with steel core	Ni	1266	327	507	206175	393	354
38017	Binders for foundry moulds or cores		2338	2338	242	38343	661	355
56011	Twine and ropes of agave fibres		3077	308	516	215534	387	355

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
36003	Fireworks	2076	922	359	74384	546	356
56004	Wadding of chemical fibres	1006	1015	341	67843	564	356
49003	Books and journals	25260	0	717	983789	190	357
85026	Electric irons	172	106	630	468789	278	358
85206	Dry transformers	2970	458	455	131263	454	359
64004	Sports footwear etc of rubber or plastics	732	667	390	87151	520	360
90008	Electro-medical apparatus	368	48	675	682742	236	361
94004	Cane and bamboo furniture etc	2506	952	352	70031	559	361
82006	Cutting tools w/active part of cemented carbide	1540	349	495	171108	418	362
85015	Electro-mechanical domestic appliances	494	370	487	157688	426	362
73010	Pipes of alloy steel	2483	248	543	235838	371	363
21011	Mustard	5234	944	353	66650	566	364
42007	Trunks, rucksacks etc of textile materials	786	699	387	79845	532	364
84031	Cooling towers	236	129	614	375304	308	365
90013	Apparatus for massage and mechanotherapy	282	82	649	484999	274	366
20001	Misc. products of vegetables, fruit or nuts	746	746	379	74550	545	367
87014	Trailers with tank	956	364	488	142876	439	368
60001	Miscellaneous textiles	742	742	381	74150	547	369
56014	Twine and ropes of synthetic fibres	976	953	351	61323	578	370
63013	Made-up textiles, except felt/knitted fabric	815	502	438	101915	494	371
48002	Kraft paper and kraft board	17516	0	717	750124	217	372
79002	Articles of zinc	1827	460	453	109795	482	373
38022	Preparations to prevent deposit of boiler scale	1318	1054	336	54169	600	374
70011	Other articles of glass	2385	2454	234	28695	703	375
85034	Fax machines	148	101	634	386657	304	376
61013	Babies' garments of cotton (knitted fabric)	1282	249	542	183688	406	377
85017	Bicycle lamps, dynamo lamps etc	459	920	360	58372	588	377
20004	Frozen French fries and other prep veget.	13288	276	530	167614	420	378
34002	Toilet soap, soap flakes etc.	10860	230	554	195683	397	379
72005	Chromium-plated sheets of iron/non-alloy steel	6114	611	404	73368	549	380
85257	Other apparatus for electrical circuits	753	580	413	75801	541	381
40016	Rubber tubes for bicycles and vehicles	636	613	403	71046	556	382

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
61005	Women's trousers of knitted fabric	Pb, Cu	929	334	502	124390	460	383
70005	Glass mirrors, except for vehicles	Ni, Cu, Pb	1571	1490	291	35832	671	383
95003	Dolls and accessories	Ni, Cu, Pht	853	873	366	55534	596	383
95015	Christmas decorations and novelty jokes	Cu, Pb, Pht	1217	718	385	61300	579	384
86007	Passenger coaches, not selv-propelled	Cu, Pb, Pht	2608	658	392	63908	573	385
89008	Motor boats	Ni, Cu, Pb, Cd	98	65	659	375909	307	386
84037	Machinery for cleaning of bottles etc	Ni, Cu, Pb	472	39	682	449056	285	387
84047	Anchor winches	Ni, Cu, Pb	1839	201	571	196867	396	387
55007	Woven fabric with less than 85% PE		795	465	450	88270	518	388
73003	Railway construction material of iron and steel		5845	584	412	70134	558	389
49001	Printed books, newspapers, pictures etc		641	641	399	64100	572	390
16010	Preserved crustaceans, in shell or not		5047	453	456	88281	517	391
28010	Inorganic bases		26090	0	717	573969	257	392
82002	Garden and household tools, hand tools etc	Ni	4002	348	496	112136	478	392
20011	Fruit preserved by other than sugar	Pb	5746	483	444	79783	533	393
54005	Woven fabric with more than 85% polyester		653	658	392	58541	585	393
87016	Caravans, not mechanically propelled	Ni, Cu, Pb, Pht, Cd	2152	532	428	72274	550	394
62010	Women's jackets and blazers	Pb, Cu	706	565	417	69042	562	395
62002	Overcoats, raincoats, car-coats etc	Pb, Cu	823	453	456	82597	529	396
95001	Misc toys, games and sports requisites		605	605	405	60450	581	397
3005	Fish, salted		5237	396	474	89200	513	398
30001	Miscellaneous pharmaceutical products		590	590	409	59000	584	399
25002	Salt		45964	0	717	468833	277	400
39008	Reinforced flexible pipes/hosees of plastic & fittings	Pb, Pht	918	909	363	45262	634	401
83008	Safes and strong-boxes etc	Ni, Cu, Pb, Cd	2364	1079	330	36870	668	402
85255	Relays for electrical circuits	Pb, Cu, Ni	1122	521	432	64293	570	403
66002	Garden umbrellas		774	579	414	58083	589	404
84009	Vacuum pumps	Ni	187	69	656	271547	348	405
95017	Balls for games and sports	Pb, Pht	714	588	410	54971	597	406
64009	Footwear with uppers of textile materials	Pb, Pht	652	452	457	72256	551	407
74004	Bolts, screws etc of copper	Cu, Pb	591	588	410	53922	601	408
42010	Articles of apparel etc of leather and artificial leather	Cu, Pb	1639	151	602	178894	412	409

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
55001	Miscellaneous man-made staple fibres	557	557	419	55650	595	409
79003	Other wrought articles of zinc	1404	354	492	84368	526	410
84007	Fuel pumps etc	473	107	629	211206	389	410
17006	Marzipan	5925	311	514	96106	507	411
33001	Miscellaneous cosmetic preparations	543	543	423	54250	599	412
87005	Electrically powered vehicles	241	317	511	91413	512	413
33009	Personal deodorants	737	662	391	45318	633	414
63005	Curtains, interior blinds	937	186	579	137219	446	415
84101	Calculating machines	87	105	631	201860	394	415
87009	Military vehicles	328	155	600	158636	425	415
83017	Other wires and electrodes for welding	417	422	466	69174	561	416
82001	Miscellaneous tools, implements, cutlery etc	535	535	425	53450	604	417
38007	Wood tar, wood tar oils etc.	1246	1246	309	26154	721	418
33002	Perfume, toilet water and similar preparations	674	791	374	38582	658	419
89007	Yachts and other vessels for pleasure or sports	611	488	443	57931	590	420
73016	Containers for compressed and liquefied gas	3194	348	496	75921	540	421
90012	Instruments and apparatus for doctors	593	427	465	64177	571	421
85057	Lamp sockets and plugs	581	587	411	46119	630	422
21006	Active yeasts	12292	0	717	311911	327	423
19010	Rusks and similar toast	6408	142	607	143039	438	424
94014	Non-electric lighting articles	488	512	434	51614	611	424
62003	Windcheaters, anoraks etc	562	377	484	68617	563	425
34005	Lubricating preparations with oil	1212	1111	326	26149	722	426
40010	New tyres of rubber for bicycles, motor cycles etc	561	523	431	49703	618	427
39035	Clothing of plastics	578	501	439	50945	612	428
60003	Knitted fabric of cotton	1024	139	608	138927	445	429
28011	Iron chlorides	28522	0	717	290924	338	430
84062	Sowing machines and fertilizer distributors	2604	289	524	80651	531	430
84056	Graders and levellers	238	33	687	237303	369	431
19004	Flour mix for pastry	8812	176	586	114885	472	432
33003	Beauty or make-up preparations	2510	976	347	27515	711	432
28014	Sodium and ammonium carbonates	28034	0	717	285942	343	433

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING		
		Tonnes	Tonnes	Ranking	GJ	Ranking			
96005	Machine brushes		Pb	1025	598	408	40051	653	434
44020	Tools, tableware and kitchenware of wood			1816	352	493	65366	569	435
62019	Ski suits		Pb, Cu	511	382	481	60127	583	436
40004	Tubes and hoses of rubber, other than hard rubber			768	533	427	44105	639	437
18004	Sweats containing cocoa			4456	96	638	147872	432	438
85020	Bakery ovens, biscuit ovens		Ni, Cu, Pb, Pht, Cd	25	3	714	255424	357	439
90023	Miscellaneous measuring instruments			476	476	445	47600	626	439
63004	Towels, facecloths, dish towels etc.			1162	72	655	171854	417	440
60002	Velvet and plush fabric			944	110	626	134884	449	441
90009	Apparatus for radiation		Cu, Pb, Pht	131	201	571	97474	505	442
60004	Knitted fabric of synthetic fibres			481	383	480	54828	598	443
84069	Harvesting machinery for root crops		Ni, Cu, Pb	1494	195	575	98512	503	443
44013	Fibre boards			12903	0	717	247728	362	444
82008	Table and kitchen knives w/handle of wood/plastics		Ni	475	448	458	48636	622	445
10002	Rice			7909	165	594	105325	487	446
83015	Sign-plates		Ni, Cu, Pb, Pht	1285	250	541	75451	543	447
83003	Other locks, striking plate etc		Ni, Cu, Pb	955	496	440	41826	646	448
84065	Mowers		Ni, Cu, Pb	3090	372	485	53825	603	449
84060	Equipment for excavators		Ni	1841	184	580	93154	510	450
84108	Moulding boxes			3394	364	488	53842	602	450
93002	Steel and lead shots		Pb	941	941	355	23757	737	451
85044	Other media, e.g. sound and video tapes		Ni, Cu, Pb	322	554	420	35150	673	452
52004	Woven fabrics of cotton, max.85%cotton w/chem.f.			865	164	595	99122	499	453
73009	Pipes of alloy steel containing carbon/Cr/Mo			1200	120	619	114000	475	453
61016	Panty hoses			384	300	520	62339	576	454
22012	Fruit wine			5837	469	448	41535	649	455
82005	Tools for extrusion, punching etc		Ni	1028	103	632	120218	465	455
84098	Tolls for working in the hand, pneumatic		Ni, Cu, Cd, Pb	341	86	645	132759	452	455
73024	Household articles of stainless steel		Ni	1314	92	641	126998	459	456
85030	Toasters		Ni, Cu, Pb, Pht	140	99	635	119781	467	457
42006	Trunks, brief-cases etc of plastics/textile materials		Cu, Pb, Pht	442	402	473	45368	632	458

	NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
			Tonnes	Tonnes	Ranking	GJ	Ranking	
84046	Pulley tackles and hoists	Cu, Ni, Pb	346	41	680	150134	429	459
62018	Apparel of coated/covered/laminated textiles	Pb, Pht, Cu	435	377	484	46214	629	460
73020	Screws, bolts etc of stainless steel	Ni	428	429	464	41469	651	461
85064	Carbon electrodes and heating elements	Cu, Pb	925	1017	340	17980	777	462
54004	Woven fabric with more than 85% polyamide		330	332	503	50510	615	463
73012	Towers and lattice masts of iron and steel		2574	396	474	42154	644	463
32005	Artists', students' & signboard painters' colours etc.	Pb	214	770	377	22564	745	464
38026	Preparations for fire&water protection,build industry		868	912	362	20677	761	465
62006	Men's jackets and blazers, working clothes	Pb, Cu	494	249	542	60348	582	466
82011	Hand saws and blades for saws	Ni	1015	147	603	84752	524	467
48018	Paper for calculators etc.		4906	0	717	179371	411	468
85042	Grammophone records	Pb	433	432	463	36975	666	469
68005	Worked up slate		1155	1155	321	13854	809	470
72014	Profiles of stainless steel	Ni	1258	63	661	119463	469	470
48015	Self-copy paper		4972	0	717	174847	414	471
48013	Disposable plates of cardboard		1479	307	517	49814	616	472
28012	Iron and aluminium sulphates		26805	0	717	161356	423	473
64006	Safety footwear etc with uppers of leather	Pb, Cu	458	328	506	44499	635	474
74003	Semi-manufactures of other Cu-alloys than brass	Pb, Cu, Ni	1105	111	625	88370	516	474
39019	Baths, lavatory pans etc of plastics	Pb	474	473	446	29962	697	475
42001	Misc articles of leather and travel goods		382	382	481	38150	662	475
84086	Sewing machines	Ni, Cu, Pb, Pht, Cd	186	55	668	112516	477	476
87001	Miscellaneous vehicles and parts thereof		378	378	483	37800	663	477
84055	Bulldozers	Ni, Cu, Pb, Pht, Cd	180	28	690	129211	458	478
38006	Disinfectants		3237	404	472	34187	677	479
84079	Printing plates for the graphic industries	Ni, Cu	2601	413	469	33294	683	480
83004	Keys	Ni, Cu, Pb	266	267	535	49006	620	481
90024	Thermostats	Cu, Pb, Cd	632	312	513	42903	642	481
90027	Parts and accessories for instruments & machines	Cu, Pb, Cd	844	280	527	46504	628	481
44003	Impregnated material of miscellaneous wood	Cu	11406	0	717	142803	440	482
85053	Electrical capacitors	Cu, Pb, Pht	333	334	502	39566	655	482

NUMBER AND NAME OF COMMODITY GROUP		HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
			Tonnes	Tonnes	Ranking	GJ	Ranking	
85216	Starting motors	Ni, Cu, Pb, Cd	1902	250	541	49749	617	483
90026	Automatic reg instruments except thermostats	Pb, Cu	539	387	478	33656	680	483
38001	Miscellaneous chemical substances		356	356	490	35600	672	484
37002	Photographic plates, film, paper, sensitised	Pb	2577	52	671	102822	492	485
83011	Ornaments etc	Ni, Cu, Pb	499	258	538	47719	625	485
95022	Stalls, carousels and similar fairground amusements	Cu, Pb, Cd	106	20	697	120104	466	485
61002	Women's or girls' suits of knitted fabric	Pb, Cu	532	108	628	76786	536	486
38024	PCB chloro-paraffins, PE glycols		436	436	462	28078	706	487
92001	Misc. musical instruments & parts therefor	Cd	348	348	496	34800	675	488
58001	Mischellaneous, special woven fabrics		344	344	497	34400	676	489
19002	Milk substitutes, ready-made dishes		1569	181	581	57388	593	490
64003	Waterproff footwear of plastics	Pb, Pht	456	444	460	26922	715	491
84110	Propellers	Ni, Cu, Pb	492	53	670	96939	506	492
55008	Woven fabrik <85% PE including regenerated fibres		501	332	503	35011	674	493
64001	Miscellaneous footwear		339	339	500	33850	679	494
19003	Powder for ready-made dishes		2931	82	649	77432	535	495
84070	Field ensilage harvesters	Ni	1438	189	577	52352	609	496
57002	Knotted/woven carpets of wool and other animal hair		1664	0	717	118810	470	497
73017	Cables, ropes etc of iron and steel	Pb, Pht	2423	329	505	33421	682	497
85008	Permanent magnets	Ni	448	64	660	84344	527	497
62014	Women's shorts	Pb, Ni, Cu	384	278	529	38364	660	498
95014	Requisites for parlour games	Ni, Cu, Pb, Pht, Cd	796	301	519	35858	670	498
64007	Footwear with outer soles and uppers of leather	Pb, Cu	813	51	672	87033	521	499
22007	Champagne and other sparkling wine		1457	577	415	17788	780	500
96011	Slates and boards		1388	408	470	25299	725	500
82003	Adjustable spanners, pipe wrenches, bolt cutters etc	Ni	654	65	659	76518	538	501
28003	Inactive gases		13861	28	690	95854	508	502
87015	Baby carriages and strollers	Ni, Cu, Pb, Pht	900	216	563	44410	636	503
89012	Inflatable floats	Cd, Pb	1055	178	584	49163	619	504

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
		Tonnes	Tonnes	Ranking	GJ	Ranking		
96003	Brushes and pencils	505	402	473	24441	734	505	
33010	Prepared room deodorizers	Pb	600	385	479	24792	729	506
61003	Robes of knitted fabric	Cu, Pb	404	153	601	52796	608	507
62009	Women's suits, ensembles	Pb, Ni, Cu	383	220	560	40826	652	508
61015	Other garments of knitted fabric	Pb, Cu	384	180	582	45447	631	509
62005	Men's jackets and blazers	Pb, Cu	408	221	559	39864	654	509
96014	Vacuum flasks	Ni	506	502	438	18318	775	509
48011	Paper and cardboard coated with wax, oil etc		1179	186	579	44219	638	510
82009	Razors and razor blades	Ni	254	340	499	26309	719	511
84040	Weighing machinery, max capacity 5 t	Ni, Cu, Pb, Cd	482	217	562	38790	657	512
96007	Swabs	Ni, Cu	391	270	533	32416	687	513
25005	Marble and similar types of stone		1621	1621	277	1135	944	514
84063	Garden roller etc	Ni	2453	268	534	31589	690	515
93004	Ammunition for military purposes		434	504	437	16627	787	515
18005	Cocoa powder for beverages		2304	121	618	53136	607	516
18006	Food preparations containing cocoa		725	290	523	28695	703	517
54002	Woven fabric of polyamide and polyester		276	279	528	29757	699	518
61009	Nightdresses of knitted fabric		458	64	660	66138	568	519
90022	Electricity supply meters	Ni, Cu, Pb, Pht, Cd	453	262	537	31464	691	519
61007	Women's blouses of knitted fabric	Pb, Cu	395	119	620	52136	610	520
84017	Heating aggregates	Ni, Cu, Pb, Cd	205	25	693	76574	537	520
90003	Photographic cameres	Ni, Cu, Pb, Pht, Cd	112	354	492	23594	739	521
40017	Gloves of rubber		621	144	605	46880	627	522
84054	Escalators, moving pavements	Ni, Cu, Pb	81	12	705	81113	530	523
62011	Robes	Pb, Cu	332	181	581	38419	659	524
85019	Portable electric lamps etc	Ni, Cu, Pb, Cd	171	328	506	24257	735	525
57003	Woven carpets of cocoa fibres		696	56	667	62362	575	526
48008	Paper/cardboard treated with bitumen/tar/asphalt		273	273	532	27300	712	527
72011	Plated sheets of iron/non-alloy steel	Cu, Pb	2475	247	544	29694	700	527
15001	Misc oleagenous seeds and fruits		273	273	532	27250	713	528
19006	Stuffed pasta		1775	93	640	53394	605	528
96002	Toothbrushes		233	329	505	23523	741	529
74007	Copper foil with backing of plastics, cardboard etc		419	421	467	17581	783	530

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
		Tonnes	Tonnes	Ranking	GJ	Ranking		
56007	Impregnated needle felt	Pb, Pht	350	349	495	21199	756	531
85066	Insulators of plastics	Ni, Cu, Pb	284	285	526	24752	730	532
40019	Fenders of rubber, other than hard rubber		342	275	531	24661	731	533
82004	Screwdrivers, tongs, files etc	Ni, Pb, Pht	353	157	598	37342	664	533
94001	Misc furniture, mattresses, lamps etc		252	252	540	25200	726	534
56003	Napkins, tampons and wadding of cotton		593	25	693	63313	574	535
57005	Woven carpets of chemical fibres		242	218	561	27797	707	536
55005	Woven fabric with more than 85% polyacrylic fibres		249	250	541	24630	733	537
86008	Goods wagons	Ni, Cu, Pb, Cd	701	221	559	26498	717	538
83014	Clasps, tubular rivets, buckles	Ni, Cu, Pb, Pht	368	111	625	39016	656	539
8002	Fruit, frozen		4870	99	635	41766	647	540
22015	Spirits in containers > 2 litres		790	64	660	47743	624	541
42003	Trunks, suit-cases, brief-cases etc of leather	Cu, Pb	544	53	670	50595	614	541
66003	Umbrellas	Ni, Cu	329	302	518	20208	766	541
82010	Cutlery of stainless steel	Ni	328	164	595	32090	689	541
63002	Blankets and travelling rugs		351	166	593	30483	692	542
80002	Articles of tin	Pb	320	291	522	19992	769	543
29001	Miscellaneous organic chemicals		233	233	551	23300	742	544
28015	Chlorine and hypochlorites		8333	0	717	61876	577	545
38027	Halogenated acyclic hydrocarbons		314	314	512	17647	782	545
91001	Miscellaneous clocks & watches and parts thereof	Cd	232	232	552	23200	743	546
21016	Syrup		2708	84	647	41498	650	547
55004	Woven fabric with more than 85% PE		235	237	549	21084	758	548
61004	Skirts etc of knitted fabric	Pb, Cu	309	57	666	43129	641	548
30008	Psychoactive drugs in packings for retail sale	Pht	525	224	558	22079	750	549
49006	Transfers	Pht	433	296	521	16475	789	550
36005	Solid combustibles		444	444	460	9324	853	551
93001	Misc. arms and ammunition		216	216	563	21550	752	552
22010	Dessert wine in containers < 2 litres	Pb	3474	167	592	25512	724	553
95013	Gambling machines	Ni, Cu, Pb, Pht, Cd	167	24	694	48487	623	554
95005	Cuddle toys		255	254	539	17893	779	555
56008	Non-wovens, coated, covered or laminated	Pb, Pht	272	268	534	16537	788	556
95019	Apparatus for gymnastics and athletics	Ni, Cu, Pht	613	177	585	23747	738	557

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
4011	Honey	3032	106	630	29759	698	558
61018	Gloves, mittens etc of knitted fabric	255	92	641	32309	688	559
20009	Roasted nuts	1861	137	610	26278	720	560
40001	Misc. rubber and articles thereof	207	207	568	20650	762	560
86001	Misc locomotives, coaches etc.	207	207	568	20650	762	560
90021	Liquid meters	421	79	651	33041	685	561
38023	Preparations for galvano techniques	391	391	475	8211	863	562
83009	Office articles	383	383	480	8477	861	563
68006	Millstones, sharpening stones etc	459	459	454	5502	888	564
95011	Miscellaneous toys, not plastics or metals	341	160	597	22329	747	565
57001	Misc. carpets and other textil floor coverings	196	196	574	19550	771	566
85012	Rechargeable nickel-cadmium accumulators	180	166	593	21332	754	567
38008	Articles for soldering, welding etc.	237	173	588	20944	760	568
44027	Articles of fibre boards etc	580	145	604	22833	744	568
85018	Lighting or signalling equipment for motor vehicles	240	241	546	14005	804	569
31001	Mischellaneous fertilizers	187	187	578	18700	774	570
96012	Typewriter ribbons	228	229	555	15409	798	571
68003	Terrazzo stone and mosaic cubes	624	624	402	436	953	572
57006	Woven carpets of other vegetable textiles	531	0	717	43223	640	573
63012	Cleaning cloths	361	62	662	30022	696	574
90016	Thermometers	287	106	630	24947	728	574
38025	Chem. products & prep. for medical & surgery purposes	360	360	489	7550	870	575
96008	Ballpens	242	231	553	13906	808	576
52002	Cotton yarn	264	20	697	37134	665	577
64010	Espadrilles	507	0	717	41828	645	577
20005	Frozen, prepared potatoes	1388	73	654	27703	709	578
83010	Staples, paper clips etc	327	355	491	7263	873	579
84099	Machines for soldering and welding	131	35	686	33955	678	579
96013	Disposable lighters	224	236	550	13555	814	579
48016	Duplicator stencils or offset plates	1075	0	717	41594	648	580
38005	Plant-growth regulators	351	209	567	14075	803	581
9003	Tea	1014	26	692	33618	681	582
7003	Dried beans, manioc etc.	5537	56	667	27738	708	583

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
62021	Women's smocks, working coats	205	83	648	24983	727	583
65002	Hats and peaked caps etc	264	99	635	23541	740	583
17004	White chocolate	725	38	683	30278	693	584
38016	Laboratory reagents	336	336	501	7056	876	585
55009	Woven fabric <85%PE w/chemical fibre filament	166	168	591	16994	786	585
33005	Preparations for permanent waving of hair	425	212	565	13588	813	586
84066	Haymaking machines	850	130	613	20243	765	586
51002	Fabric of carded yarn, min. 85% wool/animal hair	511	5	712	36858	669	587
19008	Crispbread	1614	18	699	33182	684	588
25012	Asbestos	379	379	482	4548	902	589
8003	Nuts and fruit, dried	4837	98	636	22163	749	590
71001	Natural pearls, precious metals etc	164	164	595	16350	790	590
74005	Kitchenware and household articles of copper	238	118	621	20514	764	590
44024	Wooden ornaments and boxes	547	120	619	20186	768	591
72001	Iron and steel	161	161	596	16050	794	592
55010	Woven fabric <85% PE combed wool etc	209	138	609	17475	785	593
84094	Machine-tools for planing of metal	58	17	700	30103	694	593
65001	Miscellaneous headgear	156	156	599	15550	796	594
39018	Profiled sheets of plastics	181	187	578	12725	819	595
84028	Distilling apparatus	131	20	697	29140	702	596
42008	Trunks, cases, rucksacks etc of plastics	198	169	590	13758	810	597
84042	Fire extinguishers	340	199	572	11139	830	598
4010	Birds' eggs	1207	0	717	32704	686	599
38018	Ion exchangers	330	330	504	4851	899	599
53001	Misc. other vegetable textile fibres	147	147	603	14650	800	599
38020	Anticorrosive preparations containing amines	192	202	570	10321	835	600
64002	Waterproof footwear of rubber	315	50	673	24648	732	600
64005	Wooden shoes	351	85	646	20967	759	600
85016	Shavers and hair clippers	65	102	633	19347	773	601
54001	Miscellaneous man-made filaments	144	144	605	14400	802	602
63006	Bed valances	153	123	616	16202	792	603
29002	Organic solvent to be used as fuels	287	287	525	5740	885	604

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
95010	Miscellaneous toys of metal	Ni, Cu, Pb, Pht, Cd	207	220	560	9454	851	605
28007	Calcium carbonate		2949	0	717	30080	695	606
84071	Sorting machines for agriculture	Ni, Cu, Pb	132	9	708	28422	705	607
37004	Chemical, photographic preparations		2227	117	622	16131	793	608
94016	Wooden silos		1137	97	637	17941	778	608
85055	Automatic switches	Cu, Pb, Cd	263	134	611	13992	805	609
85265	Insulators of ceramics	Cu, Pb	203	203	569	9679	847	609
96004	Paint rollers		244	220	560	8815	857	610
67002	Artificial flowers, leaves and fruit		230	132	612	13920	807	611
51001	Misc wool and fine & coarse animal hair		138	138	609	13750	811	612
95006	Toy figures of plastics	Pb, Pht	168	179	583	10151	837	612
54006	Woven fabric w/more than 85% other synthetic fibres		136	137	610	13479	815	613
85054	Fuses	Cu, Pb	237	240	547	6284	880	614
62022	Other women's apparel of chemical fibres	Pb, Cu, Cd	125	109	627	14480	801	615
42004	Trunks, suit-cases, brief-cases etc of plastics	Pb, Pht	206	143	606	11813	824	616
49005	Drawings and prints		624	0	717	27139	714	617
61006	Men's shirts of knitted fabric	Pb, Cu	155	49	674	21094	757	617
92002	Keyboard pipe organs		129	129	614	12900	818	618
68017	Articles of peat		1100	0	717	26840	716	619
84067	Straw balers	Ni, Pb	480	66	658	18272	776	620
24003	Cigars, cigarillos and cherootes		806	0	717	26413	718	621
62017	Babies' garments, other than knitted fabric	Pb, Cu	156	37	684	21510	753	622
95012	Billiard equipment	Ni, Cu, Pb	345	202	570	7737	868	623
56012	Packing twine of agave fibres		315	0	717	25972	723	624
30009	Gauze also coated with pharmaceutical substances		211	10	707	24158	736	625
51003	Fabric of carded yarn of wool etc & chemical fibres		269	41	680	20611	763	625
84041	Weighbridge	Ni, Cu, Pb	500	59	664	17713	781	626
19013	Spicy extruded foodstuffs		620	18	699	22228	748	627
21009	Soya sauce		359	171	589	8757	858	627
17005	Caramel without cocoa or chocolate		730	8	709	22376	746	628
72016	Rods of silicon/manganese iron		1015	102	633	12180	823	629
75002	Articles of nickel	Cu, Ni	70	16	701	21243	755	629

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
		Tonnes	Tonnes	Ranking	GJ	Ranking		
96009	Felt-tipped pens and fibre-tipped pens	Ni, Cu, Pht	163	147	603	9314	854	630
16001	Misc. preparations of meat and fish		109	109	627	10850	831	631
55006	Woven fabric with > 86% other synthetic fibres		87	87	644	13259	816	632
39003	Artificial intestines of plastics		408	26	692	19916	770	633
36001	Miscellaneous powders and other explosives		106	106	630	10550	833	634
72015	Bars of high-speed steel	Ni	213	21	696	20188	767	634
63011	Air mattresses	Pb, Pht	122	117	622	9798	845	635
44012	Boards of ligneous materials		1702	0	717	21786	751	636
73025	Sanitary articles of iron and steel	Pb	814	89	643	11207	829	637
62004	Men's suits/lounge suits of synthetic fibres	Pb, Cu	135	85	646	11378	827	638
95018	Ice and roller skates	Ni, Pht	126	127	615	8408	862	639
87012	Mobile cranes	Ni, Cu, Pb, Pht, Cd	116	24	694	17489	784	640
95021	Fishing and hunting requisites	Ni, Cu, Pb	117	110	626	9170	855	641
34010	Modelling pastes		75	80	650	10627	832	642
40014	Used tyres of rubber	Ni	122	97	637	9793	846	643
25003	Quartz		227	227	556	2718	928	644
15004	Lards and flavoured lards		608	42	679	13938	806	645
38003	Liquid resins (tall oil)		351	0	717	19375	772	646
44023	Wooden stairs		802	24	694	15625	795	646
45002	Articles of agglomerated cork		388	61	663	11603	826	646
30007	Diuretic medicaments in packings for retail sale		349	139	608	6136	882	647
68016	Articles of asbestos		220	220	560	2640	930	647
70008	Laboratory and quartz glass		312	156	599	5141	894	648
81003	Articles of titanium		110	39	682	13745	812	649
59002	Table cloths of coated textile fabrics	Pb, Pht	118	79	651	9811	844	650
95008	Toy weapons	Ni, Cu, Pb, Pht, Cd	115	122	617	6460	878	650
22011	Dessert wine in containers > 2 litres		1370	66	658	10058	838	651
81002	Articles of other base metals		106	38	683	13245	817	652
61010	Housecoats, bathrobes etc	Pb	112	7	710	16263	791	653
55003	Yarn with less than 85% synthetic fibres		115	62	662	10042	840	654
60005	Knitted fabric of regenerated fibres		261	14	703	14937	799	654
90011	Drills for dentists	Ni, Cu, Pb, Pht, Cd	75	12	705	15535	797	654
59004	Adhesive tape of textile fabric	Pb	108	75	652	9431	852	655

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
		Tonnes	Tonnes	Ranking	GJ	Ranking		
81004	Articles of manganese	102	35	686	12683	820	656	
90017	Counterflow plants	Ni	238	37	684	12347	822	656
21002	Instant coffee		346	101	634	7230	874	657
96010	Writing or drawing chalks	Pht	147	145	604	4502	904	657
28001	Miscellaneous inorganic chemicals		82	82	649	8200	864	658
55002	Yarn with more than 85% synthetic fibres		81	83	648	8158	865	658
20012	Fruit in sweetening spirit		306	134	611	4538	903	659
90018	Pressure gauges	Ni, Cu, Pb	207	35	686	11254	828	659
95002	Wheeled toys to be ridden by children	Pb	188	102	633	6245	881	659
95016	Equipment for aquatics	Ni, Pb	107	50	673	9937	842	660
95023	Golf equipment	Ni, Cu, Pb, Pht	93	66	658	8757	858	661
84003	Steam turbines	Ni, Cu, Pb	232	33	687	10357	834	662
42002	Saddlery and harness for animals	Ni, Pb, Cu	130	19	698	11780	825	663
38021	Inorganic composite solvents and thinners		97	97	637	5423	889	664
90020	Gas meters	Cu, Pb	144	58	665	7816	867	665
4007	Produce of natural milk constituents		372	20	697	10315	836	666
19001	Bread, pastry, cakes etc.		69	69	656	6900	877	666
54008	Woven fabric of regenerated fibres		215	20	697	10048	839	667
28013	Copper sulphate	Cu	1231	0	717	12551	821	668
55011	Woven fabric <85% regenerated fibres		147	52	671	7691	869	669
85046	Television cameras	Ni, Cu, Pb, Cd, Pht	88	27	691	9465	850	670
21004	Instant tea		361	15	702	10026	841	671
72009	Non-alloy steel sheet, gilt	Pb, Cu, Ni	224	112	624	3369	920	672
40013	Massive retreaded tyres		74	68	657	5396	890	673
93003	Cartridges for weapons with rifled bore	Cu, Pb	84	90	642	4359	905	673
43001	Furskin and artificial fur		59	59	664	5850	884	674
85253	Resistors	Pb, Cu, Ni	95	69	656	5361	892	674
44026	Wooden spools, reels etc	Pb	256	54	669	5943	883	675
82007	Handoperated mincers etc for households	Ni	92	21	696	8528	860	676
83007	Automatic door closers	Ni	134	19	698	8611	859	677
48017	Other copying or transfer paper		255	0	717	9852	843	678
95007	Puzzles		272	6	711	9497	849	678
90025	Manometers	Cu, Pb	214	46	676	5606	886	679
57004	Woven carpets of cotton		65	0	717	9516	848	680
83006	Mountings, fittings for cars	Ni, Cu, Pb, Pht	159	18	699	7834	866	680

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
		Tonnes	Tonnes	Ranking	GJ	Ranking		
83013	Tubes and hoses	Ni, Cu, Pb, Pht	128	25	693	7383	872	680
40009	New tyres of rubber for aircrafts	Ni	68	49	674	5161	893	681
90015	X-ray generators etc	Ni, Cu, Pb, Pht	110	20	697	7528	871	682
38010	Preparations and charges for fire extinguishers		306	79	651	3374	919	683
30005	Medicaments w/alcaloids in packings for retail sale	Pht	118	49	674	4869	898	684
28016	Sodium sulphites		885	0	717	9027	856	685
84010	Air pumps	Pht	70	59	664	3901	910	686
83001	Miscellaneous articles of base metals	Ni, Cd, Cu	48	48	675	4800	900	687
45003	Articles of natural cork		266	14	703	7128	875	688
38015	Prepared culture media		164	38	683	4698	901	689
36004	Matches		370	11	706	6449	879	690
90019	Equipment for measuring instruments	Ni, Cu, Pb	99	26	692	5076	895	691
37001	Miscellaneous photographic goods		40	40	681	3950	908	692
27001	Miscellaneous fuels		39	39	682	3900	911	693
59001	Coated, impregnated, covered textile fabrics		39	39	682	3900	911	693
90007	Measuring rods and tapes	Cu, Pb	61	45	677	3523	916	693
90014	Orthopaedic appliances	Ni	166	44	678	3404	917	694
89013	Navigation marks and similar floating structures	Ni, Cu, Pb, Pht, Cd	246	37	684	3896	912	695
25001	Miscellaneous mineral products		38	38	683	3800	914	696
85065	Insulators of glass		73	74	653	890	946	697
21001	Misc edible preparations		36	36	685	3600	915	698
22001	Miscellaneous beverages		36	36	685	3600	915	698
85010	Zinc carbon batteries		63	48	675	2946	926	699
56005	Wadding of other material		90	0	717	5514	887	700
52006	Surgical gauze		42	2	715	5384	891	701
88001	Aircrafts, spacecrafts and parts thereof		32	32	688	3150	923	702
36002	Explosives		51	53	670	1180	943	703
52005	Woven fabrics of cotton, not w/chemical fibres&flax		42	0	717	4974	896	703
44022	Wooden shuttering		456	0	717	4920	897	704
4001	Misc. articles of milk and cream, cheese, birds' eggs etc.		29	29	689	2900	927	705

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
		Tonnes	Tonnes	Ranking	GJ	Ranking		
21008	Prepared baking powders	194	21	696	3352	921	706	
28008	Distilled water	935	39	682	1797	935	706	
38009	Fluxes for soldering or welding	325	7	710	3976	907	706	
9002	Coffee	242	5	712	4121	906	707	
70009	Leaded panes	Pb	67	44	678	1322	940	707
72003	Lead-coated sheets of iron/non-alloy steel	Pb	144	23	695	3093	924	708
72013	Copper-coated wire of iron/non-alloy steel	Cu	223	24	694	3021	925	708
59005	Fire hoses and similar hoses	Pb, Pht	37	3	714	3915	909	709
4004	Milk and cream, added sugar, condensed	Pb	117	6	711	3891	913	710
40002	Thread and cord of rubber, other than hard rubber		69	11	706	3389	918	710
30002	Vaccines for veterinary purposes		56	18	699	2682	929	711
56002	Sanitary towels, napkins for babies of chemical fibre		65	15	702	2071	932	712
35002	Cellulose glue and paste		180	2	715	3162	922	713
50001	Miscellaneous silks		16	16	701	1600	936	713
70012	Reflectors, clock and watch glass		33	32	688	577	949	713
90006	Apparatus for drawing of circuit patterns		177	13	704	2057	933	713
23001	Miscellaneous animal fodder		15	15	702	1450	938	714
11001	Misc. flours, misc.		14	14	703	1400	939	715
17001	Misc. sugars and sugar confectionery		13	13	704	1250	942	716
38019	Alcaline iron oxide (for gas cleaning)		239	0	717	2316	931	717
44025	Wooden clothes hangers		52	6	711	1499	937	717
44019	Wooden casks, barrels etc		146	1	716	2026	934	718
21005	Instalt tea added milk		40	7	710	1253	941	719
31002	Animal or vegetable fertilizers		11	11	706	1050	945	719
86006	Railway maintenance & service vehicles	Ni, Cu, Pb, Pht, Cd	24	5	712	871	947	720
9001	Coffee and tea, misc.		6	6	711	550	950	721
85005	Generator sets without combustion engines	Ni, Cu, Pb	31	3	714	857	948	722
67001	Misc. prepared feathers/down, artificial flowers etc.		5	5	712	500	951	723
66001	Miscellaneous umbrellas and sun umbrellas		5	5	712	450	952	724
85209	Mercury batteries		6	7	710	229	955	725
52001	Miscellaneous cotton		4	4	713	350	954	726
81001	Mischellaneous, other base metals		2	2	715	200	956	727

NUMBER AND NAME OF COMMODITY GROUP	HARZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
24001	Misc. tobacco and manufactured tobacco substitutes	1	1	716	50	957	728
21003	Instant coffee added milk	0	0	717	0	958	729
78001	Miscellaneous articles of lead	Pb	0	717	0	958	729
81005	Articles of cadmium		0	717	0	958	729
86003	Diesel and electrical locomotives	Ni, Cu, Pb, Pht, Cd	0	717	0	958	729

Appendix 1b

Ranking of industrial products as to energy and resources

Based on supply quantities

Introduction

In this appendix the commodity groups are listed according to the average ranking in relation to loss of resources and energy consumption.

The calculation of loss of resources and energy consumption is based on supply quantities, cf. section 1.3 (page 29) in the main report.

The table includes the approx. 200 highest ranking commodity groups.

Explanation of the table:

In the table the following information is provided:

First column:

The number and title of the commodity group

Second column

The environmentally harmful substances contained in the products of the commodity group (cf. section 1.6). The substances are stated as the following abbreviations: Cu (copper), Pb (lead), Cd (cadmium), Ni (nickel), Pht (phthalates).

Third column:

Uncorrected commodity quantities in tonnes, i.e. quantities have not been multiplied by correction factor. The quantities stated represent the mean value of the production and supply quantities of each commodity group.

Fourth column:

Calculated loss of resources in tonnes
Ranking according to loss of resources exclusively.

Fifth column:

Calculated energy consumption in GJ (Gigajoule)
Ranking according to energy consumption exclusively.

Sixth column:

Final ranking calculated on the basis of the sum of ranking according to loss of resources and ranking according to energy consumption.

It should be noted that more than one commodity group can have the same ranking. The detailed calculations of each commodity group are shown in Appendix 2. For further information of each commodity group, see Appendices 4 and 5.

NUMBER AND NAME OF COMMODITY GROUP	HAZARDOUS SUBSTANCES	QUANTITY		LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	Ranking	GJ	Ranking	
27003	Coal	11419349	11419349	1		182709584	6	1
27009	Oil for combustion	4767501	4767501	2		95350020	8	2
27008	Petrol and petroleum	Pb	2625171	2625171	3	52503420	15	3
84005	Compression-ignition engines	Cu, Ni, Pb, Pht, Cd	11382	136362	18	1291054810	2	4
27011	Petroleum gas and natural gas		1552017	1552017	4	32592357	20	5
89003	Ocean-going cargo ships	Ni, Cu, Pb, Pht, Cd	193412	74223	28	221100005	4	6
89004	Refrigerator ships (gas tankers)	Ni, Cu, Pb, Pht, Cd	83471	61457	33	242419059	3	7
31003	Nitrogenous fertilizers		620094	620094	8	15502350	38	8
28006	Ammonia		307880	301722	11	13577533	41	9
87004	Motor cars and vans < 3500 kg	Ni, Cu, Pb, Pht, Cd	93037	46965	40	58001284	13	10
31006	Mixed fertilizers		972739	972739	6	10700129	48	11
25011	Cement	Pb	1369381	1369381	5	9585667	54	12
84285	Machinery for treatment of textile	Ni, Cu, Pb, Pht, Cd	1262	154658	16	11772985	45	13
84084	Washing machines	Ni, Cu, Pb	11527	73990	29	13509232	43	14
23006	Oil-cakes and similar residues		2436292	24607	54	28282768	22	15
27014	Asphalt and other bituminous mixtures		2375821	118791	21	7253382	64	16
89002	Passenger ships	Ni, Cu, Pb, Pht, Cd	17139	16056	71	33667540	18	17
48019	Other articles of cardboard and paper		451462	23702	56	18053579	33	17
38013	Ready mixed concrete and mortars	Pb	2379803	937642	7	3675939	82	17
68014	Articles of concrete or artificial stone		1815924	544777	9	3631848	83	18
87006	Motor vehicles for the transport of goods	Ni, Cu, Pb, Pht, Cd	25041	13344	83	61432587	11	19
94020	Lighting fittings - incandescent lamps	Ni, Cu, Pb, Pht, Cd	6351	11707	92	171365533	7	20
48007	Paper and cardboard coated with chalk etc		184916	36503	46	7476820	61	21
76009	Profiles, sheets, pipes etc of aluminium		71448	17480	66	13548684	42	22
73006	Other pipes of iron and steel		437533	43753	43	5250396	69	23
94013	Other lighting fittings (not incandescent lamps)	Ni, Cu, Pb, Pht, Cd	4635	10129	105	68025910	10	24
27013	Petroleum coke		170000	170000	15	2720000	102	25
76003	Alu-foil and articles thereof		25953	26708	51	4701554	71	26
85050	Television and video apparatus	Ni, Cu, Pb, Cd, Pht	13834	12619	89	14452660	40	27
49004	Newspapers and periodicals		389541	11686	93	14982020	39	28
39012	Plates, film etc, mainly of PE		56209	54785	37	2859998	99	29
89010	Lightships		3417	9222	111	23657987	26	30
27010	Lubricating oils with more than 70% mineral oil		96708	92936	24	2158137	114	31

NUMBER AND NAME OF COMMODITY GROUP	HAZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
			Tonnes	Ranking	GJ	Ranking	
85062	Insulated wires and cables						
2002	Meat of mammals, fresh or chilled	37893	25064	47	3727750	96	32
84021	Refrigerators, freezers and other freezing equipment	442774	9033	113	18164538	32	33
39022	Various bags etc. of plastics	22424	8839	115	17754917	34	34
94008	Furniture of fibreboards	50829	50809	38	2324591	112	35
87002	Tractors and similar vehicles	89278	22989	60	3234656	93	36
34004	Washing and cleaning preparations etc.	14149	8487	122	18176483	31	36
27002	Anthracite	122676	54851	36	1976157	120	37
84036	Dish washing machines	109088	109088	23	1745408	136	38
84087	Casting machines	4187	10578	101	8175817	59	39
86005	Diesel-electrical trains (IC3)	57	175275	13	1472434	147	39
73011	Structures of iron and steel	4093	9510	110	10464462	51	40
39037	Other articles of plastics	182971	23237	58	2488405	106	41
40008	New tyres of rubber for cars, buses etc	23558	23558	57	2355800	110	42
22005	Bottled beer	23199	19627	63	2029308	117	43
72019	Steel reinforcement	569013	13019	85	2970703	97	44
25007	Broken stone and macadam	121472	60736	34	1457664	149	45
39017	Plates, sheets, film etc of other plastics	1597677	479303	10	1118374	174	46
68010	Articals of asphalt and similar materials	24815	24788	53	1808122	132	47
84102	Data processing machines	49486	24991	52	1796086	134	48
22013	Ethanol	8012	7718	129	8624217	58	49
72012	Profiles of iron/non-alloy steel	27304	26758	50	1626884	139	50
49002	Brochures, leaflets and printed matters	162699	16270	70	1952388	121	51
89011	Other floating structures	228264	6848	139	8779192	56	52
23009	Animal feed - not for cats and dogs	10051	4244	183	58004673	12	52
38028	Other products from the chemical industry	632719	6327	144	8801324	55	53
32004	Paints based on water	56260	56260	35	1181460	168	54
68012	Articles of plaster	39602	43958	42	1207972	163	55
21014	Composite food preparations	126914	119299	20	996528	185	55
57008	Tufted carpets with pile of polyamide	25999	9807	107	2418847	109	56
89005	Barges and floating cranes, not selfpropelled	16780	16946	68	1365824	151	57
32003	Paints, not based on water	27073	5865	156	6062349	65	58
23008	Cat and dog food	39049	43344	44	1066272	178	59
39026	Other articles f/conveyance&packing of	78239	8685	118	2548931	105	60
		23047	23027	59	1205703	164	60

NUMBER AND NAME OF COMMODITY GROUP	HAZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING		
		Tonnes	Tonnes	Ranking	GJ	Ranking			
15002	plastic goods Cooking oils		Pb	73147	6098	149	4196109	77	61
94006	Furniture of metal		Ni, Cu	43913	10201	104	1912215	124	62
31005	Potassic fertilizers			251146	251146	12	753438	216	62
72004	Zinc-coated sheets of iron/non-alloy steel			104576	13281	84	1483934	145	63
23002	Flours, meals and pellets of meat or fish etc.			240616	4909	172	8767191	57	63
68008	Rock wool and similar mineral wool			66796	66796	32	868348	198	64
48010	Paper and cardboard treated/coated with plastics			41393	9521	109	1951929	122	65
23003	Bran and similar vegetable residues			293518	5988	153	3708823	81	66
39033	Windows/Venetian blinds & other equipm of plastics		Ni, Cu, Pb	21771	20247	62	1106228	176	67
70002	Flat glass			94892	85403	25	759136	213	67
69003	Bricks, tiles and gutters etc			357931	143172	17	715862	226	68
4009	Cheese			150357	4782	174	4824264	70	69
73007	Articles of iron and steel with zinc coating			115307	11531	96	1383684	150	70
72002	Tin-coated sheets of iron/non-alloy steel			104841	11427	97	1350352	153	71
85028	Stoves and ovens for households		Ni, Cu, Pb, Pht, Cd	8428	2313	230	31445514	21	72
85022	Light beam and plasma welding apparatus		Ni, Cu, Pb, Cd	1566	5233	165	3384864	87	73
4002	Milk and cream, concentrated			530718	5466	162	3168324	95	74
48004	Corrugated paper and cardboard			335688	3253	208	10614420	49	74
85002	Electric motors and generators		Ni, Cu, Pb, Cd	15761	1931	256	1662056742	1	74
27006	Coke and semi-coke			46585	46585	41	745360	218	75
3002	Fish, fresh or chilled			194930	5731	158	2560928	104	76
84105	Vending machines		Ni, Cu, Pb, Cd	1146	7717	130	1749151	135	77
44011	Particle boards coated with plastics			147081	5942	155	2349496	111	78
84002	Central heating boilers		Ni, Cu, Pb, Pht	18052	2150	239	21333973	28	79
39011	Self-adhesive plates, sheets, foils etc of plastics		Pb, Pht	18187	17891	64	789065	205	80
68015	Articles of asbestos cement			78779	70113	31	655441	238	80
69006	Unglazed stoneware			14756	14756	75	885360	196	81
16004	Other prepared or preserved meat		Pb	44818	5522	161	2163875	113	82
39015	Flexible plates, sheets, film etc of PVC		Pb, Pht	16561	16546	69	787868	206	83
94003	Seats, whether or not convertible into beds		Ni, Cu	23561	11648	94	1020075	183	84
70010	Articles of fibre glass and fibre tissue			29087	29087	49	698088	229	85

NUMBER AND NAME OF COMMODITY GROUP	HAZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
			Tonnes	Ranking	GJ	Ranking	
25009	Gypsum	77640	77570	27	580024	254	86
28009	Inorganic acids	200959	112537	22	563039	259	86
94012	Plastic lamps&lighting fittings(not incandescent lamps)	933	2348	229	10346113	52	86
44015	Plywood	89433	4651	177	2447101	107	87
32006	Sealing compounds, painters' fillings etc.	38684	39076	45	641041	240	88
28004	Carbon dioxide	47432	47510	39	612499	246	88
84104	Machines for manufacture of cement and concrete etc	8077	1828	266	32731740	19	88
39013	Plates, film etc, mainly of acrylic pl/PP	12437	12426	90	865774	199	89
85060	Fluorescent tubes and vapour lamps	1534	1748	273	44244130	16	89
17002	Sugar	259387	2620	221	4619247	72	90
83005	Mountings, fittings for windows, doors etc	14112	14254	77	749144	217	91
85041	Magnetic tapes	7108	12226	91	777142	208	92
84053	Other handling, loading or unloading machinery	17879	2127	240	8057245	60	93
39023	Bulbs, bottles, flasks etc of plastics	14149	14136	79	699574	228	94
73015	Cans, boxes etc of iron/steel	83842	8383	125	1015149	184	95
27007	Mineral spirits	22089	24519	55	579870	255	96
84013	Ventilators	6526	1595	285	23695575	25	96
15003	Margarine and other fats and oils	83828	2596	223	3302523	88	97
39021	Boxes etc of plastics for packing of goods	13391	13509	81	687462	230	97
85014	Vacuum cleaners	2217	2167	238	4215696	75	98
27012	Paraffins and waxes	14252	14252	78	627088	242	99
94019	Lighting fittings of plastics - incandescent lamps	923	1904	260	7464109	62	100
29003	Organic solvents without halogens	13828	13828	80	615070	244	101
48012	Towels, napkins for babies, tampons etc of paper	23664	8287	127	801024	204	102
39007	Inflexible pipes and hoses of plastic, not seamless	13004	12993	86	614254	245	102
84050	Trucks	8721	2009	247	3563830	85	103
39006	Inflexible pipes and hoses of plastic & fittings	12911	12900	88	605553	248	104
87003	Buses	4305	1811	268	4205492	76	105
4005	Milk and cream, acidified	182712	3800	195	1365260	152	106

NUMBER AND NAME OF COMMODITY GROUP	HAZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
73022	Ovens, radiators etc	Cd	10702	1408	300	11479228	47	106
74002	Rods, sheets, pipes etc of brass	Pb, Ni	26211	2615	222	1862086	129	107
68009	Expanded clays		180116	72046	30	360232	322	108
64008	Footwear - uppers of leather - soles of other material	Pb, Cu	8754	5971	154	864703	200	109
44017	Packing cases, boxes etc of wood	Ni	77260	3863	192	1203711	165	110
85059	Halogen and incandescent lamps	Ni, Cu, Pb	1247	1041	344	54112095	14	111
44021	Doors and windows of wood		40289	9548	108	588057	252	112
94011	Eiderdowns, pillows and similar furnishing		7744	6411	143	741763	219	113
30010	Other pharmaceutical substances		7136	7136	138	713600	227	114
70004	Multiple-walled, insulating units of glass	Ni, Cu	35784	31991	48	370722	318	115
44028	Other articles of wood		80663	4033	187	1055879	180	116
39004	Seamless inflexible tubes, pipes & hoses of plastic	Pb	11147	11137	98	531797	270	117
90004	Photocopying apparatus	Cu, Pb, Pht, Cd	2364	1721	276	3246143	92	117
87013	Trailers and semi-trailers	Ni, Cu, Pb, Pht	23702	5609	159	761502	211	118
76005	Drums, tins etc of aluminium	Pb, Ni, Cu	6006	3333	207	1183812	166	119
25006	Granite		411701	123510	19	288191	355	120
69007	Glazed stoneware	Pb	9116	9116	112	546960	264	121
69008	Sanitary articles, tableware etc of porcelain or china	Pb	10391	10545	102	517179	274	121
34009	Candles		10654	10761	99	501846	278	122
20003	Preserved vegetables	Pb	49491	8790	116	552559	262	123
21012	Composite sauces		26520	4787	174	785573	207	124
69010	Statuettes etc	Pb	13096	13423	82	411365	302	125
84051	Passenger and goods lifts	Ni, Cu, Pb, Cd	3246	1410	299	3512599	86	126
84097	Machine-tools for working wood, cork etc	Ni, Cu, Pb, Cd	2511	1713	279	2443323	108	127
16003	Preserved sausages	Pb	29663	5013	168	740073	220	128
69002	Ceramic products		8749	8749	117	524940	272	129
22009	Wine in containers > 2 litres		63472	11533	95	438191	299	130
20008	Jams, purées of fruit	Pb	28442	7373	135	562374	260	131
94018	Other furniture		6073	6073	150	607300	247	132
73019	Galvanized nails etc of iron/steel wire		15804	15849	73	356034	324	132
48009	Paper and cardboard with glued surface		22925	3897	190	770996	209	133
89001	Misc. ships, boats and floating structures	Pb, Cd, Cu, Ni, Pht	6037	6037	151	603700	249	134

NUMBER AND NAME OF COMMODITY GROUP	HAZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
4003	Milk and cream, condensed/powder	Pb	23173	4101	185	756612	215	134
84081	Printing machinery	Ni, Cu, Pb, Pht, Cd	1007	2725	218	1042973	182	134
39034	Office & school supplies of plastics	Ni, Pb, Pht	12438	8651	119	494709	282	135
76004	Structures, door frames etc of aluminium	Ni	6675	3104	210	930201	192	136
84025	Other refrigerator and freezer equipment	Ni, Cu, Pb, Cd	3073	894	374	20980210	29	137
22003	Bottled mineral water containing added sugar	Pht	252210	4676	176	684644	231	138
40012	Retreaded tyres of rubber	Ni	6913	6705	141	535204	267	139
73018	Screws, nails, tacks, pins etc of iron/steel		22608	22671	61	308725	347	139
57009	Tufted carpets with pile of PP		8906	8996	114	443997	296	140
22008	Wine in containers < 2 litres	Pb	57933	10526	103	399951	308	141
85003	Electr. generator sets w/internal combustion engine	Ni, Cu, Pb, Pht, Cd	2006	1890	261	1330973	154	142
39016	Plates, sheets, film, strip etc of cell plastic	Pb, Pht	7425	7425	132	478630	286	143
32007	Printing inks	Pb	10018	10018	106	390340	314	144
44004	Timber of tropical wood		17220	17220	67	292740	353	144
39030	Bowls, buckets and pots of plastics	Pb	8556	8556	121	414864	300	145
84080	Offset machines	Ni, Cu, Pb, Pht, Cd	692	1872	263	1270318	159	146
72008	Painted/lacquered/plastic-coated sheets	Pb, Pht	41099	5590	160	550398	263	147
72017	Rods, wires etc of other alloy steel	Ni	16536	1654	282	1570920	141	147
22014	Spirits in containers < 2 litres	Pb	21417	1748	273	1295146	158	148
39005	Flexible pipes and hoses of plastics	Pb, Pht	8392	8393	124	400802	307	148
35003	Glue, paste and other adhesives	Pb	8479	10599	100	339966	333	149
44014	Coated fibre boards		40739	2057	244	956242	189	149
16006	Preserved fish	Pb, Pht	27711	4089	186	599354	250	150
85043	Compact discs		1027	6781	140	439864	298	151
23010	Vitamin and antibiotic mix for animals		7498	3442	203	669471	235	151
73004	Tubes and pipes of cast iron		45208	4521	180	542496	265	152
85013	Electro-mechanical tools for working in the hand	Ni, Cu, Pb, Pht, Cd	1595	1001	349	2928558	98	153
38004	Pesticides	Cu	13720	6194	147	412966	301	154
40003	Sheets, profiles, mats and strips of rubber		5810	5433	163	479953	285	154
84068	Combine harvesters	Ni, Cu, Pb, Cd	6179	897	371	3884264	79	155
25008	Granulates of marble and granite		249883	80212	26	174919	426	156
44009	Parquet blocks		38903	1945	252	857033	201	157

NUMBER AND NAME OF COMMODITY GROUP	HAZARDOUS SUBSTANCES	QUANTITY Tonnes	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING	
			Tonnes	Ranking	GJ	Ranking		
62013	Women's trousers, knickers, overalls	Pb, Cu	5013	3835	193	559817	261	158
39014	Inflexible plates, sheets, film etc of PVC	Pb, Pht	7429	7423	133	353425	326	159
38014	Anti-freezing preparations		5705	6218	145	370719	319	160
16005	Preparations of minced meat etc.	Pb	19701	2286	232	681890	232	160
84092	Machine-tools for drilling, boring, milling of metal	Ni, Cu, Pb, Cd	1752	1086	338	1811851	131	161
84001	Miscellaneous reactors, boilers, machinery		4596	4596	179	459600	292	162
40011	New tyres of rubber for tractors etc	Ni	6354	4715	175	443789	297	163
84085	Tumblers	Ni, Cu, Pb, Pht, Cd	2736	771	408	5784821	67	164
84109	Valves	Ni, Cu, Pb	11310	1936	253	721765	223	165
86002	Electrical locomotives etc	Ni, Cu, Pb, Pht, Cd	2030	645	447	19189131	30	166
84011	Compressors for refrigerators	Ni, Cu, Pb, Cd	1656	523	476	207923295	5	167
19011	Rye bread		130340	1263	315	1171774	169	168
94015	Illuminated signs, illuminated name-plates & similar	Ni, Cu, Pb, Cd	1182	992	352	1798093	133	169
22006	Beer in containers		149012	1505	289	881942	197	170
23005	Mash, dregs and similar residues		114020	1152	333	1323651	155	171
87011	Bicycles	Ni, Cu, Pb	6238	3506	201	475945	288	172
25004	Slate		15924	15924	72	191088	418	173
3003	Fish, crustaceans, fresh, frozen		89813	930	363	1880772	128	174
83016	Wire and electrodes for welding of steel	Ni, Cu	7233	7378	134	283227	359	175
62001	Articles of apparel, not knitted fabric		4017	4017	188	401700	306	176
84057	Self-propelled shovel loaders	Ni, Cu, Pb, Pht, Cd	4658	699	429	5927316	66	177
48003	Toilet and towel tissue, cloths etc of paper		84456	895	373	1929408	123	178
84015	Air compressors	Ni, Cu, Pb, Cd	2218	575	460	16720086	36	178
23004	Beet-pulp and similar residues		83331	875	379	2021544	118	179
61012	Sweaters, waistcoats, pullovers etc	Pb, Cu	7762	1245	319	1059147	179	180
94010	Mattresses	Ni	5213	3370	205	454203	294	181
76008	Other articles of aluminium		12337	12954	87	187831	419	182
19007	Roasted or swelled cereals etc.		21838	1561	287	736738	221	183
21013	Soup and broth		11373	1922	258	590013	251	184
94005	Furniture of wood		20501	2091	241	526097	271	185
84107	Miscellaneous other machines	Ni, Cu, Pb, Pht, Cd	5583	844	387	1908155	125	185
23007	Vegetable residues and by-products of fruit etc.		56662	1190	327	991902	186	186

NUMBER AND NAME OF COMMODITY GROUP	HAZARDOUS SUBSTANCES	QUANTITY	LOSS OF RESOURCES		ENERGY CONSUMPTION		FINAL RANKING
		Tonnes	Tonnes	Ranking	GJ	Ranking	
21015	Ice cream	44306	1932	255	564952	258	186
39002	Monofilaments, rods, sticks and profile shapes of plastics	4583	5177	166	300016	349	187
2005	Meat of poultry, frozen	43713	892	375	1513649	142	188
85011	Lead accumulators	10532	6109	148	253038	373	189
29006	Organic chemicals to be used for decalcification	8568	8568	120	212486	401	189
38011	Organic composite solvents and thinners etc.	4930	4931	171	298610	350	189
34003	Surface-active agents	6920	6020	152	251868	374	190
18003	Chocolate, filled	20227	1487	293	651086	239	191
33007	Miscellaneous hair care preparations	5319	5419	164	254922	371	192
84064	Grass mower	4982	652	445	3269160	90	192
86009	Containers for transport	26836	2765	216	364432	320	193
84016	Ventilating apparatus	3013	459	492	11799789	44	193
85036	Electric amplifiers	990	764	410	1907120	126	193
20014	Fruit juice not added sugar	61882	1986	250	476487	287	194
20002	Vegetables preserved by vinegar	23839	3745	197	322115	341	194
85027	Microwave ovens for households	2132	639	448	3263360	91	195
34007	Artificial waxes and prepared waxes	5461	5466	162	240922	381	196
85001	Miscellaneous electrical machinery and equipment	3366	3366	206	336600	337	196
84091	Lathes for metal	1612	753	413	1831631	130	196
85031	Electro-thermic household appliances	907	697	431	2146687	115	197
25010	Limestone	183700	170841	14	85472	543	198
84008	Submersible and circulating pumps etc	9132	1497	291	539591	266	198
85052	Burglar and fire alarms	326	355	531	21751397	27	199
84004	Spark-ignition engines	1150	416	509	10568575	50	200
48006	Composite paper and cardboard	39296	794	401	1264920	160	201
39027	Disposable plates of plastics	4154	4183	184	241790	380	202
85039	Tape recorders & other sound reprod apparatus	1539	1061	340	717004	225	203
69011	Other articles of ceramics	15485	15601	74	120823	492	204
33004	Hair care preparations, body shampoo etc.	10264	5127	167	215225	400	205
90001	Misc optical, photographic apparatus & similar	2920	2920	213	292000	354	205

