DANISH MINISTRY OF THE ENVIRONMENT

Environmental Protection Agency

Environmental Screening and Evaluation of Energy-using Products (EuP) Final Report

Marianne Wesnæs
2.-0 LCA consultants ApS

Jesper Thestrup
In-JeT ApS

Arne Remmen
Aalborg University

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Preface

This Memorandum is part of the project ***"Teknisk bistand til udarbejdelse af miljømæssige vurderinger vedrørende energiforbrugende produkter (EUP) i forbindelse med fastlæggelse af internationale krav for energieffektivitet og miljømæssigt mindst belastende design for 11+9 produkter samt indspil til i EU kommissionens gennemførelsesforanstaltninger"***. The project is performed for the Danish Environmental Protection Agency.

The work has been undertaken by Marianne Wesnæs and Bo Weidema from 2.-0 LCA consultants, Jesper Thestrup from In-JeT ApS and Prof. Arne Remmen from Aalborg University.

The conclusions in this memorandum do not necessarily represent the views of the EPA.

Prepared for The Danish Environmental Agency by:

Marianne Wesnæs, 2.-0 LCA consultants ApS
Jesper Thestrup, In-JeT ApS and
Arne Remmen, Aalborg University

1 Objectives and scope

1.1 Objectives

The objective of this Memorandum is to provide a background document for the Danish Environmental Protection Agency (EPA) for use in the assessing of the impact of the EuP Directive 2005/32/EC of 6 July 2005.

The EPA will assess and prioritise focus, resources and instruments according to the traditional types of environmental impact, such as health and eco-toxicity (substances and waste), resources, non-renewable energy resources and effects on climate changes and global warning.

The Memorandum thus has two objectives:

> Firstly, it aims to highlight the areas of general environmental impact affected by the directive and shall assist the EPA in prioritising the focus, efforts and instruments to be applied in relation to the implementation of the EuP directive in Denmark.
>
> Secondly, it aims at extracting and highlighting horizontal themes from the product oriented policy adopted by the European Commission.

The conclusions have been derived by the authors and do not necessarily represent the views of the EPA. However, it is our intention that the conclusions can be used as guidance for selecting the strategic focus points.

1.2 The Directive

Many aspects of energy-using products (EuPs) have a negative impact on the environment (emissions to air including greenhouse gases, to soil, water, and energy consumption, etc.). The Council and the European Parliament adopted a Commission proposal for a Directive on establishing a framework for setting Eco-design requirements (e.g. energy efficiency) for all energy using products in the residential, tertiary, and industrial sectors.

The four main objectives of the EuP Directive are:

- to ensure the free movement of energy-using products within the EU
- to improve the overall environmental performance of these products and thereby protect the environment,
- to contribute to the security of energy supply and enhance the competitiveness of the EU economy,
- to preserve the interests of industry, consumers, and other stakeholders

The Commission launched an invitation to tender for 20 preparatory studies corresponding to the major categories of Energy using Products. The studies provide the Commission with the necessary information background to prepare for the next phases, the impact assessment, the consultation with the Eco-design Forum and a draft implementing measures. References to all the Preparatory Studies are found in section 20.

The background papers produced in the preparatory studies describes relevant environmental impact issues, but the conclusions are often focused on energy aspects only. Hence, the Danish EPA is interested in a wider assessment and medium to long-term perspectives of the product groups in terms of total environmental impact, existing Ecolabelling and related regulations, market access and growth, technology trends, etc.

It has to be kept in mind that the Preparatory Studies for each product group are based on hundreds maybe even thousands of working hours by experts in each field in an attempt to identify both impacts and improvement options. Due to the limited time available for preparing this Memorandum, it has not been possible give such detailed guidelines for each product group.

1.3 Scope of this Memorandum

The memorandum is structured so that overall conclusions and comments are provided first followed by a detailed description of each product group or cluster of product groups.

Following this structure, chapter 2 provides an executive summary with the main conclusions and findings from the work performed up till now. Chapter 3 provides an overview of the methodology used in the environmental screening. Hereafter, chapters 4 through 19 provides the background data and individual conclusions for each product group or cluster of product groups.

Finally, chapter 20 through 22 provides references to all the Preparatory Studies, the literature references as well as an overview of Figures and Tables.

2 Conclusions - Environmental screening of Energy-using Products

The summary highlights key points and conclusions on the basis of the environmental screening and assessment of technology and market trends, and the parties experience and knowledge of the case. The summary is structured along the following main elements: General conclusions, environmental conclusions, technology and market trends; and regulation.

2.1 General conclusions

2.1.1 From life-cycle thinking to energy efficiency

The Preparatory Studies of EUP carried out as background for setting up implementing measures, generally have the following characteristics:

- a comprehensive and thorough work has been put into each EuP study
- experts have been involved in each product group
- the main environmental impacts of each product group are assessed
- energy consumption in the use phase – ofcourse – possesses the most significant environmental impact
- the EuP studies have been commented by stakeholders (or is in the process of being so)
- a comprehensive background material has been prepared for each product group at the expense of hundreds or thousands of hours

However, the current draft EuP Implementing Measures almost exclusively focuses on energy efficiency. It is in the transition from Preparatory Studies to the first draft of the Implementing Measures that the general understanding of the life-cycle view must be maintained.

2.1.2 A vision for a comprehensive approach to “Energy using Products”

An urgent need is present to see the environmental impacts of Energy using Products in a more comprehensive and systemic view. Individual products can (and should) be regulated in order to promote the “best of breed” products with the least environmental impact. However, the product view should, in our opinion, also be guided by a system approach supported by life-cycle thinking and governed by an overall vision about generation, distribution and use of energy – the energy system.

Hence, in terms of Energy using Products we propose to pursue a paradigm of:

“Distributed production – central coordination – local control”.

From a systemic approach, energy production should be generated distributed from many sources with a central coordination, and focus should be shifted to developing and deploying energy preserving and environmentally sustainable distribution networks and intelligent, locally situated control mechanisms.

Distributed production based on all kinds of resources, i.e. electricity from renewable sources, heat and cooling from waste, etc. is from an environmental point of view the most effective that brings production and consumption close together. However, distributed production has to become centrally coordinated as in the electricity grid and in district heating; and this coordination challenge increase with the number of production units.

One exemption is solid fuel combustion e.g. stoves in private househould, where the overall conversion efficenincy will be much less than in a central unit that not only produce heat but also electricity; and the ability to control environmental factors such as emission of substances and particles to air and soil will be much more effective with only a few large units instead of all the small stoves.

To fully exploit the potential advantages of renewable energies, it is necessary to re-think the basic philosophy governing the energy distribution systems. The present distributed generation sources should not only be connected, but must be fully integrated into the distribution system. At the same time, the networks must make use of the customers' demand for flexibilities and offer appropriate economic instruments, such as real time pricing.

The goals of transforming the current electricity grids into a resilient and interactive service network will necessitate the use of key enabling technologies such as innovative ICT (Information and Communication Technology) solutions, storage technologies, power electronics and superconducting devices. For gas and heat networks, the objective is to deploy more intelligent and efficient processes and systems for transport and distribution, including the effective integration of renewable energy sources and the use of biogas in the existing networks.

In order to optimise energy use, an entirely new breed of intelligent and interoperable local control mechanisms is needed, which can adapt and optimise the energy consumption to the immediate need of the user thus helping to decouple growth in energy consumption from economic growth.

Energy savings in buildings will progressively be achieved through distributed energy management systems that are able to interact and communicate with sensors and actuators through common open protocols and to cope with higher complexity at various scales. Improved connectivity of different systems will thus increasingly be required.

Hence, Energy using Products will increasingly be able to incorporate intelligent optimisation of the distribution and demand of energy, which is the challenge to achieve energy positive buildings and neighbourhoods. Monitoring and control systems will be able to optimize, in near-real time, the local generation-consumption matching, considering all possible elements (solar, fuel cells, micro-turbines, CHP - combined heat and power, heating, cooling, lighting, ventilation, etc).

2.1.3 Functional unit - the single product versus the system approach

Since the EuP focus on existing products rather than on the function to be carried out (such as “air conditioners” instead of “cooling of buildings”), then benefits of life-cycle thinking becomes undermined, when the scope is limited to the products.

On the one hand, EuP aims to be a catalyst for technological innovation on energy efficiency of products. On the other hand, there is a risk that EuP will be conserving old technologies, if new integrated and efficient system solutions are not sufficiently taken into account.

As an example, passive houses or energy-plus houses can (and should) include alternative and more energy-efficient solutions to the issues, which are addressed in the product groups: Boilers and water heaters, air conditioners and ventilation. Lessons learned from passsive houses show that solutions can be designed so they will reduce the overall need for products from the groups: Solid-fuel combustion; refrigerators; tumble dryers; external power supply and domestic lighting.

Summing up, at least three different trends support a system approach:

- ***Technology trend*** – an increasing product- and systemintegration, where the single products become more complex with several more functions e.g. mobile phones, and intregrated in overall systems e.g, wireless communication and the Internet
- ***Environmental impacts*** will not only be attached to the single product but to the efficiency and effectiveness of the overall technology system
- ***Improvement potentials*** – optimisation of the single product will increasingly take place as part of product-service systems that reflect the overall technology development and market demands; while manufacturers and public regulators do not necessarily have semiliar attention the system aspect as such.

The scope the EuP directive has recently been expanded from “energy-using” to “energy-related” products such as windows, insulation, etc. In the long run, the European Commision will set up minimum performance demands to single products that all are integrated in an overall system, such as a building or a communication system. In other words, when setting up demands it will be necessary to reflect the energy and environmental efficiency of the overall system, when – with Aristoletes words: “the whole is more than the sum of its parts”.

2.2 Environmental screening

2.2.1 Environmental issues in the Preparatory Studies

For most of the product groups, criteria for eco-labelling is available that highlight key environmental requirements for products. These requirements could have been, but are not included in the requirements listed in the EuP context.

For example, the screening performed revealed that the toners in fact constitute a more pressing environmental problem for printers than the energy consumption. This highlights the need for environmentally conscious design approaches and the need for focus on environmental issues in future technology and product development.

Of particular interest is a close examination of environmental issues of future energy efficient technologies, which will be promoted as a result of the EuP requirements, such as lighting based on new generations of diodes (LED).

2.3 Regulatory issues

2.3.1 The dynamics of technology trends and missing link to eco-labelling

Overall, the energy efficiency targets are set fairly ambitious, but the incentive to meet ambitious targets through intensified technology development is not so obvious.

It should be indicated what is the long term target, because industry often favours the long view. Moreover, a permanent procedure should be established for, at which intervals the targets will be reviewed (as is the case in eco-labelling).

Likewise, a procedure to ensure that the criteria for eco-labelling are more deeply entrenched in the setting up the Implementing Measures would be beneficial. EuP is aimed at banning products with the worst environmental performance, while eco-labelling is aimed at providing incentives for product development and competitive advantages for producers of cleaner products. If EuP also includes broader environmental concerns than energy efficiency, then it will require a more dynamic review of the eco-labelling criteria.

2.3.2 Interface between product- and system view

In the context of lot 1 (boilers), the prepatory study operates with a relatively broad system definition, since management of the heating system and the ability to connect to other systems such as solar collector and heat pumps, are vital to the energy efficiency of the overall heating system. This approach has not attracted unconditional support. Furthermore, it yields an interface to the building regulations. The interaction between these two forms of regulation should be investigated further.

Similarly, it should be considered how much effort is required to introduce regulation of products such as DVD players, which in a few years can be expected to be translated into a service delivered via the Internet (equivalent to the dematerialisation of the answering machine). A similar problem of regulation is felt in relation to products, which are likely to be integrated in other products (copier, printer, etc.) or where the product changes the entire nature (facsimile machines).

2.3.3 The link to the WEEE and RoHS directives

The RoHS Directive is working reasonably well in ensuring phasing out of hazardous chemicals and materials. Requests to ban further dangerous substances can most appropriate be resolved in this context (and expanded to other products groups than electronics)

On the other hand, the WEEE directive has until now mainly focused on waste management and recycling, while the Eco-design “intentions” are not realised at all. In other words, issues such as resource efficiency and the closing of the materials loop are not covered by existing regulation. The extensive knowledge of the product groups (from the Preparatory Studies) can be transformed into eco-design guidelines for the industry for: Choice of material (energy and environmentally sound choices, recyclable materials), optimization of materials (dematerialisation) and design for recycling, etc.

2.4 Overview of technology trends and important environmental issues

The following table provides an overview of the identified technology trends and the resulting important environmental issues for each product group. We have also provided our suggestions for actions that can be contemplated when addressing these issues.

Table 2.1 Overview of technology trends and important environmental issues

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 1 and 2 Boilers and combi-boilers (gas/oil/electric) and water heaters (gas/oil/electric)	Energy efficiency improvement potential for boilers and water heaters is considerable (close to 40%). Improving the energy efficiency of existing boiler systems will not contribute radically towards reduced global warming, as long as the boiler systems are based on the combustion of oil and natural gas. Improvements are also foreseen if the market is stimulated in the direction of co-producing boilers that produce both heating and electricity.	The extraction of non-renewable energy resources is significant. It is dominated by the extraction of oil and gas for the combustion during use of the boilers.	In order to promote alternatives to gas, oil and electricity based boilers and water heaters, investments in technical improvements of solar heating systems, geothermic energy, heat pumps, etc. should be facilitated. Promotion of co-producing boilers requires the existence of appropriate buy-back schemes for public utilities.

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 3 Personal Computers (desktops and portables) & computer monitors	Personal Computers and monitors will change due to emerging broadband and wireless connectivity, which will allow all devices (including computers) to be connected to central servers at all timers, anywhere.	Dematerialisation of PCs and monitors will have a significant and positive effect, since the manufacturing process will be less resource demanding. Although the amount of WEEE is going to decrease due to the smaller units, the number of communication units, gateways and modems put on the market will increase WEEE. The large data centres are large consumers of electricity and power for cooling. The centralisation of computational power allows for improved optimisation of energy use compared to a decentralised structure with billions of individual users.	Increased energy consumption from the use of DSL modems and broadband equipment must be weighted against the lower energy consumption of smaller computers and the phasing out of energy consuming desktop PCs. Physically small devices are more likely to find their way into the household waste stream than are large desktop PCs and there will be a need to improve multilevel sorting and improved attitudes towards small WEEE among households. Measures needed to improve the environmental impact are easier to implement in large centralised structures than in the consumer end.

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 4 Imaging equipment: Copiers, faxes, printers, scanners, multifunctional devices	Recent efforts have focused on reducing energy consumption and optimising recycling of print cartridges. Due to novel communication technologies facsimile machines are not expected to have material environmental impact on the longer term. Sale of scanners has seen strong growth in the past years but with the introduction of printer-based multifunction machines, the sales of flatbed scanners will decline fast.	The environmental impact comes from the consumption of paper, the consumption of toner and the electricity consumption during use. The consumption of toner is not the same for b/w printing and for colour printing.	The energy efficiency of office imaging equipment is generally at a good level. Under real life conditions, the energy efficiency potential of imaging equipment is not necessarily explored due to a potentially suboptimal use by the consumer. Focus should now be put on designing toners with less overall environmental impacts

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 5 Consumer electronics: Televisions	The main contributions to the overall environmental impacts come from the electricity consumption during use. New trend on the market having an important impact are larger screen sizes and plasma TVs, which use considerable more energy. Prospects for improving efficiency in LCD TVs are better than for improving efficiency in the old CRT TVs, in particular by introducing solid state lighting in the backlighting systems.	From the production of the hardware, it is especially the energy used for the production and eco-toxicity impacts from heavy metals arising during the extraction of materials that causes the environmental impact. The fast turnover and technological development, however, could change the energy consumption. Old CRT screens are effectively being phased out.	The energy efficiency of television equipment is generally at a good level.
Lot 6 Standby and off-mode losses of EuPs	The rapidly growing trend in home networks will lead to requirements for new functions in future products in terms of additional network interfaces and always-on and keep-alive requirements.	The relevance of this group results from the increasing numbers of devices and the long duration of power consumption, often invisible to the user.	It is recommended that at future needs for functionality and ease of use in networked civic applications (such as healthcare, ageing, ambient assisted living, entertainment, life-long education, energy efficient buildings, etc) should be taken into consideration when implementing EuP requirements on a horizontal group as this.

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 7 Battery chargers and external power supplies	The trend towards mobile and handheld computers will lead to increased use of batteries and increased need for external chargers.	The environmental aspects of battery chargers and external power supplies are similar to those of personal computers (same issues, same problems, just in a smaller scale).	It is important to take future needs for mobility and ease of use in networked civic applications (such as mobile healthcare, work-force mobility, etc) into consideration when implementing EuP requirements.
Lots 8, 9, 19 and ? Lighting (Office, public street, domestic)	Tri phosphor lamps contain 3 mg of mercury per lamp. These lamps are more expensive, but they have significantly longer life-time than the halo phosphate lamps. LED technology is a very promising technology for lowering the electricity consumption in both residential and public lighting and because it contains relatively non-toxic components and no mercury.	There is a great potential for lowering the energy consumption of mercury in florescent tubes by replacing the halo phosphate with tri phosphor lamps.	Increasing life-time even further for tri phosphor lamps is interesting, but needs some time for technical development.

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 10 Residential room conditioning appliances (aircon and ventilation)	In some EU countries the penetration of small air-conditioners reached significant penetration levels similar to that of the US.	The electricity consumption during use is by far the most significant contributor to the environmental impacts from ventilation systems but some of the refrigerants contribute to the global warming (HFC and PFC). Some refrigerants might also have other environmental impacts, like toxicity.	Solutions based on large, central units (e.g. for apartment blocks) incorporating environmental clean and renewable energy sources should be preferred over local conditioners in each dwelling. Demands for higher heat recovery rates would also be more effectively implemented in large units.
Lot 11 Electric motors 1-150 kW, water pumps, circulators in buildings, ventilation fans (non-residential)	Intelligent pumps fitted with electronics allow for considerable reductions in energy consumption of up to 50%. The technology behind these advances emanates from the development of permanent magnet motors, as these dramatically increase motor efficiency.	The trends in intelligent pumps illustrate the need and the possibilities that exist for energy savings, when the control of energy consumption is done locally in the context in which the consumption takes place.	In view of the paradigm of "Central production – local control", the need for intelligent and controllable motors (in pumps and other places) is evident and should be promoted.

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 12 and 13 Refrigerators and freezers, including chillers, display cabinets and vending machines	New refrigerators have much higher energy efficiency than do older so extended life-time for this product group is not recommended. Due to the relative slow replacement in this product group, it could take a considerable number of years before new A+ or A++ appliances replaces the old.	Waste handling of old refrigerators is very important, and is mostly covered by the WEEE directive as far as material recovery and limitation of emission is concerned,	More reliable return systems have to be set up in order to prevent the old appliances from being shipped illegally to emerging markets like India, Pakistan or China. The European Ecolabel for refrigerators ended 31 May 2008 and new regulations must be put into force.
Lot 14 Domestic dishwashers and washing machines	Locally controlled, intelligent washing machines will not only be able to save energy (washing at lower temperatures and at off-peak hours) but will also use much lower detergents and other ingredients, by matching the consumption to the content of the wash. Water-less washing machines are in the experimental stage.	The energy consumption during use is absolutely the most important environmental impact for this product group. Washing at lower degrees can significantly reduce the energy consumption by using enzyme based washing powder. The environmental impact of the materials used for rinsing the clothes (e.g. nano-scale silver and ozone) are unknown..	Great focus should be put on the ability of washing at low degrees or even in cold water. New materials used for rinsing of clothes should be followed closely. The Nordic Ecolabelling criteria for dishwashers and washing machines will expire in October 2008 and initiatives should be underway to update them

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 15 Solid fuel small combustion installation (in particular for heating)	The manufacture of stoves and furnaces has only minor environmental impacts relative to the impacts from the combustion taking place in them.	Air emission of small particles is the most important environmental aspect of this product group in addition to air emissions of NOx, SO_2 and CO.	As the EuP preparatory study focus on improving the combustion efficiency and reducing emissions of NO_x, SO_2, CO and small particles, which will cover the most important issues regarding the environmental impacts from solid fuel small combustion installations.
Lot 16 Laundry driers	Heat pump tumble driers result in significant energy savings as they consume only about half the electricity of conventional condenser driers.	Dryers are the appliance where little progresses in energy efficiency have been achieved with the mandatory energy label.	Gas heated (which are not labelled) and heat pump dryers (most of them are in A class), which use much less primary energy should be promoted.
Lot 17 Vacuum cleaners	Vacuum cleaners are basically to be regarded as mobile heating units. Airflow efficiencies vacuum cleaner is rarely above 50% and often around 35%.	The dust bags are a major sources of particle pollution, which can cause allergic reactions among private and professional users, as well as a permanent residential repository of various hazardous substances.	In order to improve both energy efficiency and emission of small particles, vacuum cleaners, and in particularly their filters, should be regularly cleaned and maintained. Users should not be able to operate machines when filters must be changed.

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot ? Simple Converter Boxes for digital television	The main area of concern in the conversion to digital broadcasts is the legacy of installed analogue televisions and how they will operate in a digital broadcast future. The short and simple answer is the digital converter. The long term trend is to move from simple set-top boxes to more complex types in the networked homes.	Increased energy consumption from the increased use of simple converter boxes is not the only environmental impact foreseen. Adding millions of electronic devices to the market every year poses a major challenge to the electronic waste, since these devices are all physically small and will easily find their way into the household waste stream. This will reduce the problem in this particular product group (but transfer it to another product group).	Physically small devices are more likely to find their way into the household waste stream than are large desktop PCs and there will be a need to improve multilevel sorting and improved attitudes towards small WEEE among households.

Product Group	Trends, to be taken into account in the Implementing Measures because of the resulting environmental impacts	Important environmental impacts which should be taken into account in the Implementing Measures	Suggestions for actions to address the most important environmental impacts
Lot 18 Complex set top boxes	Digital TV and sophisticated civic services such as healthcare, ambient assisted living, smart and intelligent homes, energy efficient buildings, etc., will result in the need for thoroughly networked and connected homes and thus more complex set-top boxes to control all the devices and appliances. These trends are presently accelerated by the convergence between Information Communication Technology equipment and consumer electronics.	The networked home is a prerequisite for realising the intelligent distribution and control of energy consumption and its environmental impact must be seen and evaluated in a systemic view and expressed in the paradigm "Central production – local control". The long term environmental impact is difficult to predict, since it is highly depending on the appearance of supporting technologies such as battery technology, wireless communication, sensor networks, etc. Adding millions of electronic devices to the market every year poses a major challenge to the electronic waste, since these devices are all physically small and will easily find their way into the household waste stream.	However, modular design, possibilities for updates and backward compatibility can alleviate some of the waste problems and should be promoted. Physically small devices are more likely to find their way into the household waste stream than are large desktop PCs and there will be a need to improve multilevel sorting and improved attitudes towards small WEEE among households.

3 Methodology

3.1 Product groups included

The Energy-using Products included in this Memorandum can be seen in Table 3.1.

Table 3.1 Groups included

Lot 1	Boilers and combi-boilers (gas/oil/electric)
Lot 2	Water heaters (gas/oil/electric)
Lot 3	Personal Computers (desktops & laptops) and computer monitors
Lot 4	Imaging equipment: copiers, faxes, printers, scanners, multifunctional devices
Lot 5	Consumer electronics: televisions
Lot 6	Standby and off-mode losses of EuPs
Lot 7	Battery chargers and external power supplies
Lot 8	Office lighting
Lot 9	(Public) street lighting
Lot 10	Residential room conditioning appliances (aircon and ventilation)
Lot 11	Electric motors 1-150 kW, water pumps (commercial buildings, drinking water, food, agriculture), circulators in buildings, ventilation fans (non-residential)
Lot 12	Commercial refrigerators and freezers, including chillers, display cabinets and vending machines
Lot 13	Domestic refrigerators and freezers
Lot 14	Domestic dishwashers and washing machines.
Lot 15	Solid fuel small combustion installation (in particular for heating)
Lot 16	Laundry driers (new)
Lot 17	Vacuum cleaners (new)
Lot ?	Simple Converter Boxes for digital television (Simple STBs).
Lot 18	Complex set top boxes (with conditional access and/or functions that are always on)
Lot 19	Domestic lighting part I
Lot ?	Domestic lighting phase II (new)

3.2 Life Cycle Assessment

The environmental screening in this Memorandum is based on the principles of Life Cycle Assessment (LCA) (The assessment of the environmental aspects, following a product from “cradle to grave” i.e. from extraction of raw materials to production, use, including recycling and final disposal).

For the screening in this Memorandum, the impact assessment method “STEPWISE 2006” has been used. STEPWISE 2006 has been developed by Bo Weidema and is based on the best parts of the EDIP-2003 method combined with the best parts of the IMPACT-2002+ method. Furthermore, new impact categories have been added (e.g. nature occupation). The method is described in Weidema et al. [Wei2008]. Table 3.2 shows the impact categories included in this Memorandum.

The aim of the environmental screening is to identify “hot spots” in the life cycle of the products, i.e. to identify the most important environmental aspects of the products in their entire life cycle from cradle to grave. However, it should be emphasized that the aim of the EuP Preparatory studies mainly is to focus on reducing the energy consumption during use (but also during other life cycle stages). Accordingly, the conclusions in this Memorandum attempt to focus on other environmental aspects than energy related environmental impacts, if relevant (and possible).

Due to the time available, the screening has only been performed where data has been immediately ready in the Ecoinvent database (The Ecoinvent database is the main European database for Life Cycle Assessments today, see www.ecoinvent.ch). For some product groups, data has not been available in Ecoinvent, at an environmental screening of these product groups has not been performed, as that would be too time demanding.

It has further been decided to show the results as characterized results. Weighting, that shows which of the environmental impacts that are most critical to nature and human beings, has generally not been included. The reason for this is that the weighting will show that the energy-related impact categories are most important (i.e. Global Warming) – but in this project we want to focus on the non-energy related environmental impacts.

The screening is performed in the LCA software tool SimaPro version 7.1.6.

Table 3.2 Impact categories included

Impact categories	IMPACT 2002+	UMIP (/EDIP)
Global warming		X
Ozone layer depletion	X	
Photochemical Ozone formation (impacts on vegetation.) [1)]		X
Respiratory organics / Photoch. Ozone form. impacts on human health") [1)]		X
Respiratory inorganics [2)]	X	
Acidification		X
Terrestrial eutrophication		X
Aquatic eutrophication		X
Human toxicity, carcinogens	X	
Human toxicity, non-carcinogens	X	
Aquatic ecotoxicity	X	
Terrestrial ecotoxicity	X	
Ionizing radiation	X	
Non-renewable energy	X	
Mineral extraction	X	
Nature occupation	Developed in the STEPWISE 2006 method	

Notes:
1) The contributions to the formation of photochemical ozone formation come from volatile organic compounds (VOCs), hydrocarbons, nitrogen oxides, methane and carbon monoxide. Ozone in the troposphere can be toxic for humans (at high concentrations) and at lower concentrations it has impacts on vegetation. It is also known as “smog” in large cities (however, the category “photochemical ozone formation” is broader than “smog”).
2) Respiratory inorganics comes from small particulates, ammonia, carbon monoxide, nitrogen oxides and sulphur dioxides. It is generally known from the discussion regarding emissions of small particles from diesel cars and their impacts on especially people suffering from asthmatics.

3.3 Data sources for the environmental screening

The environmental screening of selected Energy-using product groups has been based on data from the Ecoinvent database version 2 to the extent that data has been available. The Ecoinvent database is a comprehensive LCA database. For more information, see www.ecoinvent.ch. It has been decided not to include input-output databases in this screening as the data in input-output databases are mainly energy-related, and as the goal of this project is to focus on non-energy related environmental impacts.

Table 3.3 shows a list of for which Energy-using Products, Ecoinvent data have been available. For some of the Energy-using Product Groups, no data is available, and it has not been possible to make a screening.

Table 3.3 Data sources

EuP Product Group	Data
Lot 1: Boilers and combi-boilers (gas/oil/electric)	The Ecoinvent Database
Lot 2: Water heaters (gas/oil/electric)	Results from Lot 1 have been used as proxy.
Lot 3: Personal Computers (desktops & laptops) and computer monitors	The Ecoinvent database
Lot 4: Imaging equipment: copiers, faxes, printers, scanners, multifunctional devices	The Ecoinvent database
Lot 5: Consumer electronics: televisions	LCD monitors from Lot 3 has been used as proxy
Lot 6: Standby and off-mode losses of EuPs	No data available.
Lot 7: Battery chargers and external power supplies	The Ecoinvent database
Lot 8: Office lighting	No data available
Lot 9: (Public) street lighting	No data available
Lot 10: Residential room conditioning appliances (aircon and ventilation)	The Ecoinvent database
Lot 11: Electric motors 1-150 kW, water pumps (commercial buildings, drinking water, food, agriculture), circulators in buildings, ventilation fans (non-residential)	No data available.
Lot 12: Commercial refrigerators and freezers, including chillers, display cabinets and vending machines	No data available.
Lot 13: Domestic refrigerators and freezers	No data available.
Lot 14: Domestic dishwashers and washing machines.	No data available
Lot 15: Solid fuel small combustion installation (in particular for heating)	The Ecoinvent database
Lot 16: Laundry driers	No data available
Lot 17: Vacuum cleaners	No data available
Lot ?: Simple Converter Boxes for digital television (Simple STBs).	No data available
Lot 18: Complex set top boxes	No data available
Lot 19: Domestic lighting part	No data available
Lot ?: Domestic lighting phase II	No data available

The screening is based on the Ecoinvent database as it is when delivered with SimaPro. No changes have been made, not regarding electricity production nor regarding any other allocation/ system expansion issues. That means that the electricity production for most processes is based on the average production mix for Europe (called “RER mix” in the Ecoinvent database). A few of the processes are modelled using the Swiss electricity production mix (for the ventilation systems). The choice of electricity mix is significant for the results. The RER production mix and the Swiss production mix can be seen in Table 3.4. Data on the electricity mix are taken from the Ecoinvent report no. 6_XVI by Frischknecht et al. [Fri2007]

Table 3.4 Electricity production mix for Europe (RER) and Switzerland (CH). (Source: Frischknecht et al. [Fri2007])

Electricity production based on:	Electricity production mix for Europe (RER)	Electricity production mix for Switzerland (CH)
Fossil fuels	50.7%,	1.8%
Nuclear power,	29.2%	39.9%
Hydro power,	14.4%	53.7%
Waste incineration	1.2%	3.1%
Hydropower at pumped storage plant	1.1%	1.4%
Wind power and other “new energy types (electricity produced on wood and biogas etc.).	3.3%	0.1%

As can be seen from Table 3.4, Swiss electricity production is hardly based on fossil fuels, whereas half of the average European electricity production is based on fossil fuels. That makes a significant difference regarding the environmental impacts, see figure 3.1. Figure 3.1 also shows the environmental impacts of electricity based on coal, hydro power and nuclear power in order to illustrate how huge the differences are. The European average electricity production and electricity based on coal gives tremendously larger contributions for almost all impact categories, but for the categories “Non-renewable energy” and “Mineral extraction”.

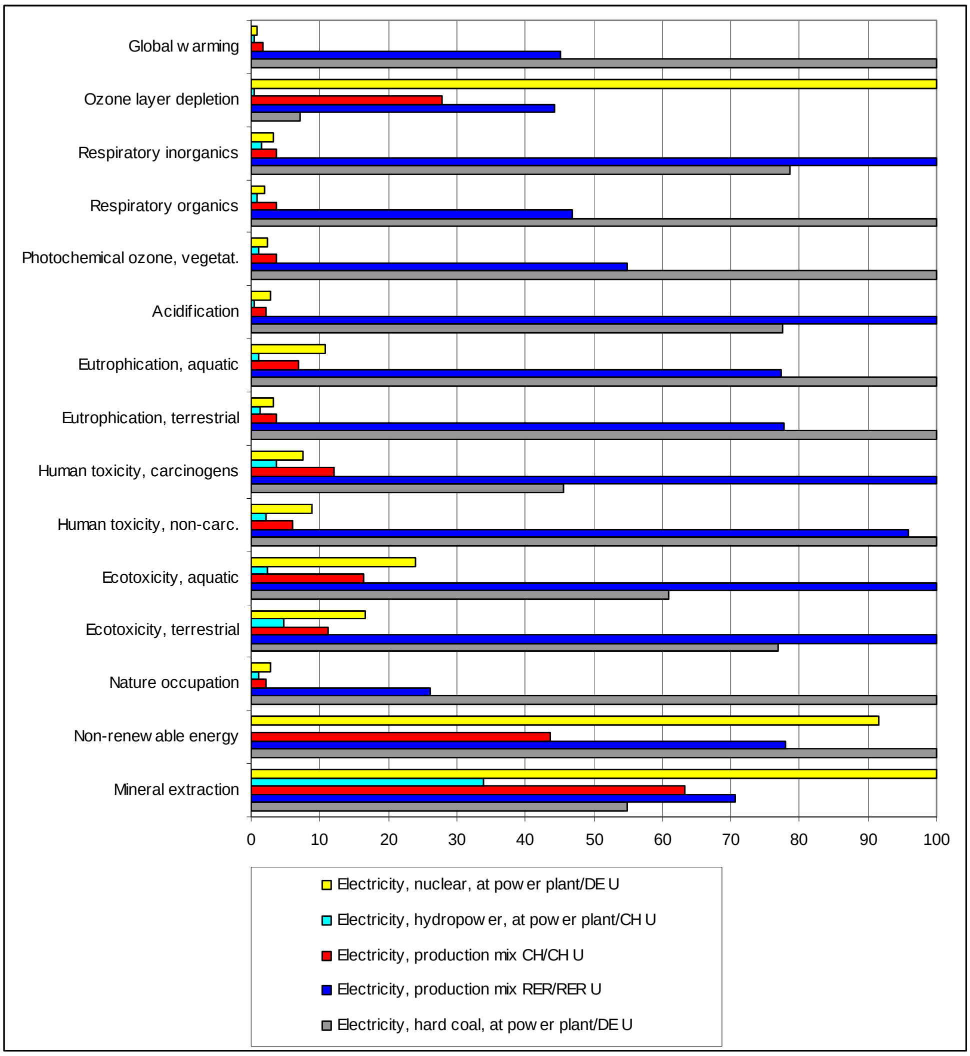

Figure 3.1 Environmental impact from electricity production (European average, Swiss average, hydropower, nuclear power and coal.).

4 Boilers and combi-boilers (gas/oil/electric) and water heaters (gas/oil/electric) (Lot 1 and 2)

4.1 Background

The Ecoinvent database includes data on boilers. However, there are no data on "water heaters". For this screening purpose, it has been assumed that the environmental focus points of water heaters are close to the environmental focus points of boilers. Accordingly, the two product groups are discussed together in spite of they constitute two different studies in the EuP scheme.

In the EuP preparatory studies, the following definitions have been used:

- A boiler is defined as an appliance designed to provide hot water for space heating. It may (but need not) be designed to provide domestic hot water or other functions as well.
- A water heater is defined as an appliance designed to provide hot sanitary water. It may (but need not) be designed to provide space heating or other functions as well.

The EuP studies for Lot 1: Boilers and combi-boilers (gas/oil/electric) and Lot 2: Water heaters (gas/oil/electric) were conducted from February 2006 to October 2007. The Final Commission workshop was held 11 September 2007. Both studies are concluded and the final documents and background information produced for the studies are available on www.ecoboiler.org and www.ecohotwater.org. The Executive Summary of the Eco-boiler project states:

"In 2005 the space heating function of gas- and oil-fired central heating boilers consumed 10.880 PJ primary energy (ca. 250 mtoe) and emitted 16-17% of all fuel-related CO2 in the EU-25. Carbon emissions are of the same magnitude as with the total Road Transport.

Around 5 % of acidification emissions (NOx, SOx) in the EU-15 can be attributed to the space heating function of boilers.

For most environmental impact categories (Global Warming, Acidification, etc.) 80-99 % of impacts follow from the use phase of the products and are mostly directly linked to energy efficiency"

4.2 Environmental screening based on the Ecoinvent database

The Ecoinvent database contains a range of processes that are relevant for the product groups "combi-boilers (gas/oil/electric)" and "water heaters (gas/oil/electric)":

- Heat, heavy fuel oil, at industrial furnace 1MW, European electricity *
- Heat, light fuel oil, at boiler 100kW condensing, non-modulating
- Heat, light fuel oil, at boiler 100kW, non-modulating
- Heat, light fuel oil, at boiler 10kW condensing, non-modulating

- Heat, light fuel oil, at boiler 10kW, non-modulating, Swiss electricity *
- Heat, light fuel oil, at industrial furnace 1MW (European electricity)
- Heat, natural gas, at boiler atm. low-NOx condensing non-modulating <100kW
- Heat, natural gas, at boiler atmospheric low-NOx non-modulating <100kW
- Heat, natural gas, at boiler atmospheric non-modulating <100kW
- Heat, natural gas, at boiler condensing modulating <100kW (European electricity) *
- Heat, natural gas, at boiler condensing modulating >100kW
- Heat, natural gas, at boiler fan burner low-NOx non-modulating <100kW
- Heat, natural gas, at boiler fan burner non-modulating <100kW
- Heat, natural gas, at boiler modulating <100kW
- Heat, natural gas, at boiler modulating >100kW
- Heat, natural gas, at industrial furnace >100kW,European electricity *
- Heat, natural gas, at industrial furnace low-NOx >100kW

However, the environmental screening for Boilers and combi-boilers (gas/oil/electric) and water heaters (gas/oil/electric) are only based on a few of these Ecoinvent processes, as the results "on a general view" leads to the same conclusions (however, the boilers based on heavy fuel oil has significant higher contributions to many environmental impacts, as expected). The Ecoinvent processes marked with a "*" has been used for the screening.

The Ecoinvent processes for boilers only include the production of the boilers and the use. The final disposal of the boiler has (to our knowledge) not been included.

From Figure 4.1 shows that when burning heavy fuel oil in a large 1 MW industrial furnace, the main contributions to all environmental impacts come from burning the heavy fuel oil and from the extraction and processing of the heavy fuel oil. The construction of the industrial furnace itself, construction of the chimney and construction of the oil storage are insignificant relative to the contributions from extraction and burning of the heavy fuel oil.

However, when dealing with smaller boilers (light fuel oil, burned in boiler 10kW, non-modulating), the construction of the boiler and the oils storage ***do*** have significance, see Figure 4.2:

- For the impact category "Mineral extraction", it is especially the consumption of nickel, copper, iron, aluminium and chromium (used as construction materials for the boiler and the oil storage) that contributes.
- For the impact category "Terrestrial ecotoxicity" emissions of zinc, copper, nickel, mercury, chromium, lead, cadmium and arsenic are the main contributors.
- For the impact category "Aquatic ecotoxicity" emissions of zinc, aromatic hydrocarbons, barium, copper and chromium are the main contributors.
- For the impact category "Human toxicity (non-carcinogens)", emissions of arsenic, dioxins and zinc are the main contributors. The dioxin emissions mainly come from steel production.

The electricity consumption is not very significant in Figure 4.1 and Figure 4.2. As discussed in chapter 3, the electricity production in the Ecoinvent database is mainly based on “Swiss electricity production”. When changing this to “electricity production based on hard coal”, the total environmental impacts in general are raised by 5 %. Accordingly it can be concluded that the electricity consumption for the systems should not be the main focus area.

The natural gas based boilers (Figure 4.3. and Figure 4.4) gives a clear picture: For global warming, the most significant contribution comes from burning the natural gas. For most other environmental impacts the main contributions come from extraction and processing of the natural gas. As for the small oil based boilers, the production of the boiler itself contributes to “Mineral extraction” and “Ecotoxicity, terrestrial”.

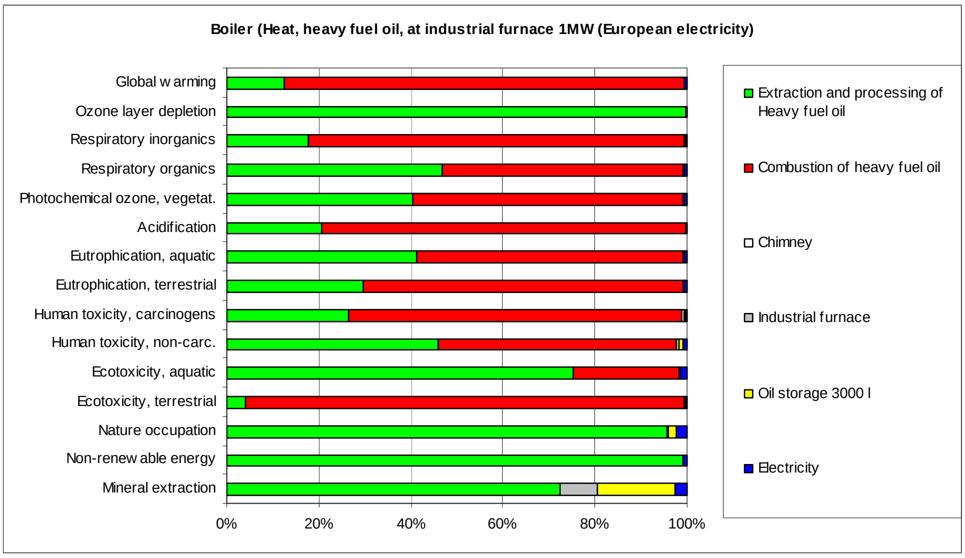

Figure 4.1 Environmental impacts from the production and use of a boiler (Heat, heavy fuel oil, at industrial furnace 1MW (European electricity))

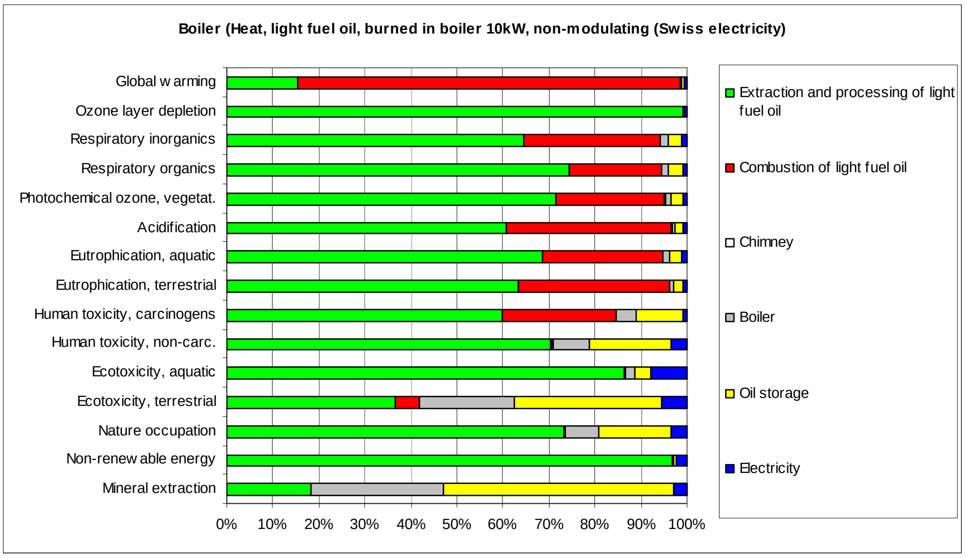

Figure 4.2 Environmental impacts from the production and use of a boiler (Heat, Light fuel oil, burned in boiler 10kW, non-modulating (Swiss electricity))

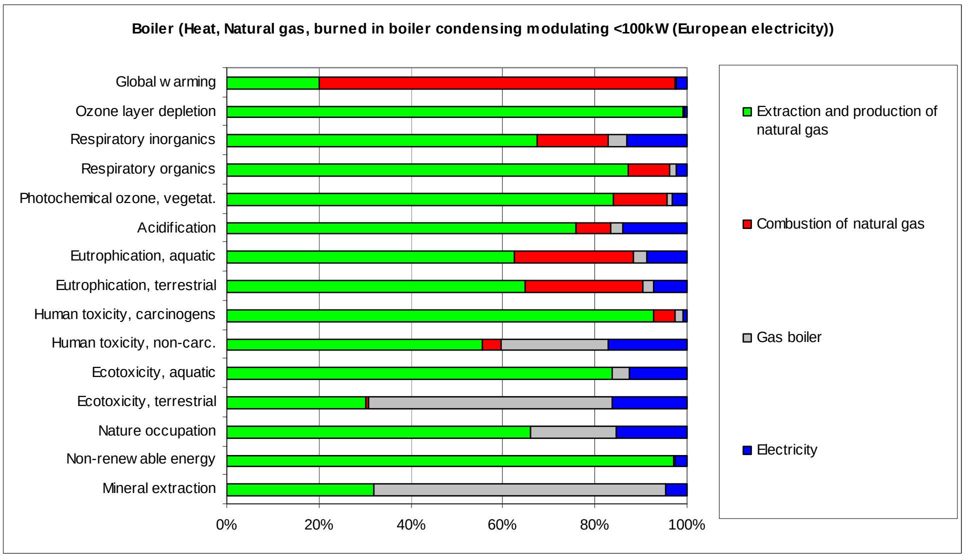

Figure 4.3 Environmental impacts from the production and use of a boiler (Heat, Natural gas, burned in boiler condensing modulating <100kW (European electricity))

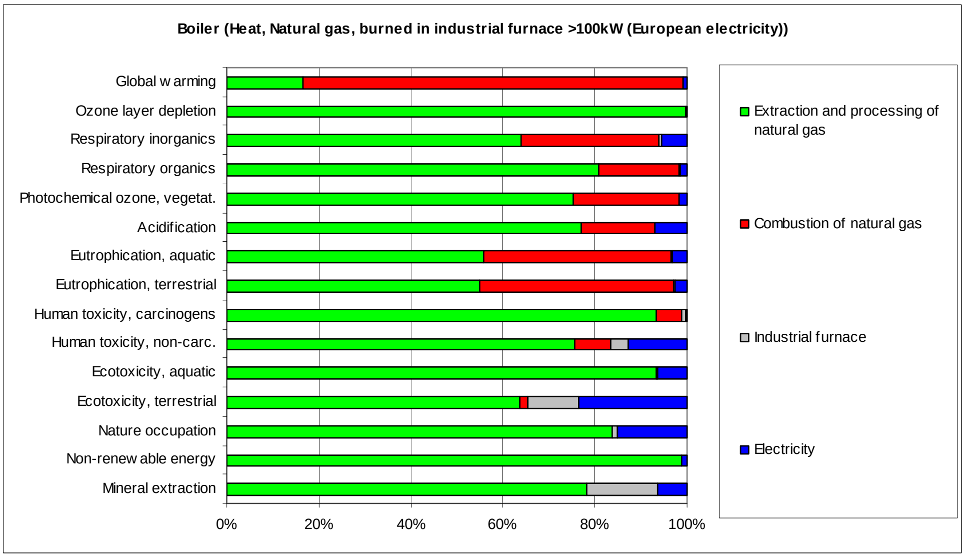

Figure 4.4 Environmental impacts from the production and use of a boiler (Heat, Natural gas, burned in industrial furnace >100kW (European electricity)).

4.3 Ecolabel requirements

In the Nordic Ecolabelling programme there is a criteria document for Swan labelling of boilers and burners for liquid and gas fuels [NE2005].

The product group in the Ecolabel document encompasses installations for heating dwellings (installations up to 120 kW). The focus points of the Swan Ecolabel criteria document are:

- Emissions into the atmosphere of nitrogen oxide (NOx), volatile hydrocarbons (HC) and carbon monoxide (CO) and soot values
- Energy efficiency
- Additives in plastic parts: Heavy metals (Cadmium (Cd), Lead (Pb), Mercury (Hg) or their compounds), phthalates and flame retardants (especially polybrominated biphenyls (PBB), polybrominated diphenyl ethers and high-chlorinated short-chained chloroparaffins).

- Additives in paints and other surface treatment agents: Heavy metals (lead, cadmium, chromium, mercury or their compounds.) and organic solvents.
- Additives in metal plating (chromium, nickel or their compounds).
- Halogenated solvents in degreasing agents
- Substances with a climatic effect in foaming agents used in insulating materials

Those parts of an installation that are eligible for a Swan label are: the burner and boiler itself up to the opening of the chimney, and parts sold together with the installation and essential for the installation to be capable of fulfilling the Swan requirements. This means that if the installation is, for example, fitted with oxygen regulating equipment and if this equipment is necessary in order to fulfil the Swan label requirements, then it will be encompassed by the requirements applicable to materials unless otherwise specified. And if the installation needs to be combined with solar heating in order to fulfil the requirements, then the solar heating equipment will form part of the system.

Nordic Ecolabelling consider to incorporate criteria regarding requirements to the technique for inhibiting corrosion for condensing boilers in the next revision of the criteria for boilers and burners for liquid and gas fuels.

4.4 Technology and market trends

Until today there has been little EU policy to improve efficiency of electric water heaters, due to the lack of suitable measurement standards, the many different types of water heaters (gas, district heating, solar, electric). Past activities for electric water heaters have concentrated on storage (tank) models and in particular on the reduction of the standing losses, through increased insulation.

The only real policy action was a unilateral agreement by the main European manufacturers through their trade association, CECED. The agreement was concluded by the manufacturers at the end of 1999, and lasted till the end of 2003. The main terms of the agreement where: 1) a standing losses declaration in the form of additional and clearly visible data; 2) a stepwise phase-out of less efficient appliances ranking in certain draft energy label classes; and 3) a reduction of the European fleet consumption of appliances, as calculated by a notary system heaters [CEC1999]. The first report published in year 2003 [CEC2003] and covering the year 2001 reported successful implementation by manufacturers, reaching the agreed target.

A promising emerging technology allows for co-production of electrical power and heat in the same unit. In this method, coal-derived fuel compositions are prepared while simultaneously producing electricity utilizing a co-generation configuration based on the so-called hydrodisproportionation of coal. The char produced from the coal is gasified to simultaneously produce steam for electrical power generation and syngas to produce methanol. The methanol purge gas is used as a fuel gas for a gas-driven power generating turbine. The waste heat from the power generation is used as the process heat for hydrodisproportionation. Co-producing boilers are only suitable for large-scale heat generation plants.

Another step towards a reduced global warming (and other energy-related environmental impacts) is to combine the natural gas boilers with existing alternative energy systems such as solar panels, air-water heat pumps, borehole heat exchangers etc.

In Denmark most heating installations are installed in the form of boilers or combi-boilers, i.e. an appliance designed to provide hot water for space heating and possibly domestic hot water or other functions as well. Several attempts to rethink the concept of houses are reported.

In one Danish project, a new energy-producing house is being built. The main objective in the project is construct a house, in which there is no costs for heat or electricity, because the house itself produces all the energy needed. The main principle for achieving this is to use solar power for producing electricity and hot water combined with geothermic heat. Ventilation is combined with a highly efficient heat recovery system. A room for drying clothes saves the tumble drier. A cold room for food storage minimizes the size of the refrigerator. The Danish window manufacturers Velfac and Velux are partners in the project and the plan is to build 8 of these houses in Europe; the first one is built in Århus. For more information (in Danish) see:

http://politiken.dk/tjek/bolig/energi/article499225.ece
http://politiken.dk/tjek/bolig/energi/article499142.ece
http://www.ue.dk/nyhedsarkiv/22156.aspx

4.5 Conclusion

The main road to a significant overall improvement in environmental impacts from boilers and water heaters is achieved by applying a systemic, life-cycle based approach and not a product oriented approach. Central generation of heat and hot water should be encouraged with all available instruments, while continuous environmental improvements in intelligent distribution networks should be supported and promoted.

Moreover, in the long term, a rethinking of the entire concept of “providing hot water for space heating and hot sanitary water” is needed. Or even better – rethinking the entire concept of “keeping a house warm at winter and cold at summer” plus “providing hot sanitary water” should be stimulated.

To facilitate this, competent authorities should fund and promote a number of “energy production houses” or, at least “energy neutral houses” across Europe. These new concepts and technologies are in the process of being demonstrated and evaluated, and can form the basis for formulation of demands on new buildings with regard to “energy production”.

4.5.1 Environmental impact in a system and life-cycle perspective

The main contributions to the overall environmental impacts come from combustion and extracting oil and gas. When using the STEPWISE2006 weighting method, the most significant environmental impacts from boilers are Global Warming and “Respiratory inorganics” (leading to respiratory troubles for especially asthmatics), mainly from nitrogen oxides, sulphur dioxide and small particulates.

The extraction of non-renewable energy resources is significant, and it is totally dominated by the extraction of oil and gas for the combustion during use of the boilers. The extraction of non-energy related resources (called

"Extraction of minerals" in the screening) is dominated by the extraction of minerals for the boilers, for oil storages and for material used for oil and gas extraction.

The most important materials are (not in amounts but when including perspectives for the future possibilities for extracting these materials): Nickel, copper, iron, aluminium and chromium (used as construction materials for the boiler and the oil storage)

The emissions of heavy metals during extraction of construction materials for the boilers and oil storage also give contributions to ecotoxicity and human toxicity. These are relatively more significant for smaller boilers (household size) as the oil and gas combusted in these are relatively lower. In the Ecolabel requirements for boilers some of these heavy metals must not be added to plastic parts, in the surface treatment and as metal plating.

Other environmental issues regarding boilers that could be mentioned are leaking of oil storage tanks polluting the ground water and handling and treatment of discarded oil storage tanks.

4.5.2 Environmental perspective from new technologies

The energy efficiency improvement potential for boilers and water heaters is considerable, especially when employing a system approach.

The EuP background study assumes that at Least Life Cycle Cost (LLCC) targets on average an energy saving of close to 40% per unit can be achieved with respect of the Base Case. With Best Technology (BAT) the energy efficiency improvement can be over 60%.

Carbon and NOx emission reductions per unit are in the same order of magnitude. For NOx an extra saving can be achieved with an additional emission limit value of 20 ppm, which would bring the EU in line with best international legislative practice.

Improvements are also foreseen if the market is stimulated in the direction of co-producing boilers that produce both heating and electricity. Also larger industrial furnaces should be based on a combination of natural gas boilers and alternative energy sources.

However, improving the energy efficiency of the existing boiler systems will not contribute radically towards reduced global warming, as long as the boiler systems are based on the combustion of oil and natural gas. In order to promote alternatives to gas, oil and electricity based boilers and water heaters, competent authorities at the national and EU level should promote and facilitate investment in technical improvements of solar heating systems, geothermic energy, heat pumps, etc.

4.5.3 Regulation

The EuP background study proposes to support minimum targets with a comprehensive labelling scheme, featuring 10 efficiency classes (A-G and more) as well as 9 size categories (small/ medium/large/ etc.). EU-wide consistency of EPBD standards would further promote energy efficient products and remove EU-internal trade barriers. Global competitiveness of the EU-industry will be enhanced rather than diminished by the measures, as current EU-legislation is significantly behind Japan, US, Canada, etc. in terms of ambition. Installers will benefit from the holistic approach, as it will help them to also install more sophisticated systems that are pre-set and pre-assembled.

Moreover, it will probably give environmental benefits if setting requirements to the content of heavy metals in additives to plastic parts, surface treatment and metal plating, as done in the Ecolabel criteria. It is assumed that environmental benefits can be achieved if requirements regarding the content of heavy metals in additives to plastic parts, surface treatment and metal plating, is introduced as is the case in the Ecolabel criteria.

The successful deployment of co-producing boilers in the consumer market requires that appropriate buy-back schemes exists for public utilities, in order that the consumer can sell excess electricity back into the electricity grid.

5 Personal computers (desktops and portables) & monitors (Lot 3)

5.1 Background

The Preparatory study for the Personal Computers (desktops & laptops) and computer monitors (Lot 3) uses the following product definition for personal computers:

A device which performs logical operations and processes data. Personal computers are composed of, at a minimum: (1) a central processing unit (CPU) to perform operations; and (2) user input devices such as a keyboard, mouse, digitizer or game controller.

For the purposes of this study, personal computers include both stationary and portable units, including desktop computers, integrated computers, notebook computers and tablet PCs. For further definitions of these computer categories, the Energy Star definitions are applicable.

Note that workstations, desktop-derived, mid-range and large servers, game consoles, thin clients/blade PCs, handhelds and PDAs are not included in this product definition of personal computers, and will therefore not be covered by this study [IVF2007].

According to an Eco-design study on Personal Computers and Monitors [ECC2006] in 2005 there were about 105 millions desktop, 24 millions laptops and 104 million monitors (of which 47 were flat panel) installed in household in the EU-25. As the short life-time of the computers is very significant for the overall results, improvement options regarding life-time extension are important (designing computers for easy change of important parts like the memory, the hard disk etc.).

The Preparatory study for the Personal Computers estimates the number of personal computers and laptops in use world to approach half a billion by 2020

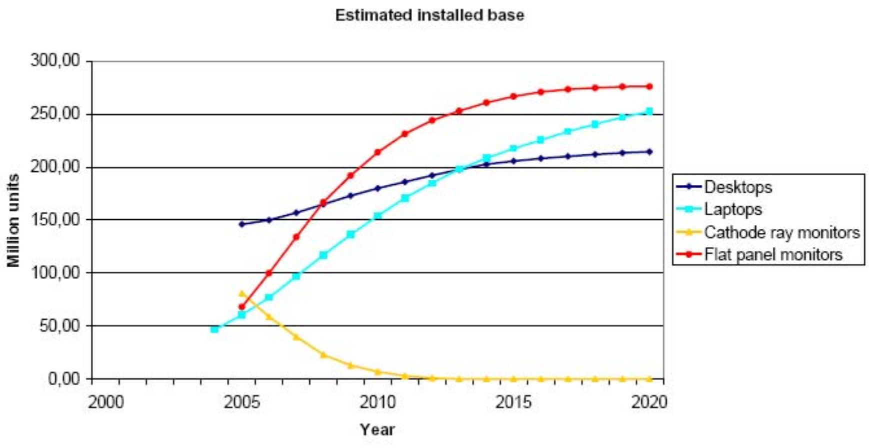

Figure 5.1 Estimated installed base of personal computers in 2020 (Source: [IVF2007])

5.2 Environmental screening based on the Ecoinvent database

The environmental screening for Personal Computers and Computer monitors is based on the Ecoinvent processes:

- Use, computer, desktop with CRT monitor, active mode
- Use, computer, desktop with LCD monitor, active mode
- Use, computer, laptop, active mode
- Desktop computer, without screen, at plant
- Laptop computer, at plant
- CRT screen, 17 inches, at plant
- LCD flat screen, 17 inches, at plant
- Keyboard, standard version, at plant
- Mouse device, optical, with cable, at plant

Figure 5.2, figure 5.3 and figure 5.4 show the contributions to the environmental impacts from the use of computers, i.e. the processes "Use, computer, desktop with CRT monitor, active mode", "Use, computer, desktop with LCD monitor, active mode" and "Use, computer, laptop, active mode". These processes include the computer, the screen, the keyboard, the mouse, transport from production to consumer and the electricity consumption during the active use of the computer. It has deliberately been chosen to show the results of the "active mode" process in contrary to the "standby-mode" or "off-mode"-processes, which is also modelled by Ecoinvent, in order to give the impression of the relative significance of the electricity consumption compared to the hardware parts.

It can be seen from the figures that when using a computer (i.e. in the "active mode"), the electricity consumption is the main contributor to all the environmental impacts, but for mineral extraction. This is not a surprise.

However, what is interesting is that even when including the energy consumption during use, the production of the hardware is significant for the overall environmental impacts. As a computer is not in "active mode" all 24 hours a day (but also "stand by" and turned off) the significance of the electricity consumptions is considerably lower.

The relative contribution from the hardware parts is highly dependant on the lifetime of the hardware. Ecoinvent has assumed a lifetime of the computers to four years, which seems reasonable.

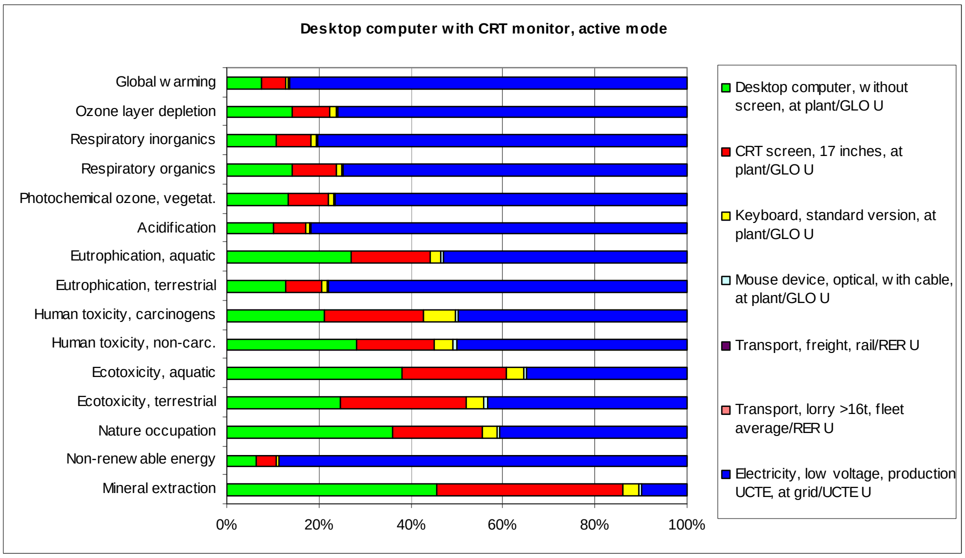

Figure 5.2 Environmental impacts from the use of a desktop computer with a CRT monitor (in active mode), including keyboard and mouse.

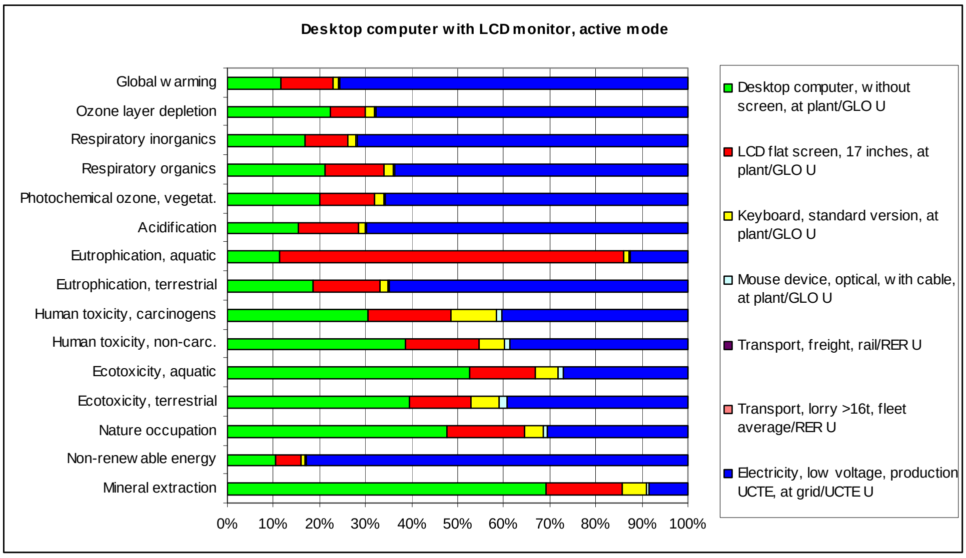

Figure 5.3 Environmental impacts from the use of a desktop computer a LCD monitor (in active mode), including keyboard and mouse.

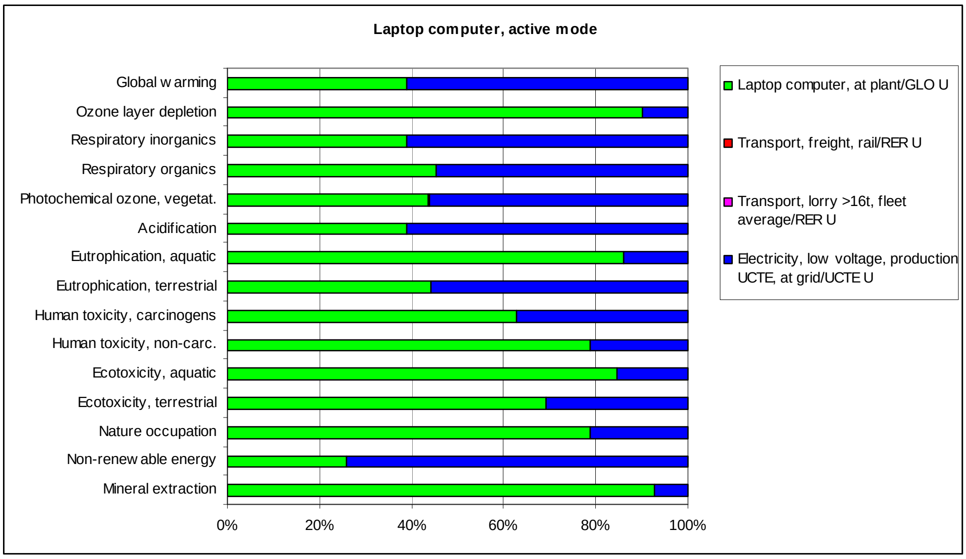

Figure 5.4 Environmental impacts from the use of a laptop computer (in active mode).

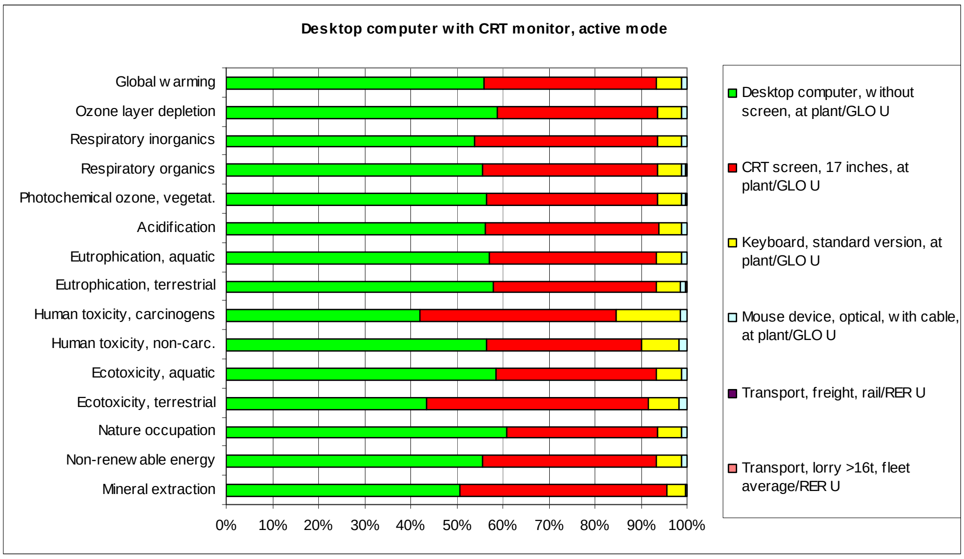

Figure 5.5 Environmental impacts from the use of a desktop computer with a CRT monitor including keyboard and mouse. Contributions from the electricity consumption during use have been omitted.

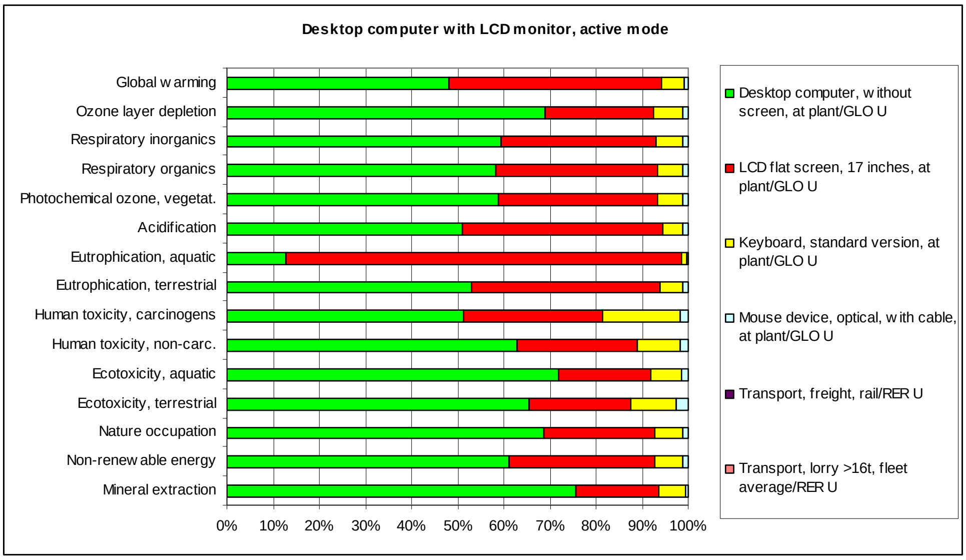

Figure 5.6 Environmental impacts from the use of a desktop computer with a LCD monitor including keyboard and mouse. Contributions from the electricity consumption during use have been omitted.

Figure 5.5 and
Figure 5.6 show the same as Figure 5.2 and figure 5.3 for a CRT and a LCD monitor respectively, but without the electricity consumption during use. From these it can be seen that the most significant contributions come from the computer and the screen.

Figure 5.7, Figure 5.8, Figure 5.9, Figure 5.10 and
Figure 5.11 show analysis of contributions from the production of a desktop computer (without screen), a laptop computer, a CRT screen (17 inches), a LCD flat screen (17 inches), a keyboard (standard version) and a mouse, all at plant.

From these figures, we can see that for the production of a desktop computer, the parts that mainly contribute to the environmental impacts are:

- The printed wiring board (and the Integrated Circuit to this, and the wafer used for the Integrated Circuit).
- The power supply unit
- The CD-ROM / DVD-ROM drive
- Steel production

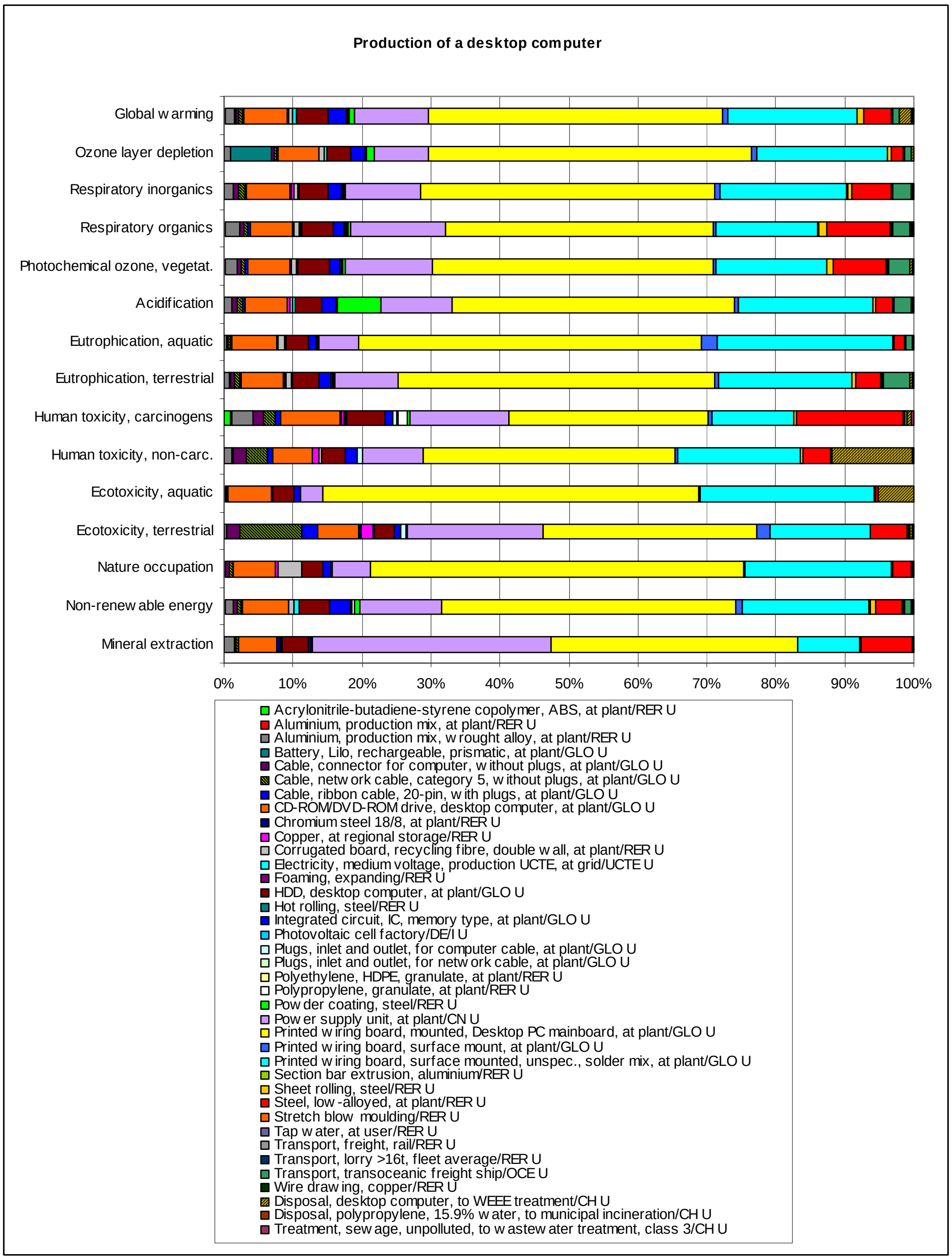

Figure 5.7 Environmental impacts from production of a desktop computer.

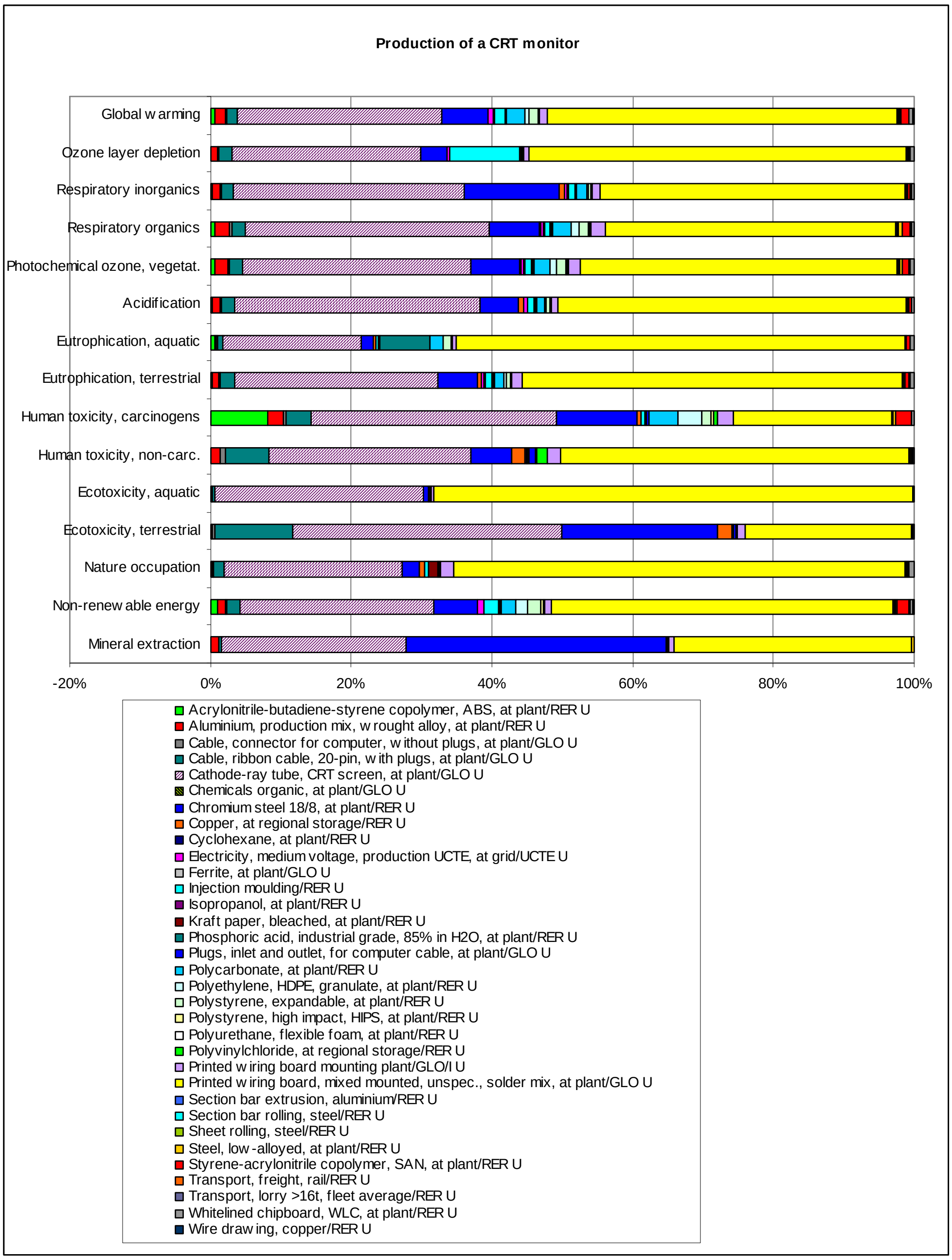

Figure 5.8 Environmental impacts from production of a CRT monitor.

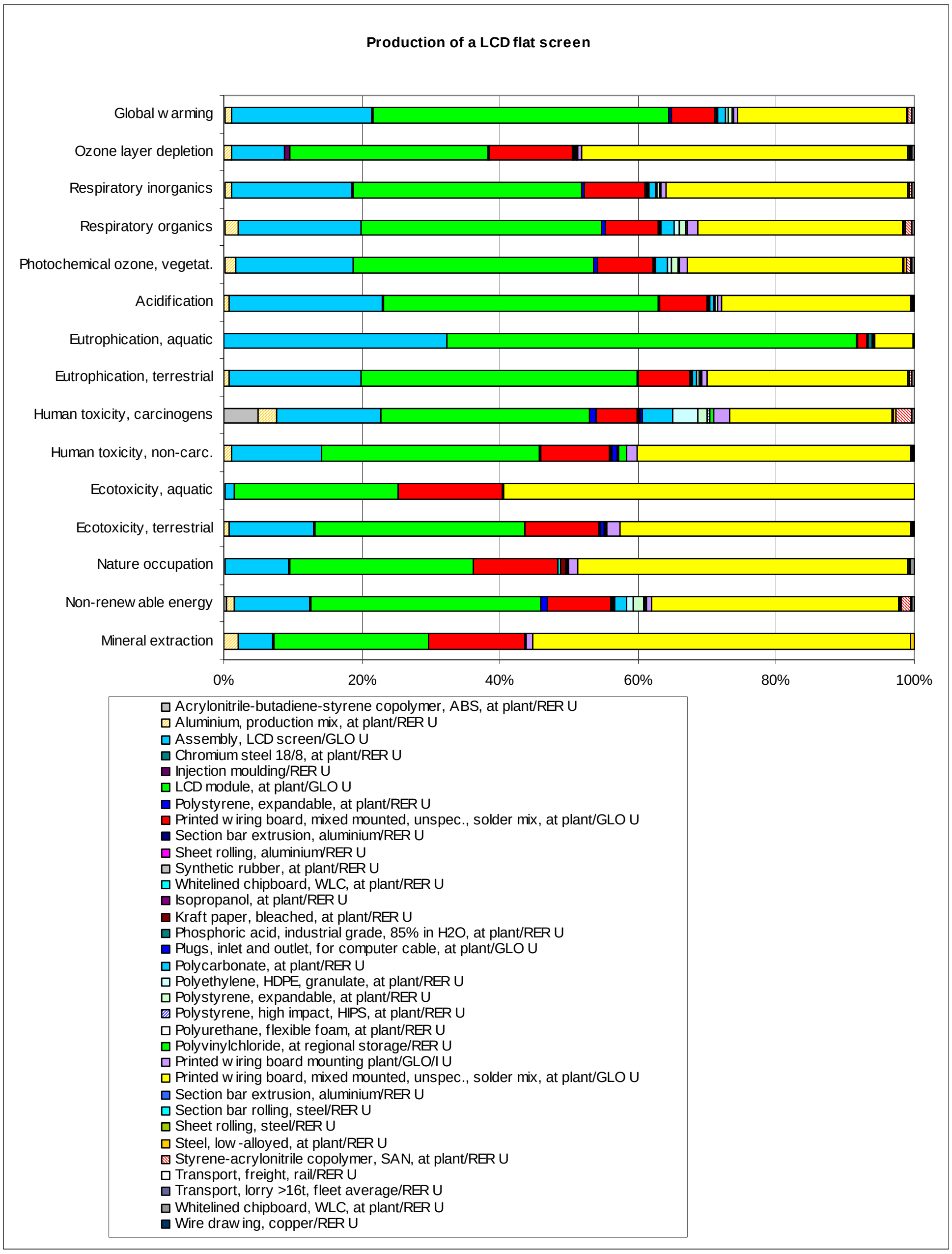

Figure 5.9 Environmental impacts from the production of a LCD flat screen.

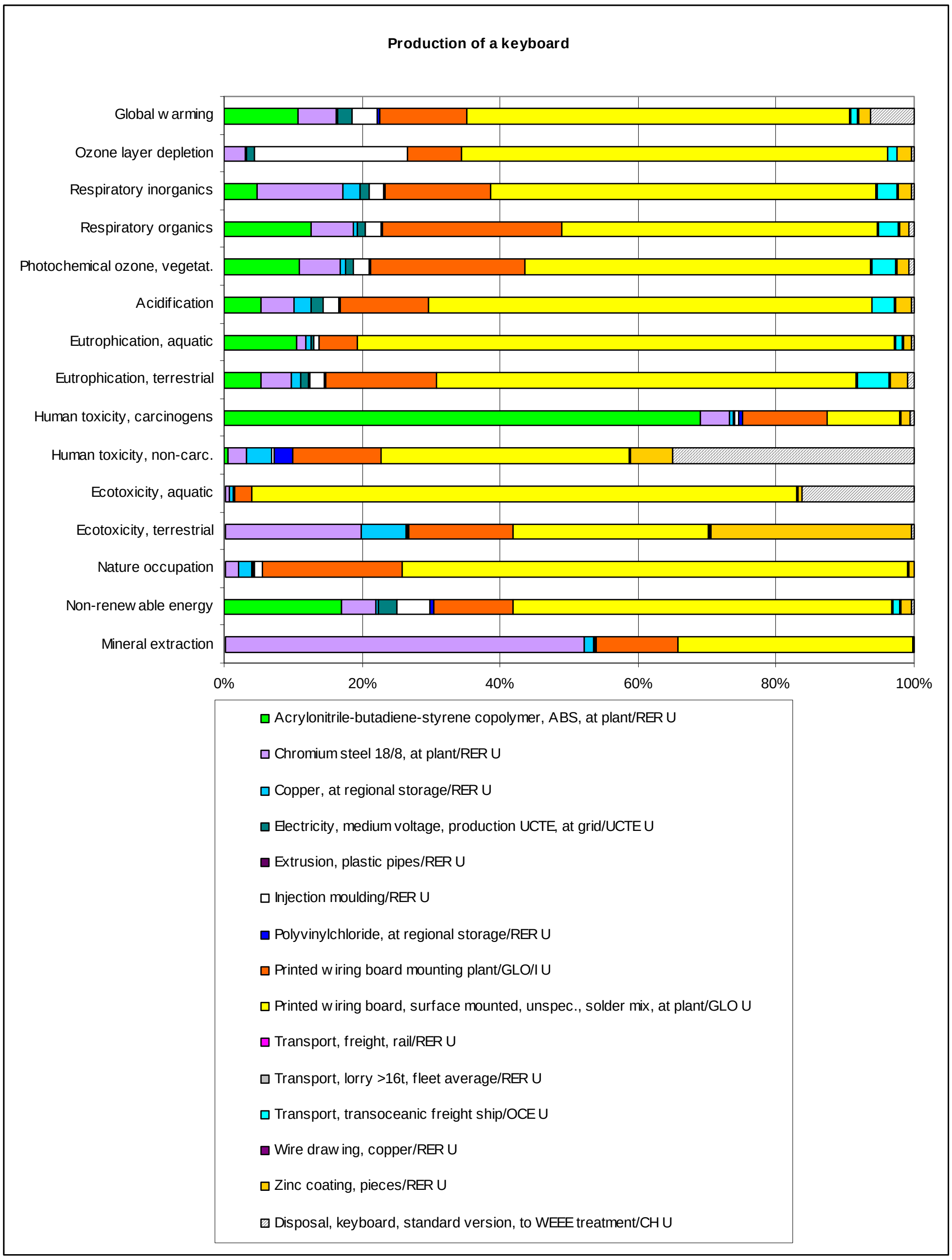

Figure 5.10 Environmental impacts from the production of a keyboard.

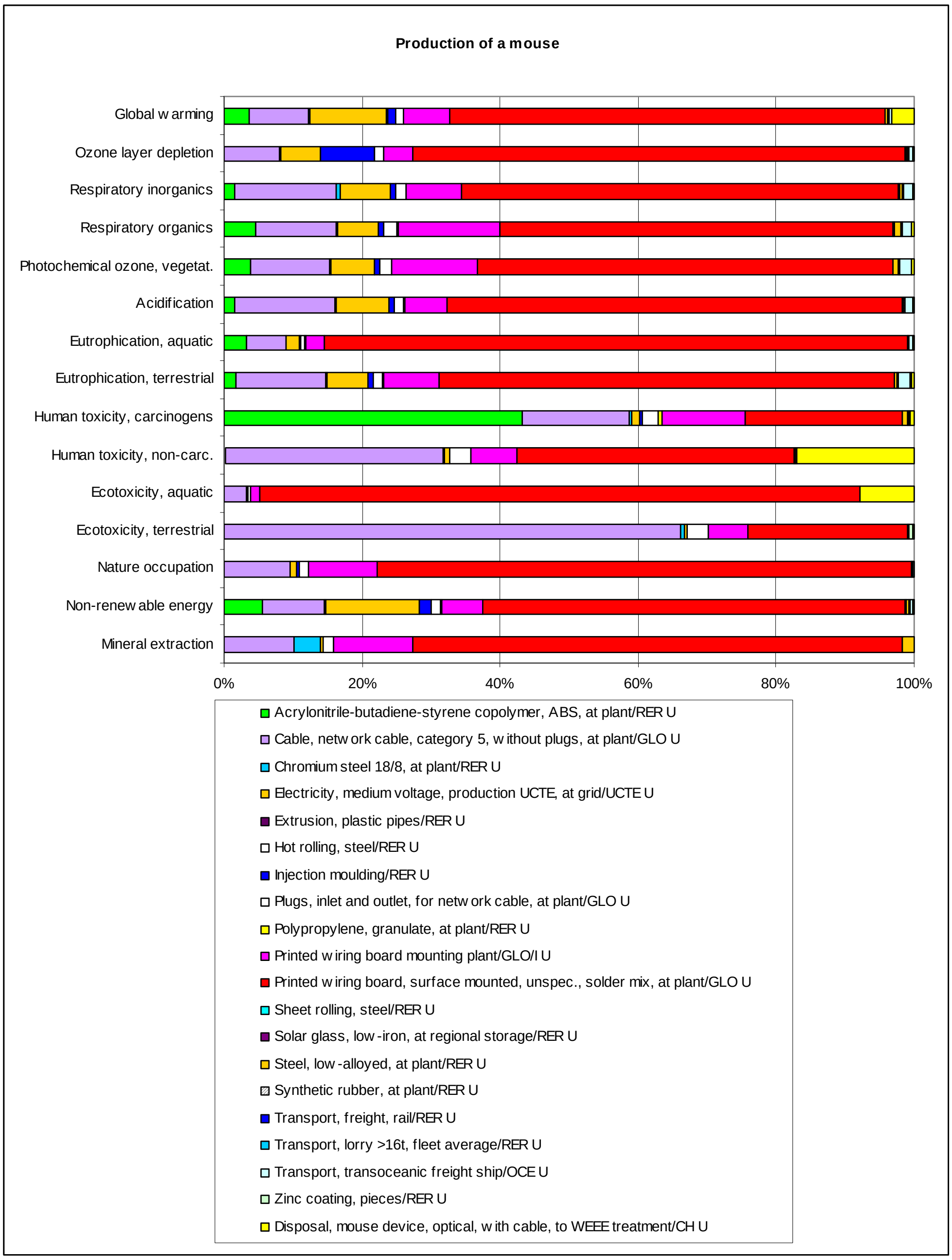

Figure 5.11 Environmental impacts from production of a mouse.

When analysing the contributions from the desktop computer, the main contributions to:

- Global warming, respiratory inorganics, respiratory organics, photochemical ozone (vegetation), terrestrial eutrophication, mainly derive from energy producing processes, especially to the energy consumption for the production of the printed wiring board and the parts for this and for the power supply unit. Also blaster, production of clinker and sinter (iron) has significance for these environmental impacts.
- Ozone layer depletion comes from the production of tetrafluoroethylene, trichloromethane, chlorodifluoromethane, for the production of wafer and from crude oil production.
- Acidification mainly comes from production of primary palladium, powder coating of steel, blasting, operation of transoceanic freight ships, primary copper production and energy production.

- Aquatic eutrophication mainly comes from production of ultrapure water, which is used in the production of the integrated circuit and the printed wiring board.
- Human toxicity (carcinogens) mainly comes from steel production, production of primary aluminium, production of primary copper and natural gas production. The contributions mainly come from aromatic hydrocarbons, arsenic, dioxins, and PAHs (polycyclic aromatic hydrocarbons).
- Human toxicity (non-carcinogens) mainly comes from the processes: disposal of hydrated cement to landfill, treatment of wafer fabrication effluent to wastewater treatment, production of primary copper, and disposal of residues from the desktop computer
- Ecotoxicity, aquatic comes from gold production (emissions of Copper, Zinc, Nickel, Mercury, Chromium, Arsenic, Lead and Cadmium).
- Ecotoxicity, terrestrial comes from production of primary copper, primary zinc, and production of the printed wiring board and steel production (emissions of Copper, Zinc, Nickel, Mercury, Chromium, Lead, Arsenic, Cadmium and Cobalt)
- Nature occupation mainly comes from disposal of sulfidic and non-sulfidic tailings in non-ferrous metal extraction and gold mining.

For the CRT-screen, the main environmental impacts come from the production of the cathode-ray-tube and printed wiring board.

For the LCD-screen, the main environmental impacts come from the production of the LCD module and assembly of the LCD screen, and, again the printed wiring board.

For the keyboard, the main environmental impacts mainly come from the Printed wiring board. Zinc coating contributes to ecotoxicity, and the production of acrylonitrile-butadiene-styrene copolymer (ABS) contributes especially to human toxicity. Disposal of the keyboard contributes to human toxicity and ecotoxicity.

For the mouse, the main environmental impacts come from the production of the printed wiring board.

5.3 Ecolabel requirements

In the European Ecolabelling programme there is a criteria document for Ecolabelling of portable computers and a criteria document for personal computers ([EC2005a] and [EC2005b]). Some of the focus points of the European Ecolabel criteria documents for computers are:

- Energy consumption in “sleep state” and “off-mode”
- Energy consumption by the power supply when it is connected to the electricity supply but is not connected to the computer (for potable computers)
- Electromagnetic emissions
- The computers shall be designed for lifetime extension (the memory, the hard disk (and if available the CD drive and the DVD drive) shall easily accessible so that they can be changed
- A maximum mercury content of liquid crystal display (LCD) monitor

- The computer shall be designed for facilitate recycling (easy to disassemble).
- Plastic parts shall have no lead or cadmium intentionally added
- Plastic parts shall not contain poly-brominated biphenyl (PBB) or poly-brominated diphenyl ether (PBDE) flame retardants
- Restrictions regarding flame retardants substances
- Maximum level for mercury, cadmium and lead in batteries

The Nordic Ecolabelling system also contains criteria for personal computers. The criteria focus on following aspects: power consumption, design (upgradeability and disassembling), plastics and their additives, e.g. flame retardants, heavy metals, recycling of discarded products, performance such as noise level, ergonomics and electrical, and magnetic fields. Some of the focus points of the Nordic Ecolabel criteria documents for personal computers are [NE2007b]:

- The computer system unit shall meet the Energy Star configuration requirements that enable energy efficiency modes.
- Desktop computers shall support the ACPI S3 sleep state (suspend to RAM) to allow a power consumption of no more than 4.0 watts and the off-mode power consumption shall be no more than 2.0 watts.
- The monitor shall have a sleep mode power consumption of no more than 2.0 watts and an off-mode power consumption of no more than 1.0 watt.
- Portable computers shall support the ACPI S3 sleep state (suspend to RAM) to allow an energy consumption of no more than 3.0 watts. The power supply of the portable computer shall have a maximum consumption of no more than 0.75 watt when it is connected to the electricity supply but is not connected to the computer.
- System units, displays, keyboards and portable computers must be designed in such a way that disassembling is possible. The substances, preparations and components listed in Annex II of WEEE Directive (2002/96/EC) must be removable. 90 wt% of plastics and metals in the housing and chassis must be technically suitable for material recovery.
- The system unit of a stationary computer must have a modular design. The user shall be able to replace the modules without the use of special tools and it shall be possible to upgrade the computer.
- The housing and chassis must not contain chlorine-based plastics. Large plastic parts (>25 g) must not be painted or metallized (this requirement does not apply to portable computers).
- Plastic parts must not contain halogenated flame retardants. The use of flame retardants that can be assigned one or more risk phrases at the time of application, in accordance with EU chemical legislation, is prohibited. However, some parts are exempted.
- Materials may not contain cadmium, lead or mercury. The exemptions are the same as in Directive 2002/95/EC (RoHS).
- With the exception of technically unavoidable impurities, batteries and accumulators must not contain any lead, cadmium or mercury. Such impurities must not exceed the limit values specified in the EU Battery Directives (91/157/EEC and 98/101/EEC).

TCO is a quality and environmental labelling system, the purpose of which is to influence the development of products to ensure optimum user-friendliness and minimum impact on the environment. Desktops are assessed in the areas of ergonomics, emissions, energy, and ecology. Desktops are certified according to TCO’99:

- A flicker-free image with good brightness and good contrast.
- Considerable reduction of magnetic and electrical fields.
- Low noise levels.
- Low energy consumption for reduced environmental impact.
- The energy saving function provides a better indoor climate through reduced heat emission, thus retaining air humidity.
- Reduced emission of brominated flame-retardants, mercury, cadmium, lead and hexavalent chromium into the environment (complies with the RoHS Directive).
- Recycling preparations facilitate material recycling.
- Manufacturer ISO 14001 certified.
- Environmental characteristics of the flame-retardants used in the product have been tested.
- Information on where the computer can be turned in for recycling.

TCO'05 provides criteria for portable computers:

- High visual ergonomic requirements for the display resulting in high image quality.
- Considerable reduction of magnetic and electrical fields.
- Low noise levels.
- Low energy consumption for reduced environmental impact.
- The energy-saving function provides a better indoor climate through reduced heat emission, thus maintaining air humidity.
- Reduced emission of brominated flame-retardants, mercury, cadmium, lead, and hexavalent chromium into the environment (complies with the RoHS Directive).
- Recycling preparations facilitate material recycling.
- Manufacturer ISO14001 certified.
- Environmental characteristics of the flame-retardants used in the product have been tested.
- Information on where the computer can be turned in for recycling.

5.4 Technology and market trends

Practically all personal computers for office and private use are connected to the internet, which is a major driver for the purchase and use of computers. It is also a major driver for renewal and upgrade of hardware.

According to OECD; Denmark is positioned as number four in the world in terms of computers connected to the internet with almost 80 per cent of all computers connected [OECD2007]:

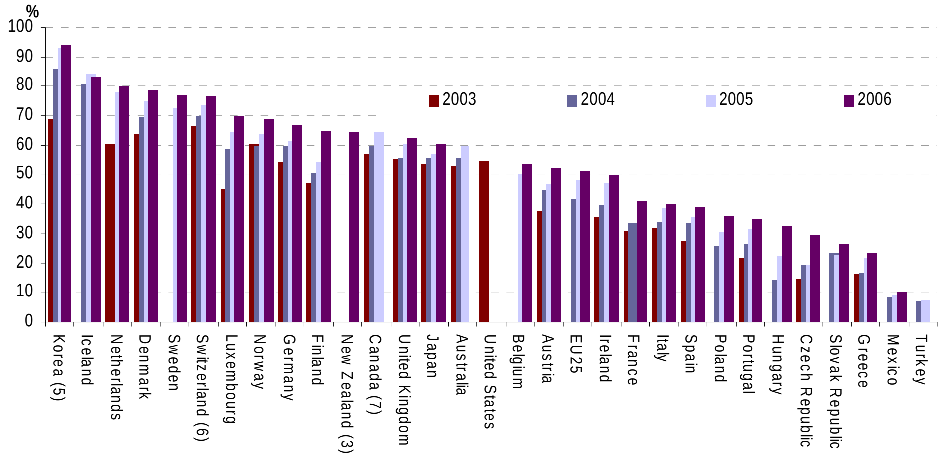

Figure 5.12 ICT usage in households and by individuals, April 2007[OECD2007].

Connection to media and rich information on the Internet require fast transmission of digital content. Broadband is thus one of the fastest among new communication technologies in Europe. The total number of broadband lines in the EU has quadrupled in just three years. In October 2005, 80% of broadband subscribers in the 25 EU Member States used DSL to connect to broadband Internet. Cable modems currently account for about 16% of all broadband connections in the EU-25 [Com2006]. In January 2006, broadband reached almost 60 million subscriber lines in the EU-25 and had a penetration rate of about 25% of households. Growth in broadband is mainly market-driven. Broadband growth is uneven across Member States. The best performers on broadband penetration have been and are the Denmark and the Netherlands.

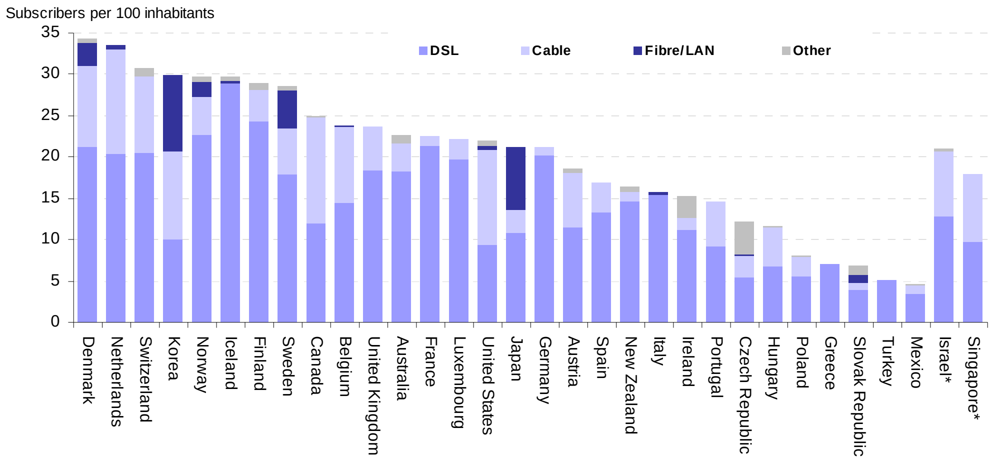

Figure 5.13 OECD Broadband Portal [www.oecd.org/sti/ict/broadband].

Current projections show that the predicted uptake of the two key broadband WANs (wide area communication networks), DSL (digital subscriber line) and digital cable, will have a large potential impact on European household energy consumption. Even with the unlikely application of best practice in energy efficiency for all the network and end-user hardware, a simple broadband terminal for, say, 200 million EU households by 2010 would increase annual domestic electricity demand by an estimated 6,6 TWh. This could effectively be doubled by associated LAN equipment [IES2007].

Figures on energy consumption for DSL modems vary significantly. In the UK, the largest national telecommunication provider, BT, has, through energy efficient procurement policy, provided basic, self-powered external DSL modems with a 4,0W power requirement. More typical devices in the open market and supplied by some other European telecommunication groups have a power requirement of about 10 W. With the latter, up to 87 kWh per annum could be added to a household's energy overheads. The EU added in 2005 more than 17 million new DSL subscribers in the period to reach 52.8 million – at a growth of 48% – extending its global share of the DSL subscriber market to almost 35%. Expectations are that broadband equipment will contribute to the electricity consumption of households in European Community in the near future. Depending on the penetration level, the specifications of the equipment and the requirements of the service provider, a total European consumption of up to 50 TWh per year can be estimated for the year 2015 [IES2007].

To address the issue of energy efficiency whilst avoiding competitive pressures to raise energy consumption of equipment all service providers, network operators, equipment and component manufacturers helped the European Commission to develop the Code of Conduct for Broadband equipment[1]. The Code of Conduct sets out the basic principles to be followed by all parties involved in broadband equipment, operating in the European Community, in respect of energy efficient equipment. The Code of Conduct covers, both on the consumer side (end-use equipment) and the network side (network equipment), for services providing a two way data rate of 144kb/s or above. With the general principles and actions resulting from the implementation of the new Code of Conduct on energy consumption of broadband equipment the (maximum) electricity consumption in this sector could be limited to 25TWh per year.

The increased networking capabilities, faster bandwidth, wireless accessibility and the need for mobility has a further implication on personal computers, which could cast doubt on the longer term forecast for energy consumption of computers. When every corner of the personal and professional space is accessible via wide-bandwidth, secure networks, the need for powerful processors and mass storage in each device diminishes. The facilities provided by the network allow the user to perform massive computations on central server centres store large amount of (multimedia) data.

The user will access the server centres through simple lightweight devices with multimodal user interfaces (graphics, sound, speech, gestures, biometric authentication, etc.). A Tablet PC is a notebook or slate-shaped mobile computer, first introduced in the early 90s and popularized by Microsoft. Its touch screen or graphics tablet/screen hybrid technology allows the user to operate the computer with a stylus or digital pen, or a fingertip, instead of a keyboard or mouse. The form factor offers a more mobile way to interact with

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[1] Further information can be found at: http://energyefficiency.jrc.cec.eu.int/html/standby_initiative_broadband%20communication.htm

a computer. Tablet PCs are often used where normal notebooks are impractical or unwieldy, or do not provide the needed functionality. Some Tablet PC's have keyboard (slates). Thin-client slates consist of a touch screen and an integrated wireless connection device. These units by design have limited processing power which is chiefly involved with input/output processing such as video display, network communications, audio encoding/decoding, and input capture.

Handheld Computers, PDA's (Personal Digital Assistants) and Smart Phones are also becoming more and more used as interface devices to applications running on large servers.

The number of huge server centres operating today to server the present Internet is already impressive. Though the numbers are not publicly known, some people estimate that Google maintains over 450,000 servers located in clusters in cities around the world. The so-called Next Generation Network (NGN) will facilitate the deployment of millions of new services (entertainment, security, health) in the global networks with a corresponding exponential growth in server centres.

5.5 Conclusion

The EuP preparatory study [IVF2007] provides several specific suggestions for environmental improvements in the design and use of personal computers, such as:

- Reducing the environmental impact from board assembly
- Improvements in monitors for PCs
- LED backlight for LCD monitors
- Possibility to take the lamps out of the LCD for End of Life treatment
- Minimizing the content of flame retardants in plastics
- Change to renewable plastics
- Batteries for Laptops
- Make it easy to remove the batteries
- Effective charging methods
- Minimise battery aging
- New battery chemicals (Best Not Yet Available Technology)
- Fuel cells (Best Not Yet Available Technology)
- Best Not Yet Available Technologies
- OLED Displays (organic light-emitting diode)

However, when describing the improvement options, it seems that not all the suggestions mentioned above are actually included in the final recommendations.

5.5.1 Environmental impact in a system and life-cycle perspective

The main contributions to the overall environmental impacts come from the electricity consumption during use of the computer (in "active mode"), which is not a surprise. The electricity consumption is the main contributor to all the environmental impacts, but for "mineral extraction".

However, what is interesting is that even when including the energy consumption during use, the production of the hardware is quite significant for the overall environmental impact. From the production of the hardware, it is especially the energy for the production and eco-toxicity impacts from heavy metals (arising during the extraction of materials for the components of the computers and monitors and during production of the hardware - e.g. emissions of Copper, Zinc, Nickel, Mercury, Chromium, Lead, Arsenic, Cadmium and Cobalt).

As the short life-time of the computers is very significant for the overall results, improvement options regarding life-time extension are important (designing computers for easy change of important parts like the memory, the hard disk etc.).

Design for reuse of components and recycling of materials from computers should be highly prioritised and more efforts should be devoted to automated and efficient disassembly and recovery technologies. Due to the short life-time of computers and monitors, the end of life (disposal / dismantling for recycling) of computers and monitors is very significant for the overall environmental impacts of the products.

Waste handling and incorrect recycling methods especially in developing countries constitutes a significant environmental problem. Incorrect recycling of computers might lead to huge environmental impacts, for example when second hand computers are collected and sent to developing countries to be “recycled” – some are repaired and reused, but a significant amount ends up as rubbish. Scientists have documented serious environmental contamination with potentially toxic metals from crude e-waste recycling in a village located in southeast China and in Mexico. Recycling methods used in family-run workshops could pose a serious health risk to residents of the area through ingestion and inhalation of contaminated dust [SD2008].

5.5.2 Environmental perspective from new technologies

The EuP preparatory study [IVF2007] lists a few effective designs that can be deployed to achieve a significant reduction of energy consumption in the use phase:

The processor in a 2005 desktop computer takes roughly 40 % of the energy. In a laptop, which also has a LCD-screen, the processor uses around 20 % of the energy. Dual core technology, offers 60 % savings in processor energy use.

One method of reducing the power consumption in a desktop is to reduce the intensity of the processor e.g. by reducing clock frequency or voltage when the need for capacity is reduced. This is often applied in laptops in order to increase the battery time. As much as 40 % of the power consumption of the processor can be saved if adaptive intensity is used. By using a switched power supply designed to high standard, the power supply efficiency can be increased from currently 65-70 % (2005) to 80 % or even 90 %. It should be noted that Energy Star 4.0 requires “80-plus” power supplies.

However, the longer term trend towards tablet PCs and handheld computers will have a more profound effect on the environmental load.

Dematerialisation of PCs will have a significant and positive effect since the manufacturing process will be less resource demanding. It is estimated that manufacturing of one desktop computer requires 240 kg of fossil fuels, 22 kilograms of chemicals and 1.500 kg of water [Rue 2003]. Compared to other products, computers are very materials intensive. The amount of fossil fuels used to manufacture one desktop computer amounts to nine times the weight of the actual computer versus two times for an automobile. Dematerialising computers from large desktops to tablet PCs will remove substantial amount of material from the product, e.g. hard disk, DVD drives controllers, keyboards, large power supplies, I/O ports, etc. Hence, the manufacture becomes less resource demanding.

Adding another 17 million electronic devices (modems and gateways) to the market every year poses a further challenge to the electronic waste system, since these devices are all physically small and will easily find their way into the household waste stream. This is also the case for smaller PCs such as tablet PCs and handheld PCs.

Increased energy consumption from the increased use of DSL modems and other broadband equipment must be weighted against the lower energy consumption of smaller computers and the phasing out of energy consuming desktop PCs. However, large data centres are also large consumers of electricity and power for cooling and the largest server centres today already pose considerable strain on public utilities, most profoundly found in the largest Google centre in Mountain View California (the California utility companies have at times difficulty in providing enough power to keep the centre running).

It is estimated that these servers and data centres in the US consumed about 61 billion kilowatt-hours (kWh) in 2006 (1.5 percent of total U.S. electricity consumption) for a total electricity cost of about $4.5 billion. This estimated level of electricity consumption is more than the electricity consumed by colour televisions and similar to the amount of electricity consumed by app. 5.8 million average U.S. households. The energy use of the servers and data centres in 2006 is estimated to have more than doubled since 2000. Under current efficiency trends, US energy consumption by servers and data centres could nearly double again by 2011 to more than 100 billion kWh. [EPA2007]

Several key trends toward more efficient microprocessors, servers, storage devices, and site infrastructure systems have been identified that could have a significant impact on the future energy use in data centres. Microprocessor technology is continuously advancing, and trends in server microprocessor technology, such as multiple-core microprocessors, hold great promise for reducing server energy use in the near future. Disk storage devices are expected to become more efficient during the next five years in part because of a shift to smaller form factor disk drives and increasing use of serial advanced technology attachment (SATA) drives. Finally, many data centres are pursuing energy-efficiency improvements to infrastructure systems including improved airflow management and upgrading to water-cooled chillers with variable-speed fans and pumps.

In conclusion, centralisation of computational power allows for improved optimisation of energy use compared to a decentralised structure with billions of individual computers. In large computer centres, decisions can be taken centrally and put into action, environmental regulations can be targeted few stakeholders and investments have better chance of paying off.

Due to the pure scale of the centres, the measures needed to improve the environmental load are thus easier to implement in centralised structures than if they were to be applied in the consumer end.

5.5.3 Regulation

The end of life of computers and monitors will be heavily influenced by the WEEE directive and its future revisions and the use of hazardous substances in the products will be covered by the RoHS directive and its future revisions.

However, some environmental aspects mentioned in the Eco-label criteria, seem not to have been sufficiently covered by the environmental screening in the EuP preparatory study [IVF2007]:

- Issues regarding flame retardants (poly-brominated biphenyl (PBB) or poly-brominated diphenyl ether (PBDE) flame retardants which might cause harm to unborn children
- Electromagnetic emissions
- Mercury content of liquid crystal display (LCD) monitor
- Design for facilitating recycling (easy to disassemble).
- Lead and cadmium in plastic parts
- Mercury, cadmium and lead in batteries

These issues should be address in the regulatory framework.

Finally, to secure optimal energy performance of large servers and data centres, building codes and technical infrastructure regulations should incorporate requirements for energy efficiency and capturing of waste energy.

Most building codes in Member States do not include provisions for data centre heating and cooling use or for the IT equipment itself. If building codes were to incorporate data centre requirements into its commercial energy code, it could have a market transformation effect that would lead to greater efficiency. The US building standard institute ASHRAE currently has four books covering various aspects of data centre design, and a fifth book in preparation that addresses energy efficiency and total cost of ownership. [EPA2007]

Advanced metering would also provide data centre managers with the information they need to save energy and money as part of an effective operations and management practice. Beyond simply measuring electricity consumption, metering also facilitates bill allocation and energy management and helps data centre managers identify energy savings opportunities, verify savings, and participate in utility demand reduction programs.

6 Imaging equipment: Copiers, faxes, printers, scanners, multifunctional devices (Lot 4)

6.1 Background

European Commission has specified “imaging equipment” as a product category which consists of printer, copier, scanner, facsimile machines, and multifunctional devices[2]. For the purpose of the EuP preparatory study Lot 4 was re-defined as Office Imaging Equipment:

Office Imaging Equipment is a commercially available product which was designed for the main purpose of producing a printed image (paper document or photo) from a digital image (provided by a network/card interface) through a marking process. Office Imaging Equipment is also a commercially available product which was designed for the main purpose of producing a digital image from a hardcopy through a scanning/copying process.

The definition covers products which are marketed as printer, copier, facsimile machine, and (document) scanner. The definition also covers multifunction devices (MFD) which incorporate a printing function in combination with a scanning/copying function and/or facsimile function.

Copiers are the most energy intensive type of office equipment. Because they waste energy sitting idle for several hours each day, there is great potential to improve their energy efficiency. All Energy Star compliant copiers automatically turn off after a period of inactivity.

High-speed (> 44 copies per minute) copiers are set to automatically make double sided copies, saving energy and paper costs. Easy and reliable duplex operation will encourage users to copy on both sides. A mid-volume (20 to 44 copies per minute) copier in a low volume office can use 70 percent more energy per page than an efficient low-volume (< 20 copies per minute) copier.

Printers are typically left on 24 hours a day, but are active only a small percent of the time, which means they can waste a lot of energy and money. Energy Star printers automatically power down to 15-45 watts, which can cut a printer's electricity use by over 65 percent.

According to the EuP preparatory study there are considerable uncertainty as to how to define the terms “stand-by”, “sleep mode” and “networked standby”, as defined in Lot 6.The definition of certain power levels or modes

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[2] Call for tenders No. TREN/D140-2005 Preparatory Studies for Eco-design Requirements of EuPs.

such as “on mode” (also referred to as “active mode” or “operation mode”, etc.), “ready mode” (also referred to as “waiting mode”, etc.), “sleep mode” (also referred to as “energy-saving mode” or “standby-mode”, etc.) and “off mode” is not consistent in existing standards or eco-labels and need therefore harmonization in order to be applicable. [Fra2007]

In the future, it is likely that printer products will have two distinct market profiles: 1. High-end, high performing and high quality Laser Printers, primarily for commercial and professional use, and 2. Low-end, cost effective Ink-jet printers, primarily for private use, including photo printing.

6.2 Environmental screening based on the Ecoinvent database

The environmental screening for imaging equipment: Copiers, faxes, printers, scanners, and multifunctional devices are based on the Ecoinvent processes:

- Use, printer, laser jet, b/w, per kg printed paper
- Use, printer, laser jet, colour, per kg printed paper
- Printer, laser jet, b/w, at plant
- Printer, laser jet, colour, at plant
- Toner, black, used for printing
- Toner, colour, used for printing

It has been assumed that the printers can be used as a proxy for copiers, faxes, and multifunctional devices. As scanners cannot print, is likely that their environmental profile will be more like the computers with the exception of the glass and the light source part.

Figure 6.1 and Figure 6.2 show the contributions to the environmental impacts from the use of printers, i.e. the processes “Use, printer, laser jet, b/w, per kg printed paper” and “Use, printer, laser jet, colour, per kg printed paper”. These processes include the production of the printer, production of toner, transport from production to consumer and the electricity consumption during the active use of the printer. Furthermore, the emissions of benzene during use are included (However, there are apparently no data for ozone emissions and emissions of small particle during printing, which are also known issues). The use of paper is not included. It has deliberately been chosen to show the results including the electricity consumption during use (in spite of the fact that the overall goal is to focus on non-energy related environmental impacts) in order to give the impression of the relative significance of the electricity consumption compared to the hardware parts.

It can be seen from Figure 6.1and Figure 6.2 that when using a printer, the electricity consumption is significant for most of the environmental impacts (but for mineral extraction). However, the main contributor to the environmental impacts is the toner. The significance of the production of the printer itself is relatively insignificant. That means that when focusing on environmental aspects, the product development of printers should focus on the toner rather than the hardware.

Figure 6.3 and Figure 6.4 show the screening of the printers and toners. The results of the screening have only been shown for the black and white printer, as the results for the colour printer was almost identical. This also applies for the toner; the environmental impacts where almost the same for the black toner as for the colour toner (per kg). The environmental impacts from production of a printer mainly come from the production of chromium steel (18/8), polystyrene and the toner module. Moreover injection moulding gives significant contributions to ozone layer depletion. The final disposal of the printer gives significant contributions to human toxicity (non-carcinogen) and ecotoxicity (aquatic). The contributions to these are mainly due to emissions of antimony, dioxins, arsenic and copper.

The environmental impacts from the production of toner mainly come from production of the toner module, the toner (powder), production of aluminium and electricity for production the toner.

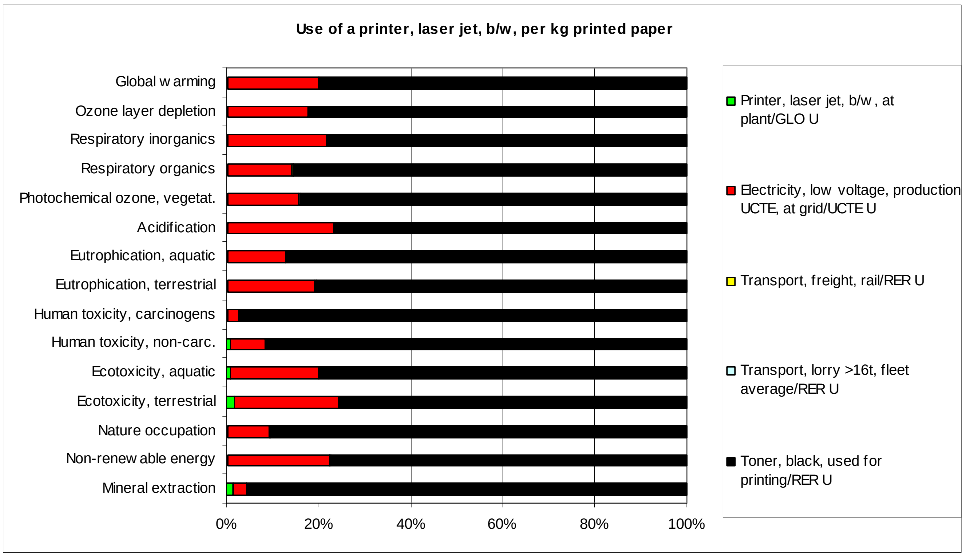

Figure 6.1 Environmental impacts from the use of a laser jet printer (black and white print) including toner and electricity.

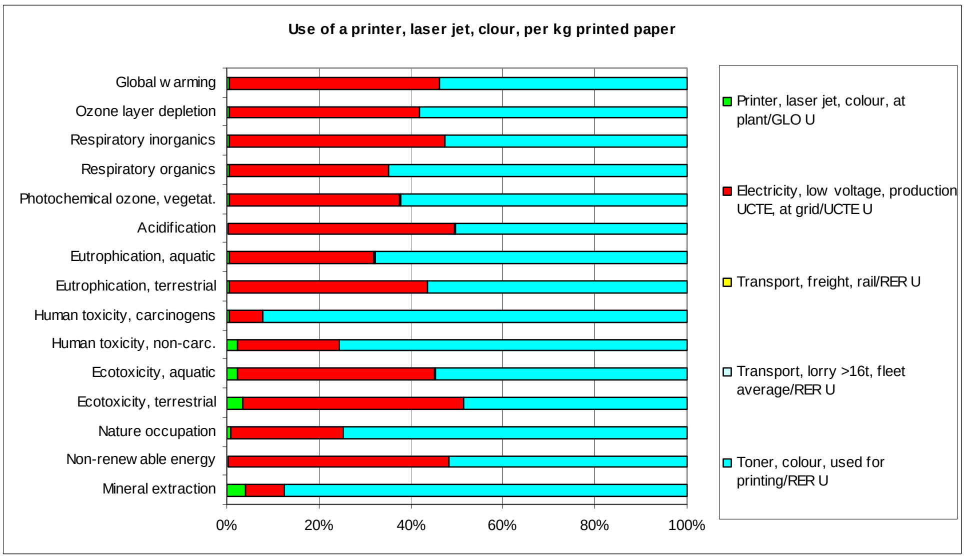

Figure 6.2 Environmental impacts from the use of a laser jet printer (colour print) including toner and electricity.

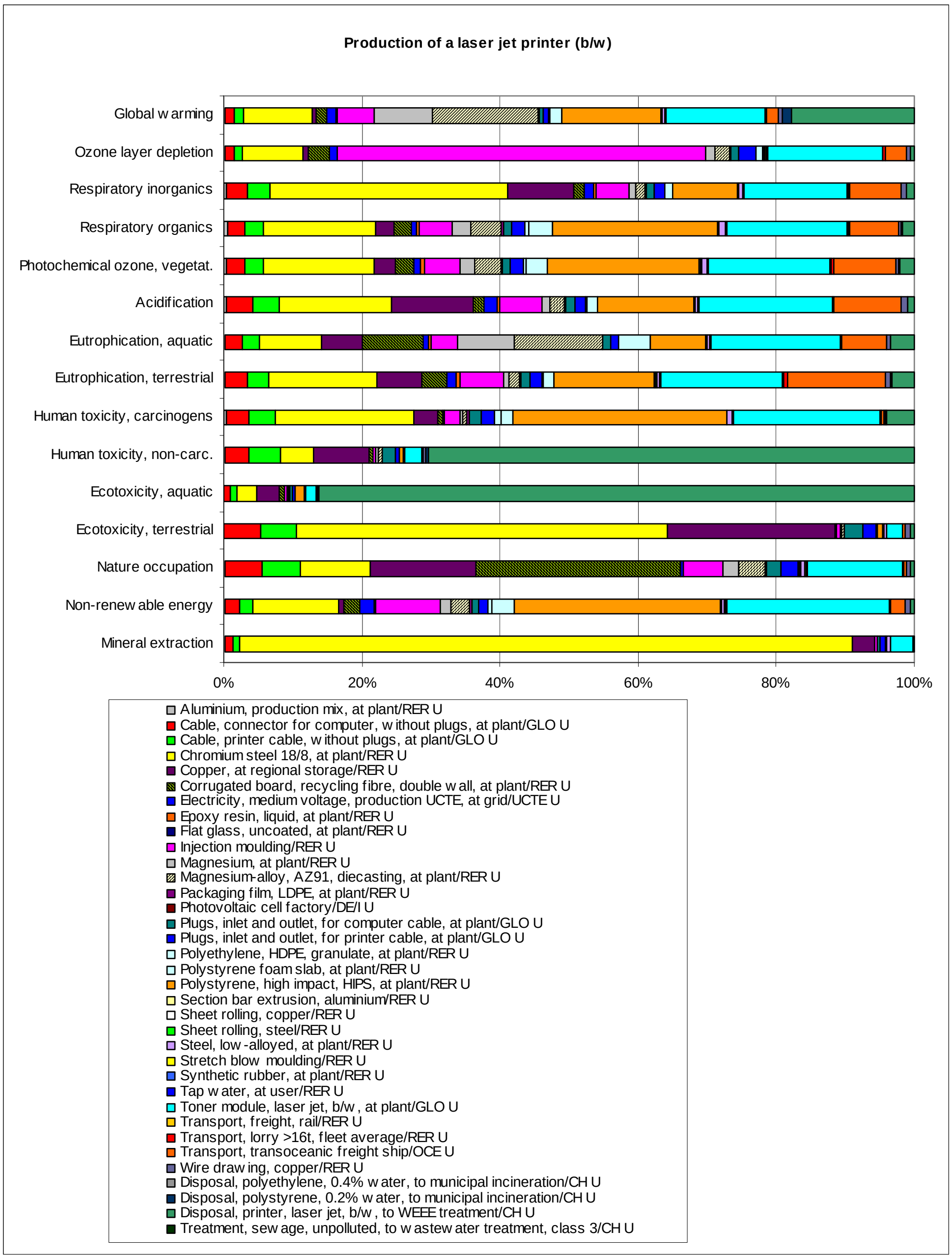

Figure 6.3 Environmental impacts from the production of a laser jet printer (black and white printer).

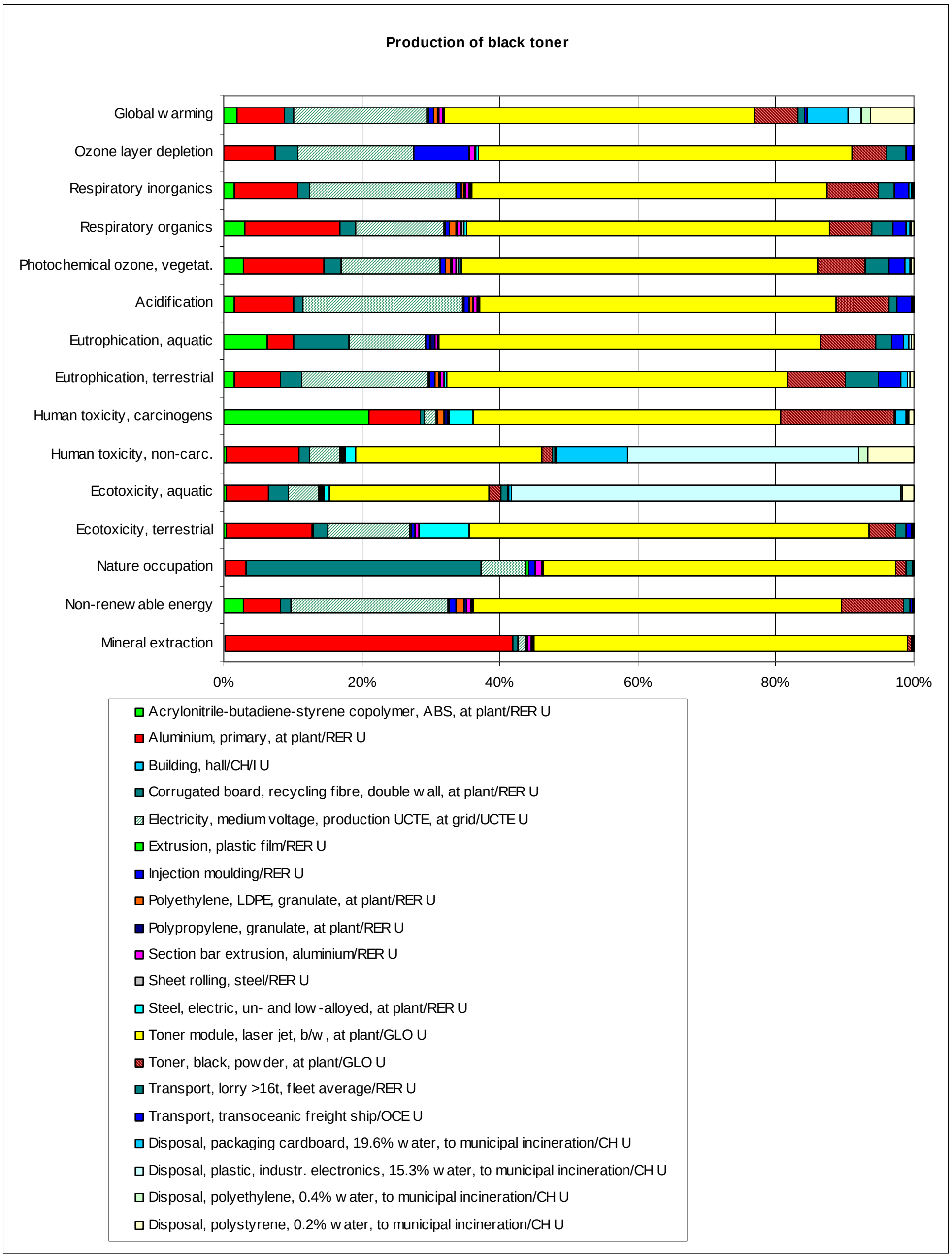

Figure 6.4 Environmental impacts from the production of black toner.

6.3 Ecolabel requirements

In the Nordic Ecolabelling criteria for imaging equipment (i.e. Copiers, digital duplicators, facsimile machines (fax), multifunction devices, printers and scanners) [NE2007a], the main focus points are:

- Energy consumption
- Design for recycling (marked plastic parts, prepared for disassembly)
- Reuse of toner cartridges (Products must accept remanufactured toner cartridges. In order to ensure that the toner cartridges are returned for reuse, a return system must be offered for recycling combined toner cartridges and information to user about the return system must be provided.)
- PVC not permitted

- Restrictions on flame retardants and other additives to plastic (cancerogenic, toxic, chemicals that may cause harm to unborn child etc.)
- Batteries used must not contain cadmium, mercury, lead, and their compounds.
- Chemicals containing the following substances regulated in the Montreal Protocol must not be used in the end production of the machines or in the production of circuit boards: CFCs, HCFCs, 1.1.1 trichloro-ethane or carbon-tetrachloride (chemicals that have impact on the ozone layer).
- Supply of spare parts: The availability of spare parts must be guaranteed for at least five years (possibilities for increasing the life time of the product).
- Double-sided copying: Appliances with a maximum operating speed of more than 45 sheets per minute for A4 size paper must be equipped with automatic double-side copying (a duplex-unit). Possibilities for saving paper.
- Limits on the emissions during use for volatile organic compounds, especially benzene and styrene, ozone and dust (following the criteria in "Der Blaue Engel" for office printing devices).

Furthermore, there is Nordic Ecolabelling criteria for remanufactured toner cartridges [NE2006]. The main principle is that the Swan-labelled toner cartridges are remanufactured, refilled cartridges, drum units or powder containers in order to reduce the waste amounts and to lower consumption of energy and raw materials. The toner powder and the toner must not be toxic, carcinogenic, mutagenic etc. and there are restrictions on heavy metals and aromatic amines, and there are demands on establishing a take-back system for the used cartridges.

The Energy Star Imaging Equipment specification provides eligibility criteria for products addressed by the Operational Mode (OM) approach and the Typical Electricity Consumption (TEC) approach. The Energy Star Program compliance requirements (power consumption limit values) limits are focusing on the 25% best performing products in each segment. The values indicate good performance only in regards to power consumption.

The German "Blue Angel for Office Equipment with Printing Function" sets out requirements for toners and inks, substance emissions, noise and energy, as well as general requirements for recyclable design, material, marking of plastics, batteries, paper use, photoconductor drums, repairs and maintenance.

6.4 Technology and market trends

Whereas early concern in laser printer technology was focussing on ozone emission, recent efforts in technology development in areas of copiers and printers have mainly focused on reducing energy consumption and optimising recycling of print cartridges.

Most, if not all, modern laser copiers and laser printers now incorporate automatic low-power mode and automatic power down a after set time. Power-managed laser and LED printers can use less than half the energy of a conventional laser model. Most HP LaserJet products require now no more than 1 watt of power in off mode and with Instant-On Technology (IOT), up to 50 percent energy savings have been achieved over traditional fusing technology. The savings enabled by Instant-On Technology since 1993 is more than 5.25 million tons of CO2 [HP2008].

Inkjet printers, which unlike laser printers do not apply a heat fusing mechanism, use less energy than many of the energy-efficient laser printers.

Fax machines employ a variety of technologies including laser, direct thermal, thermal transfer, and ink jet, which consume varying amounts of energy. While the energy use of any type of fax may seem low because of its relatively low use, the fact that it is likely to be kept on around the clock can generate significant costs. By powering down, fax machines can reduce energy costs by almost 40 percent.

Energy Star compliant scanners can enter a low-power mode less than or equal to 12 watts within 15 minutes of inactivity. As a result, they can save more than 50 percent of the equipment's electricity consumption, run cooler and are thus expected to last longer.

Multifunction machines are becoming increasingly popular, particularly among small users. These machines offer users significant energy savings by displacing three or four separate machines with one. Multifunction machines can power down to between 25 and 105 watts after 15 to 120 minutes of inactivity and thereby reduce energy costs by almost 40 percent [ACE32008].

6.5 Conclusion

One overall conclusion in the EuP documents is that the energy efficiency of office imaging equipment is in general on a good level. The reason for this statement is related to the justified assumption that under real life conditions the energy efficiency potential of imaging equipment is not necessarily explored due to a potentially suboptimal use by the consumer. This means for instance, that power management functions could be disabled by the user or that transition mode settings are prolonged to its maximum (e.g. 4 hours). Networked standby and off-mode power consumption requirements are also still of concern. [Fra2007]

6.5.1 Environmental impact in a system and life-cycle perspective

For copiers, printers, and multifunctional devices the main contributor to the environmental impacts is the consumption of paper, the consumption of toner and the electricity consumption during use.

For faxes and scanners, the environmental aspects is assumed to be very close to the environmental aspects of personal computers, as it is assumed that the glass plate has only small environmental impact itself.

Depending on how much the devices are actually used, the significance of the production of the printer itself is relatively insignificant (especially when printing large quantities). This means that when focusing on environmental aspects, the product development of printers should focus on toner (and paper) rather than the hardware.

The conclusion of the Ecoinvent data is that for printing devices the consumption of toner has higher environmental impacts than the electricity use. Focus should be put on designing toners with less environmental impacts. The data also shows that the electricity consumption and the consumption of toner is not the same for b/w printing and for colour printing. This is explained by the fact that colour printing requires far more electricity per page than does b/w printing.

According to the Ecoinvent background reports, colour printing is generally slower, which we assume is the reason for the higher electricity consumption. In real life, the facts will be very dependant on what is printed. Photos require far more toner than a black-and white text page.

The environmental aspects mentioned under "Personal computers and monitors" are also relevant for copiers, faxes, printers, scanners, multifunctional devices (mainly due to the electronic parts). Other aspects of interest are emissions during printing, e.g. ozone, benzene, small particulates and toner chemicals etc. constitute a health risk for the persons working / being in the same room as the printer.

6.5.2 Environmental perspective from new technologies

The functionality and performance of a product will be determined by its design and applied technologies. For copier and printers the image quality – especially colour capability – is a determining factor of increased important. A second factor is the functionality.

Scanners have seen strong market dissemination in the past years. However, market forecasts predict that with the introduction of printer-based multifunction machines, the sales of e.g. flatbed scanners will decline fast. The environmental impact of a scanner is expected to be most directly linked to the power consumption of the light source. Material aspects such as glass and electro-mechanics (MEMS) might also contribute to the environmental footprint of such devices.

Facsimile machines are characterized by an "always online" operation status, a telephony interface and long product usage time. Readiness for immediate operation is therefore determined by the applied marking technology and digital data processing capability. Due to the existing replacement technologies for this type of communication devices (with some few exceptions), the lifecycle of facsimile machines in the decline phase and is not expected to have material environmental impact on the longer term.

6.5.3 Regulation

The results of the base case assessment in the EuP Preparatory study in conjunction with the analysis of best available technology indicate that the energy efficiency of office imaging equipment is in general on a good level. Nevertheless energy efficiency remains a task for continuous improvement.

7 Consumer electronics: Televisions (Lot 5)

7.1 Background

The term television (TV) refers to a wide spectrum of products depending on the system boundaries we apply. The term has come to refer to all the aspects of televisions from the television devices (TV-set), television related equipment (e.g. TV/video combinations), up to the complete television broadcasting and receiving system including:

- An image source - this may be a camera for live pick-up of images or a flying spot scanner for transmission of films.
- A sound source.
- A transmitter, which modulates one or more television signals with both picture and sound information for transmission.
- A receiver (television) which recovers the picture and sound signals from the television broadcast.
- A display device, which turns the electrical signals into visible light and audible sound.

TVs are the largest electricity consuming appliance in the residential sector. Total sales of TV continue to grow, and reached 30 million in 2005 [IES2007]. It includes traditional equipment such as TVs and Hi-Fi, as well as new devices such as MP3 players, PVRs etc. In this sector there is a fast turnover and technological development, which could change the energy consumption.

7.2 Environmental screening based on the Ecoinvent database

There are no Ecoinvent data on televisions. However, it has been assumed, that all future televisions have LCD-screens. Accordingly, LCD-monitors from computers have been used as a proxy for the product category “televisions”.

The conclusions for the environmental screening of the LCD-screen are:

- The main environmental impacts come from the printed wiring board, the assembly of the LCD-screen and the production of the LCD-module.
- The main impacts from the production of the LCD-module mainly come from the assembly of the LCD-module, the printed wiring board (in the LCD-module), the integrated circuit (in the LCD-module) and from the production of the backlit to the LCD-screen.
- The main contributions to the assembly of the LCD-module come from electricity production and production of electronic components.

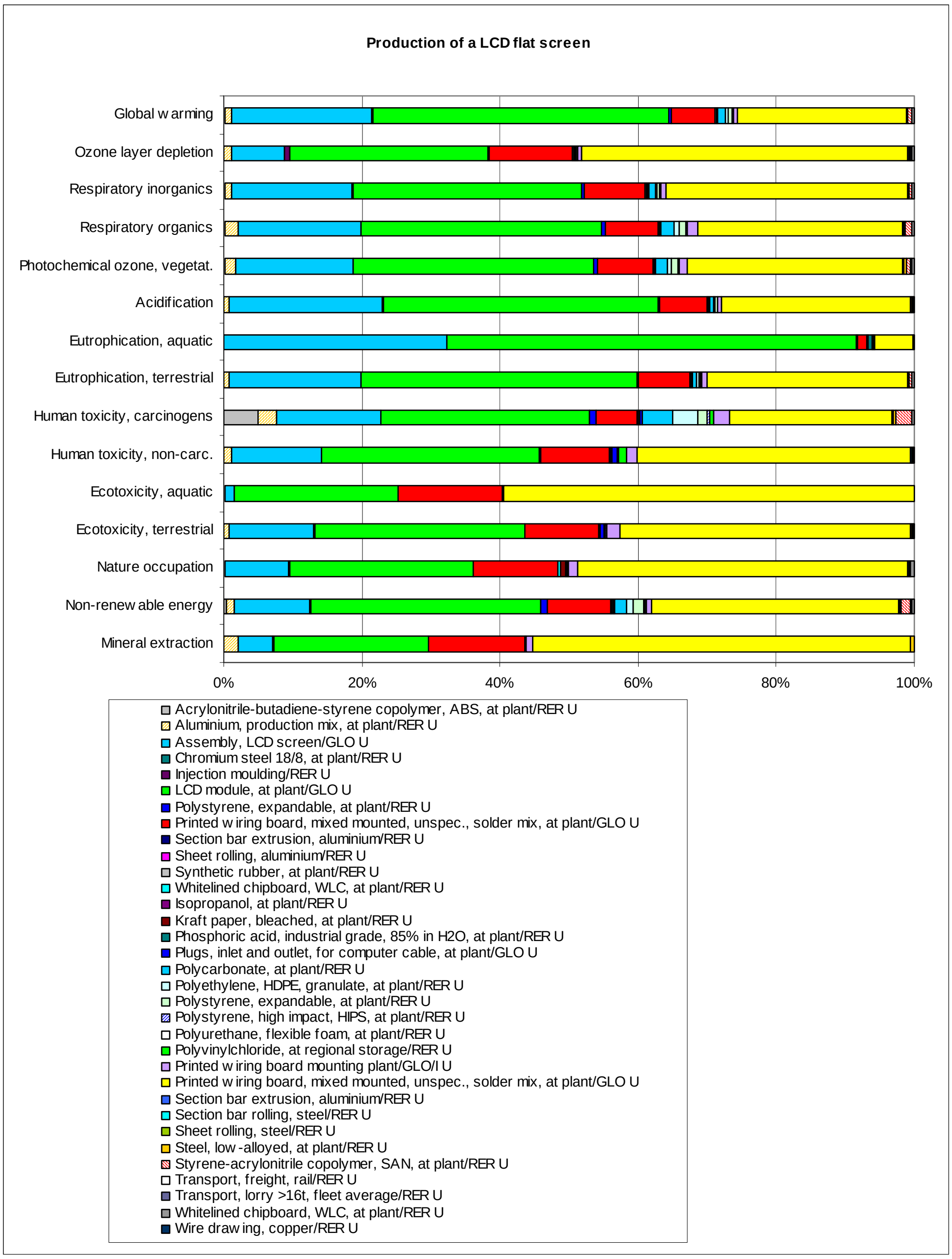

Figure 7.1 Environmental impacts from the production of a LCD flat screen.

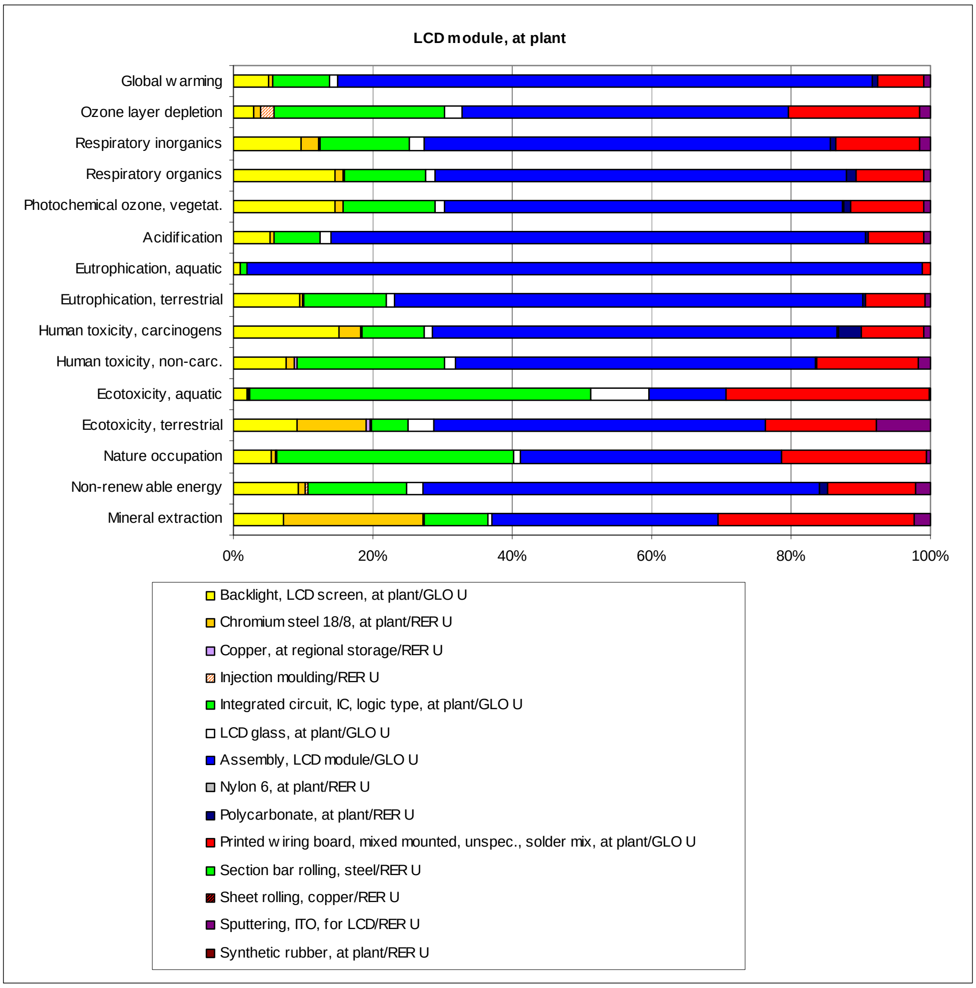

Figure 7.2 Environmental impacts from the production of the LCD module.

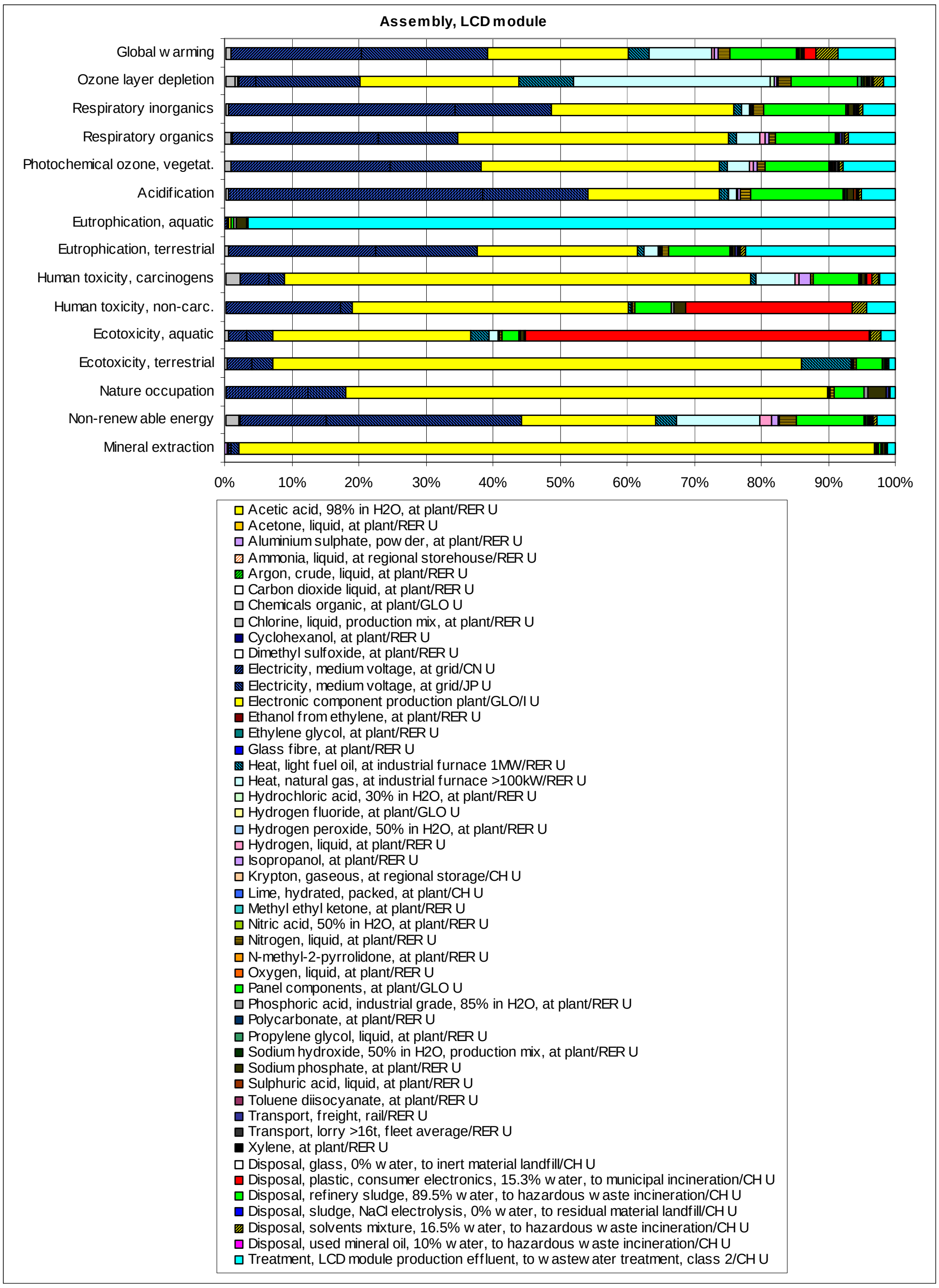

Figure 7.3 Environmental impacts from the assembly of the LCC module.

7.3 Ecolabel requirements

European policies to improve TV efficiency were introduced starting from 1996 and initially covered only standby losses. The first measure was the TVs and VCRs standby losses unilateral agreement which was signed in 1997 by 16 companies and notified to the competition authorities by the consumer electronic trade association (at the time EACEM, now EICTA). Manufacturers agreed that the company sales-weighted average would be progressively reduced towards 3 W by 2009. The target refers to the company sales-weighted TVs and VCRs stand-by consumption. Models with standby consumption over 10 W were to be phased out. In 2003 already sale-weighted average power consumption of 2.21 W and 3.53 W was achieved for TVs and VCRs respectively.

The European Ecolabel from 2002 [EC2002] for televisions focuses on:

- Energy consumption
- Life time extension: The availability of compatible electronic replacement parts shall be guaranteed for 7 years from the time that production ceases.
- Take-back and recycling systems (arranged by the manufacturer).
- Design for recycling.

More recently EICTA (the European Industry Association for Information Systems, Communication Technologies and Consumer Electronics) submitted in 2003 to the European Commission a new Self Commitment (unilateral commitment), signed by the a large number of the their member companies, to reduce the energy consumption of consumer electronics by continuously seeking to improve the energy performance per appliance.

7.4 Technology and market trends

TVs are the largest electricity consuming appliance in this sector. Total sales of TV continue to grow, and reached 30 million in 2005 [IES2007]. However, CRT TVs and VCRs are sharply reducing their sales in favour of flat TVs and DVDs as can be seen from the GfK market research presented in Figure 7.4 on the following page.

However, the shift from CRT TV's to LCD TV's does not necessarily mean that the total energy consumption decreases. Recent research indicates that households move the old TV to other rooms and in many cases operates two or more TV's simultaneously. This assumption is backed by the increased penetration in households and the increased number of viewing hours. Referring to the year 1995 GfK found the number of viewing minutes on TVs increased with 13% (27 minutes more per day) till 2005.

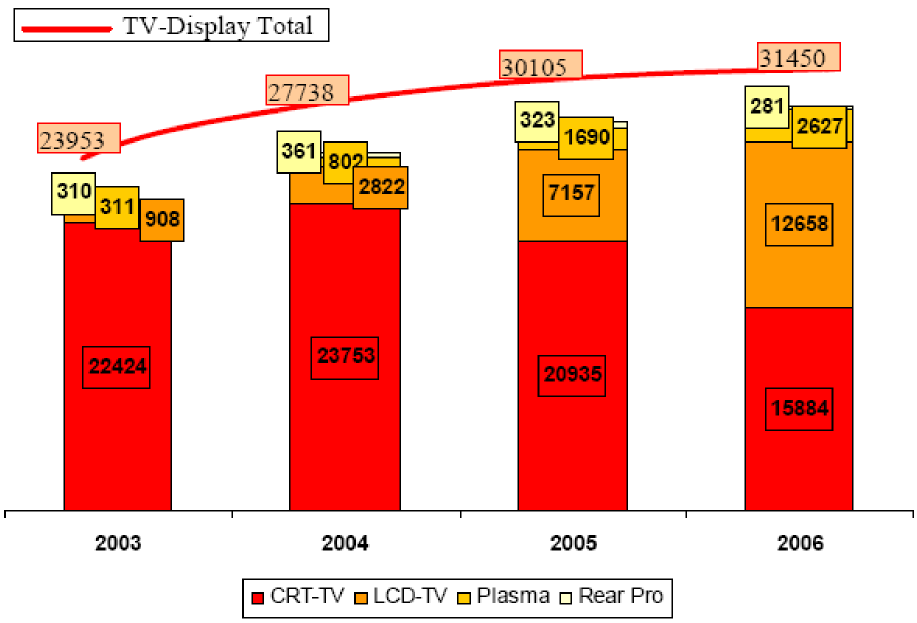

Figure 7.4 Number of TV's sold per type. (Source: The GfK market research group (www.gfk.de))

Many new TV models have now standby consumption well below 1 W, some companies have introduced a company policy to have all their models below 1 W. For VCRs the best appliances have a standby consumption around 1 W (eco-mode), many have standby consumption around 2W, however, it must be noted that VCRs sale are decreasing very rapidly. For DVD players (which take the place of VCRs on the market and are experiencing a boom in sales) standby passive of best appliances is below 0.5 W. More recently policy makers' attention has been drawn to the television on-mode consumption, due to increase in viewing hours and the size of the TVs.

In order to compare on-mode consumption of TVs having the same size and features (TV consumption is strongly related to the size), an Energy Efficiency Index (EEI) has been developed by industry EICTA and experts. However, data on TVs' EEI is still very limited because most manufacturers do neither indicate the energy efficiency index nor the power consumption in the on-mode.

Conversion to digital broadcasts is perhaps the most significant issue with regard to future environmental impact and energy consumption associated with televisions. Most governments around the world have announced the conversion of free-to-air television services from analogue to digital broadcasts. The main consequence of concern is the legacy of installed analogue televisions and how they will operate in a digital broadcast future. The short and simple answer is the digital converter – this is a digital receiver that can convert digital broadcasts into a suitable analogue signal which can continue to be viewed using existing equipment (often called a set top box). Another result of the conversion is the increased WEEE from old analogue television sets being replaces by new units, mostly because of convenience on behalf of the consumer (to avoid set-top boxes or because it is desirable to move to flat screen technology). Please se chapter 18 and 19 for further discussion on this subject.

7.5 Conclusion

The authors believe that the environmental impact from televisions is substantially the same as the environmental aspects that are important for personal computers. This is especially true as the convergence of media accelerates culmination with the complete convergence of the High Definition TV (HDTV) and the computer.

7.5.1 Environmental impact in a system and life-cycle perspective

The main contributions to the overall environmental impacts come from the electricity consumption during use of the television. The electricity consumption is the main contributor to all the environmental impacts, but for "Mineral extraction".

However, what is interesting is that even when including the energy consumption during use, the production of the hardware is quite significant for the overall environmental impact. From the production of the hardware, it is especially the energy for the production and eco-toxicity impacts from heavy metals (arising during the extraction of materials for the components and during the production of the hardware - e.g. emissions of Copper, Zinc, Nickel, Mercury, Chromium, Lead, Arsenic, Cadmium and Cobalt).

Improvement options regarding life-time extension are important (designing televisions for easy change of important parts). Design for reuse of components and recycling of materials from televisions should be highly prioritised.

Waste handling and incorrect recycling methods (especially in developing countries) constitutes a huge environmental problem. Depending on the weight put on to this issue, it might be the most important environmental aspect of televisions. Due to the short life-time, the end of life (disposal / dismantling for recycling / reuse in developing countries) is very significant for the overall environmental impacts of the products. Incorrect recycling of TVs may also lead to huge environmental impacts.

7.5.2 Environmental perspective from new technologies

New trend on the market having an important impact on energy consumption are larger screen sizes and plasma TVs, which use considerable more energy (350-400 W, but new developments can decrease this to less than 300 W). Smaller LCD TVs typically have an EEI of 0.4. Larger LCD TVs tend to have the same consumption as CRT TVs. The best CRTs on the market have an EEI of 0,995. Finally, prospects for improving efficiency in LCD TVs are better than for improving efficiency in CRT TVs, in particular by introducing solid state lighting in the backlighting systems.

7.5.3 Regulation

The end of life of televisions will be influenced by the WEEE directive and its future revisions and the use of hazardous substances in the products will be covered by the RoHS directive and its future revisions.

8 Standby and off-mode losses of EuPs (Lot 6)

8.1 Background

The intention of looking at standby and off-mode losses is primarily to minimise the power draw on electricity networks occurring when products are not actively used. The relevance of these power consumptions or losses results from the increasing numbers of devices, for which such energy consumptions may occur, and the long duration of power consumption, often invisible to the user.

The primary differentiation is between the active mode or modes of a product and all other energy uses (which can then be subdivided into standby and off-mode). The energy consumption not attributed to active mode operation is summarized under the term “standby and off-mode losses”.

It is not clear why products being evaluated by product specific lots are separately and extensively discussed in lot 6. EICTA has expressed their concerns over this procedure since their members have mainly provided input to the product specific lots only, as these were seen to be the most relevant for the industry. They wish that it should also be more clearly stated that the products covered in lot 6 study are examples only and the possible outcome will apply to all products in the same category, not just the ones covered by the study. [EICTA2007].

8.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for this theme, an environmental screening has not been performed for this product group.

8.3 Ecolabel requirements

It has not been possible to identify relevant Ecolabel criteria for this product group.

8.4 Technology and market trends

Nowadays almost all TVs have a remote control and, hence, always have some sort of standby relevant functions. Some new and complex TVs have integrated additional functions like DVD player/ recorder, HD-recorder or digital decoder (set-top-boxes), which create different standby power consumptions.

In Europe, most televisions have an off mode (where the unit cannot be activated by a remote control - although the presence of off switches in televisions is no longer universal in these markets) and the power consumption in most cases is at or close to 0.0 Watts. Data collected in late 2005 suggests that 60% of users leave their televisions in off mode or unplugged while 40% are left in passive standby mode [EES2006]. Data collected in USA shows that nearly all televisions in the USA do not have a "off mode", so passive standby is the only relevant mode for this region [NRDC2005], [ROS1999].

There is a trend towards further additional devices like speakers or AV receivers creating a "TV-based media centre" and towards PCs with all additional devices equipped and used as a "PC-based media centre". Both can lead to increasing standby levels.

Manufacturers in EICTA have agreed that the company sales-weighted average standby losses would be progressively reduced towards 3W by 2009. Models with standby consumption over 10 W were to be phased out. In 2003 already sale-weighted average power consumption of 2.21 W and 3.53 W was achieved for TVs and VCRs respectively. Please refer to chapter 7 for further details.

The trend of growing home networks will also lead to requirements for new functions for coming products in terms of additional network interfaces and always-on and keep-alive requirements for products that do not need this functionality today (white goods, sun blinds, curtains, etc.). Please refer to chapter 18 and 19 for further details.

For products depending on external power supplies (and chargers), improvements in design provide has provided low cost, high efficiency, off-line switcher solution in the 0 to 10 W range, with as little as 80 mW off-mode loss. Please refer to chapter 9 for further details.

8.5 Conclusion

It is not clear why products being evaluated by product specific lots are separately and extensively discussed also in this horizontal view. This product group is a horizontal group that does not fit into the system approach that the authors find is a more reasonable approach to the environmental impact from EuP.

8.5.1 Environmental perspective from new technologies

The rapidly growing trend in home networks will lead to requirements for new functions in future products in terms of additional network interfaces and always-on and keep-alive requirements.

8.5.2 Regulation

In the authors view, no separate regulations are required for standby and off-mode losses of EuP, but should be covered by regulatory demands for the specific product group or system.

Since this is not likely to be possible, due to the already agreed implementing measures, the authors think that it is important to take future needs for functionality and ease of use in networked civic applications (such as healthcare, ageing, ambient assisted living, entertainment, life-long education, energy efficient buildings, etc) into consideration when implementing EuP requirements on a horizontal group as this.

9 Battery chargers and external power supplies (Lot 7)

9.1 Background

External power supplies (EPS) and battery chargers (BC) are important to the operation of many electrical and electronics products. They especially accompany portable appliances which are found in increasing numbers in household and office environments.

A single voltage external ac-dc / ac-ac power supply (EPS) is designed to convert line voltage ac input into lower voltage dc output / into lower voltage ac output. A battery charger is a device intended to replenish the charge in a rechargeable battery.

These products are estimated to consume an important portion of daily electricity consumption. Apart from battery chargers sold individually for charging rechargeable batteries, EPS and BC are often delivered as a part of an end-appliance, e.g. mobile phone, laptop computer, inkjet printer, flat screen display.

The study on External Power supplies in the frame of the EcoDesign Directive [ECH2006] assumed sales in the EU for external power supplies and battery chargers of about 500 millions with mobile telephone representing about 50% of these sales.

The study estimated the current stock of external power supplies to be in the order of 2 billions, which correspond to an average of about 12 external power supplies per household, however the stock includes the external power supplies in the non residential sector. A better estimate would be to have 5 to 8 external power supplies per household.

9.2 Environmental screening based on the Ecoinvent database

The screening for battery charges and external power supplies is based on the Ecoinvent process: “Power supply unit, at plant”.

The screening is shown it Figure 9.1. From this it can be seen that the main contribution to the environmental impacts comes from the printed wiring board. However, the electricity consumption during use is not included, and this is presumably very significant for the overall environmental impacts.

An analysis of the printed wiring board for power supplies is shown in Figure 9.2. It shows that various electronic components contribute to the environmental impacts, especially the capacitor, the inductor, the integrated circuit, the printed wiring board and the transistor.

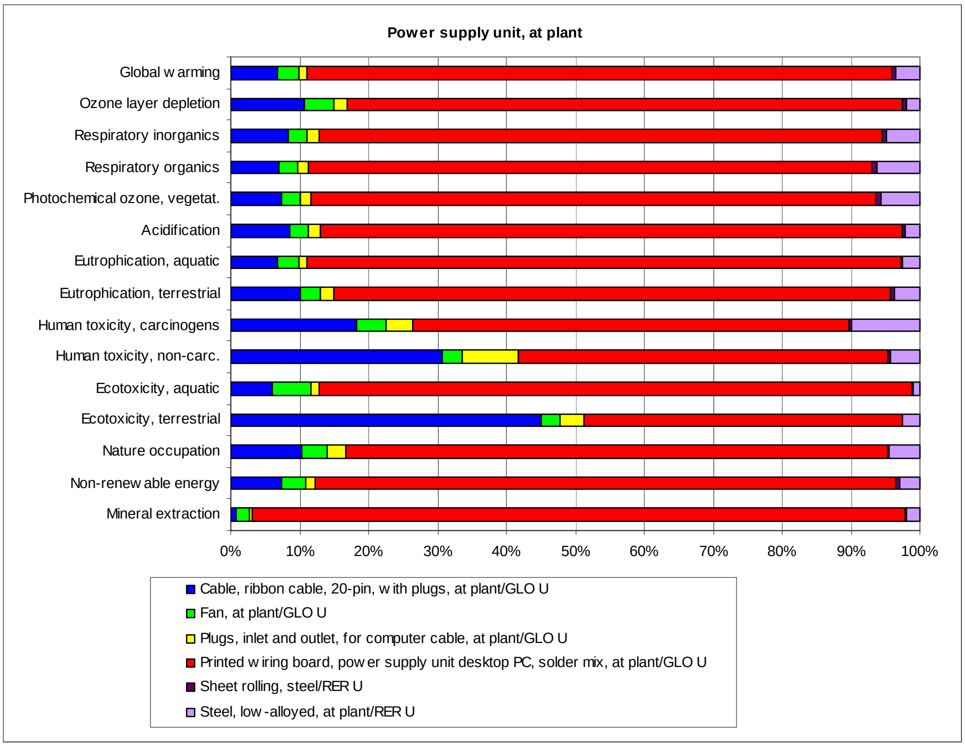

Figure 9.1 Environmental impacts from the assembly of a power supply unit.

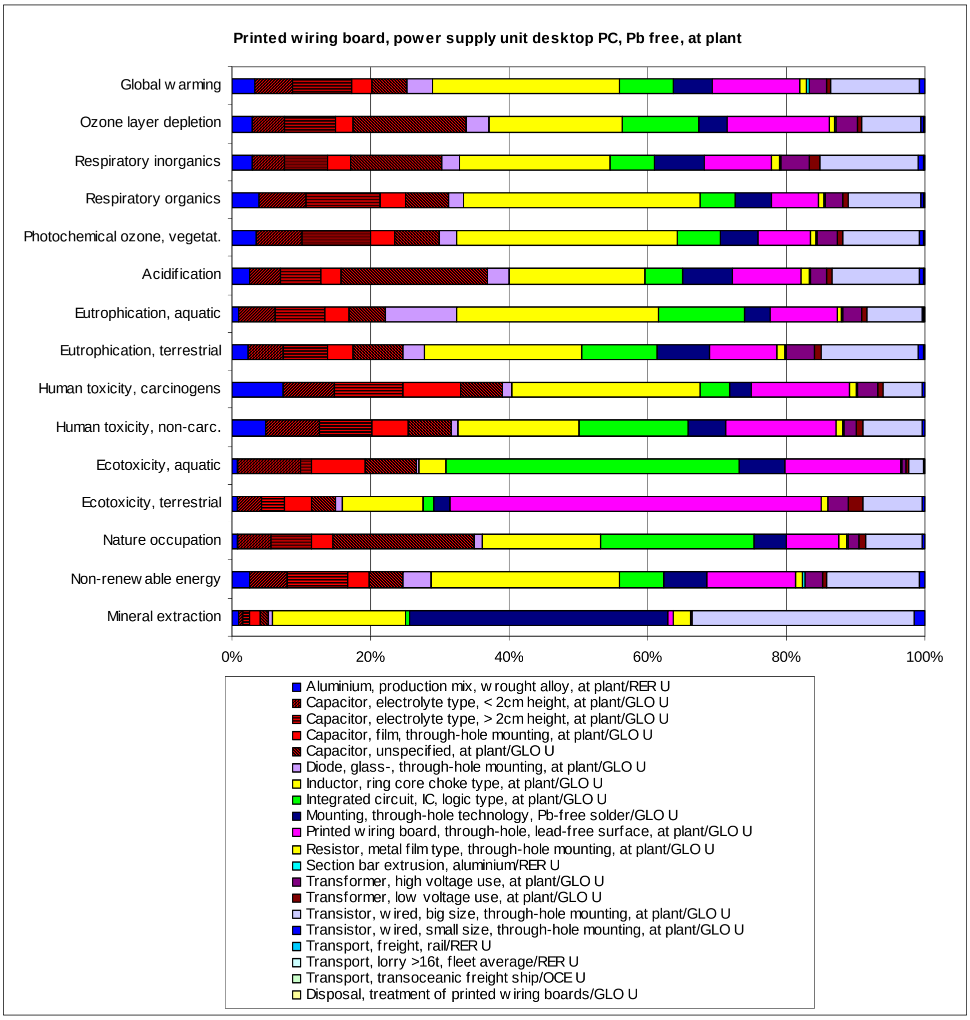

Figure 9.2 Environmental impacts from the assembly of the Printed wiring board, power supply unit desktop PC, Pb containing, at plant.

9.3 Ecolabel requirements

It has not been possible to identify relevant Ecolabel criteria for this product group.

The only energy efficiency policy in place at the moment is the European Code of Conduct[3], which was introduced in year 2000 to reduce the no-load losses, and recently also to improve the on-mode efficiency.

[3] all the information can be found at http://energyefficiency.jrc.cec.eu.int/html/standby_initiative_External%20Power%20Supplies.htm

9.4 Technology and market trends

External power supplies are contributing massively to the increase of the electricity consumption. External power supplies are used for many different types of electric and electronic devices, but most frequently as charges for mobile telephones, digital cameras, cordless phones, and notebook PCs. However, large quantities of external power supplies and chargers are now also being found for kitchen tools, power tools, games, etc.

The number of mobile phone subscribers in the world has now surpassed 3 billion units. Although not all of these units are in use (many are older types that users save for later), serious estimates indicate that more than 2.2 billion phones are in active use. In many of the lately developed countries (eastern and central Europe, China, Southeast Asia and Africa), have prioritized the roll out of wireless communication networks rather than building fixed networks. The table below show the large increase in mobile phone users.

Table 9.1 Mobile subscriptions, 2004-2008, in thousands (Source: EITO Task Force, [Lam2006])

Mobile subscriptions	2004	2005	2006	2007	2008	CAGR % 2004-2008
Denmark	5120	5251	5377	5498	5618	2,3
Finland	4937	5344	5483	5609	5717	3,7
France	44544	46221	47422	48659	49828	2,8
Germany	71437	78104	81618	84385	86917	5
Italy	62751	69032	72208	75396	78748	5,8
Spain	38716	42226	44126	45935	47936	5,5
Sweden	9529	9923	10101	10266	10451	2,3
United Kingdom	61835	65914	68814	71153	72913	4,2
Western Europe*	411444	441111	459511	476101	490633	4,5
Eastern Europe**	180082	255716	311973	358769	394646	21,7
Total Europe	591526	696827	771484	834871	885279	10,6
USA	181243	205219	225420	240482	253446	8,7
Japan	90273	94730	97539	100231	102851	3,3
Rest of the world	857564	1153982	1400436	1618680	1804172	20,4
World	1720606	2150757	2494879	2794264	3045748	15,3

*Includes also Turkey, **Geographical demarcation

Other devices are believed to have the potential to show an even higher growth, as the concept of the Networked Home (or Internet of Things) gains momentum. While the development of intelligent devices ushered in the information age, the connection of those devices to one another increased their power and utility by an order of magnitude. Thus, while the home PC saw increasing popularity as functionality increased and prices decreased, only with the introduction of the Internet and the resulting connectivity have PCs become a fixture in the mass market [Bea2001].

Home networking, defined as the connection of intelligent devices to each other and the Internet within the home, is very useful but not yet as compelling to consumers as the Internet-enabled PC, once the standardisation and interoperability issues have been solved.

The emergence of a standard interconnection as well as interoperability platform will drive both home networking and the digital home and thus require a great deal of home networking components for automation, monitoring and security. All the devices will be supplied with power either from batteries (hence with a significant environmental impact), by individual external power supplies (thus adding massively to the energy consumption of private dwellings) or from new and ingenious sustainable energy picking micro sources, using sun, wind, pressure or other natural energy sources.

The European Code of Conduct (CoC) for external power supplies, was introduced in year 2000 to reduce the no-load losses, and recently also to improve the on-mode efficiency.

In Figure 9.3 and Figure 9.4 below are shown the results achieved by the participating manufacturers in the CoC. Before the introduction of the Code of Conducts many external power supplies had no-load power consumption above 1 W, and low efficiency in operational modes.

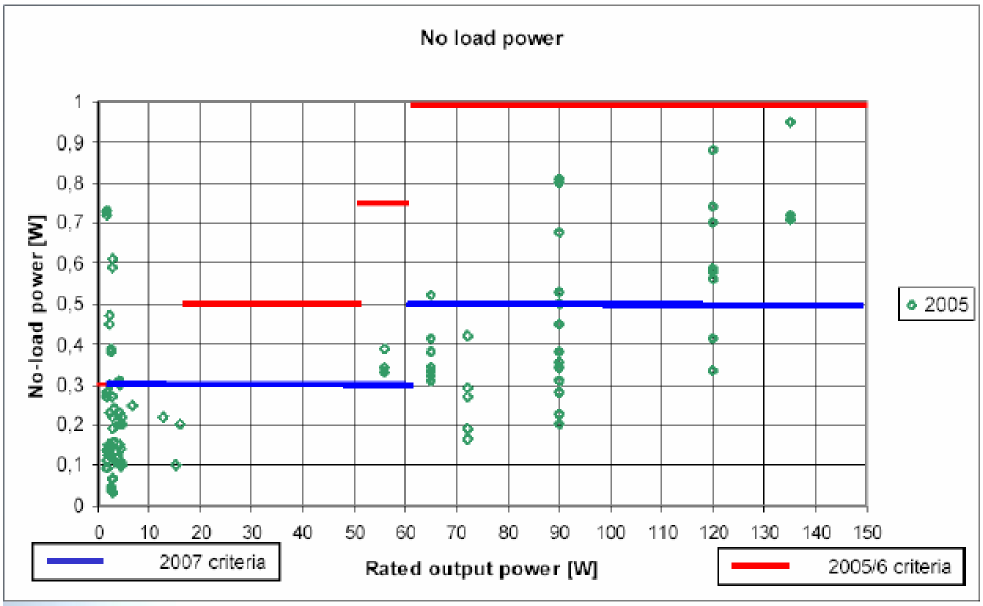

Figure 9.3 No-load power new criteria for external power supplies and results achieved by participating companies (Source: [Har2006])

By 2005 many of the external power supplies in the European market have no-load losses below 1 W.

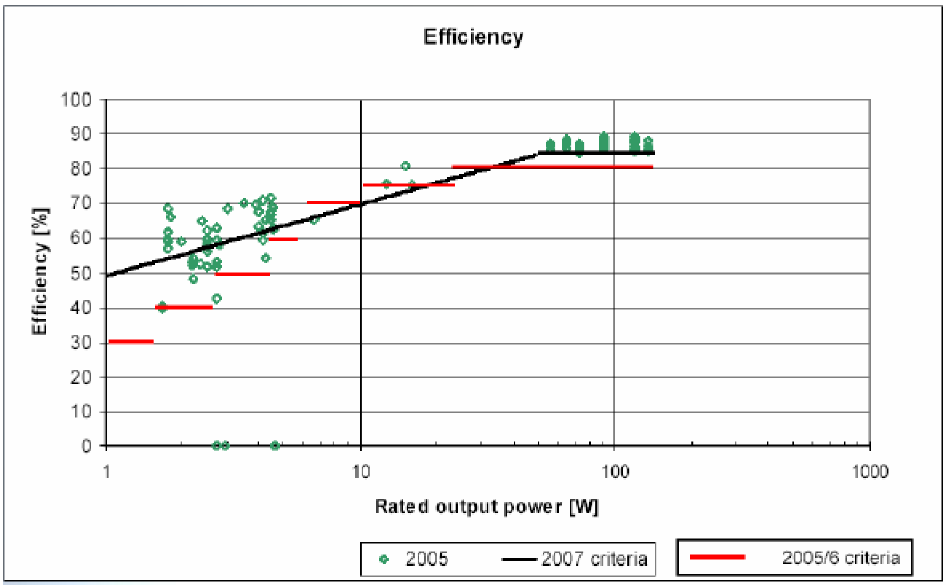

Figure 9.4 New efficiency criteria for external power supplies and results achieved by participating companies (Source: [Har2006])

The so-called switch mode design has been used for ages in high-performance power supplies but is gaining increased interest also in the low end (below 25W) typical for external power supplies. Switch mode power supplies have the advantage of

1. Very high efficiency both at low and high load
2. Very low no-load power consumption
3. Wide input voltage range (Full AC-range possible)
4. An overall simple control circuit

However, there are also drawbacks from this design:

1. More complex when compared to conventional design
2. Switch mode generally requires EMC (Electromagnetic disturbance) considerations
3. Can make audible noise at low load
4. More expensive compared to conventional design

A relatively promising design technology for switched mode external power supplies is the TinySwitch® family from Power Integrations, Inc., USA, which claims to overcome almost all of the negative drawbacks above [PCI2003].

The TinySwitch uses a switch mode design to provide low cost, high efficiency, off-line switcher solution in the 0 to 10 W range, which is more than sufficient for mobile phones and standby operations of most consumer electronic devices including televisions.

The chargers run on power derived from the internal semiconductor circuits, thus eliminating the need for power consuming transformers. It continuously measures the load applied to it and switches the power cycles to a minimum, when no load (less then 40 µA) is present. This design allows for a no-load power consumption of only 80 mW placing it in the lower left square in the Figure 9.3 above. Moreover, the design also provides very short power up/down times (time to come alive and turn off), typically within 0.3 msec, thus making it very useful for standby operation of critical equipment like network and communication components.

9.5 Conclusion

In the view of the authors, the environmental aspects important for battery chargers and external power supplies are much the same as the environmental aspects that are important for personal computers (same issues, same problems, just in a smaller scale). Please refer to the section about computers.

9.5.1 Environmental perspective from new technologies

Ongoing development efforts have tried, but failed, in standardising certain types of external chargers, such as those used for mobile phones. However, this has, for various reasons, been resisted by the manufacturers. One technical reason is that the charger must closely match, in terms of charging current, the battery used in the phone, in order not to cause serious damage. From a product liability point of view, manufacturers wants to have control over which charger is used. This can be done by making the connector plug brand/model unique. Another point is the lifetime of the battery and the derived product image. Incorrect charging of some types of batteries may reduce the lifetime and adversely affect the brand image.

The trend towards mobile and handheld computers will lead to increased use of batteries and increased need for external chargers. The authors think that it is important to take future needs for mobility and ease of use in networked civic applications (such as mobile healthcare, work-force mobility, etc) into consideration when implementing EuP requirements.

10 Lighting (Office, public street, domestic) (Lot 8, 9, 19 and ?)

10.1 Background

In this Memorandum, the following four lots have been treated together:

- Lot 8: Office lighting
- Lot 9: (Public) street lighting
- Lot 19: Domestic lighting
- Lot ?: Domestic lighting phase II

Lighting is by far the major end-use category in the non-domestic sector consumption (public sector, education, healthcare, services and commerce) responsible for about 175 TWh or 26% of total electricity consumption in that sector. As far as non-residential buildings lighting is concerned, this is dominated in lumen and energy terms by linear fluorescent lamps. T12 fluorescent lamps are the oldest technology of fluorescent lamps. These lamps have an efficiency of less than 75 lumens per Watt (lm/W). In the majority of cases there exists a T8 lamp that can be retrofitted into the same lighting point. Depending on whether this T8 lamp is a halo phosphor or a tri-phosphor the lamp efficiency can be improved to between 80lm/W (halo phosphate) and 90lm/W (tri phosphor).

About 207 millions are new installed lamps in 2004 [CEL2005], which tends to be of higher efficiency compared to already install lamps.

10.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for this theme, an environmental screening has not been performed for this product group.

10.3 Ecolabel requirements

It has not been possible to identify relevant Ecolabel criteria for this product group.

Directive 2000/55/EC on energy efficiency requirements for ballasts for fluorescent lighting has the purpose to improve the efficiency of the systems by limiting the ballast losses

The Directive 98/11/EC on Energy labelling of household lamps was published on 10th March 1998, applies the energy labelling requirements to household electric lamps supplied directly from the mains and to household fluorescent lamps. The Directive sets out the design and content of the label, as well as the colours that may be used. The label must include the following information:

- the energy efficiency class of the lamp;
- the luminous flux of the lamp in lumens;
- the input power (wattage) of the lamp; and
- the average rated life of the lamp in hours.

The Directive also sets out how the energy efficiency class of a lamp will be determined. Albeit these lamps are not commonly used for office lighting, this directive can be an example of lamp labelling for office lighting.

10.4 Technology and market trends

The T8 lamp now dominates the linear fluorescent market in the non-residential domain. The existing mix of lamps is still two-thirds halo phosphate lamps with the remaining third being three-band rare earth phosphor lamps which are currently increasing their market share year by year. Barrier coat technology has allowed the mercury content in current tri-phosphor lamps to be reduced to below 5 mg.

The average lamp wattage for T12 lamps is 65 W (1500 mm long). The average energy saving per lamp when switching from T12 (65 W) to T8 (58 W is 12%). The total annual sales figure for T12 lamps in the European Union is 16 million lamps. This is more or less a stable replacement market. The total sale of linear fluorescents is estimated to be 350 million lamps per year [Str2004]. There is a relatively new technology, T5 which has a higher efficiency and is designed to be fed only by electronic ballasts (in addition these lamps perform best at a temperature of about 35C, which is often the case in luminaries, while T8 perform best at 25C). However, the market penetration of T5 lamps is still limited, though slightly increasing overtime [IES2007].

Compact Fluorescent Lamps (CFLs) represent one of the most efficient solution available today for improving energy efficiency in residential lighting. The recent drop in price to together with several information and promotion campaigns had a positive impact on sales. In particular, two different types of CFLs are marketed: the short life (average life around 6000 hours) and the professional models (average life around 12000 hours). The first type is mainly marketed for the residential sector. Direct sales comparison between incandescent and CFLs and incandescent is not meaningful as CFLs have a longer life time (6 to 12 times or more). Moreover it is difficult to gain access to sales data, and sales data available includes lamps not destined to the residential sector.

CFLs are of two types, with an integral ballast (ballast inside the package) or pin-based. The first type dominates the market for the residential sector. Recently some pin-based CFL luminaires have appeared on the EU market for residential lighting. Of particular interest are the CFL based “torchieres”, which could replace halogen based upright floor lamps, the latter using light sources up to 500W. There is also a certain use of linear fluorescent lamps, especially in some countries, e.g. the UK, and in specific rooms such as kitchens and garages. For the residential sector any linear fluorescent lamps even with a magnetic ballast could be considered an efficient solution if it replaces an incandescent lamp.

Table 10.1 on the following page shows that there are still a large number of households in the EU-25 which do not own a CFL, moreover only a few countries show a number of CFLs close to the cost-effective saturation level (about 25% of lighting points per households using a CFL).

Table 10.1 National lighting consumption and CFL penetration data (Source: [Ber2006])

	no. of hslhlds [milions]	residential electricity cons. [TWh]	Lighting consumption [TWh]	Lighting consumption from total residential electricity consumption [%]	Average cons lighting/HH [kWh]	Number of HH with CFLs [%]	CFL's/HH [including HH without CFLs]	Lighting points/HH	CFL/ Lighting points [%]
AT	3,08	15	1,1	7,3	357,14	70	4	26	15,4
BE	3,90	18,20	2,23	12,23	343,22	70,50	2,50	26,00	9,6
DK	2,31	9,71	1,36	14,00	589,00	65,00	4,90	25,40	19,3
FIN	2,30	12,20	1,7	13,93	739	50	1	23,5	4,3
FR	22,20	141,06	9,07	6,43	409	52	2,26	18,9	12,0
GR	3,99	16,87	3,04	18	761	50	1	12	8,3
DE	39,10	140,00	13,2	9,43	337,6	70	6,5	32	20,3
EI	1,44	7,33	1,32	18	920	38	1,5	18	8,3
IT	22,50	66,67	8	12	370	60	0,8	18	4,4
LU	0,20	0,75	0,098	13	487,5	70	2	20	10,0
NL	6,73	23,75	3,8	16	524	60	4	40	10,0
PT	4,20	11,40	1,7	14,91	404,8	54	1,7	11,4	14,9
ES	17,20	61,11	11	18	639,5	15	2	25	8,0
SE	3,90	43,50	3,4	16	872	55	3,3	32	10,3
UK	22,80	111,88	17,9	16	785	50	2	20	10,0

The same innovation that makes laptop screens thinner turns out to be one of the best energy-saving technologies in domestic and professional lightning due to a well-known member of the semiconductor family, the light-emitting diode (LED). A light-emitting diode is a semiconductor device that emits incoherent narrow-spectrum light when electrically biased in the forward direction. This effect is a form of electroluminescence. The colour of the emitted light depends on the chemical composition of the semiconducting material used, and can be near-ultraviolet, visible or infrared. Most typical LEDs are designed to operate with no more than 30-60 milliwatts of electrical power. Around 1999, commercial LEDs capable of continuous use at one watt of input power were introduced. These LEDs used much larger semiconductor die sizes to handle the large power input. As well, the semiconductor dies were mounted to metal slugs to allow for heat removal from the LED die. In 2002, 5-watt LEDs were available with efficiencies of 18-22 lumens per watt. It is projected that by 2005, 10-watt units will be available with efficiencies of 60 lumens per watt. These devices will produce about as much light as a common 50-watt incandescent bulb, and will facilitate use of LEDs for general illumination needs.

There are two types of LED panels: conventional, using discrete LEDs, and Surface Mounted Device (SMD) panels. Most outdoor screens and some indoor screens are built around discrete LEDs whereas most indoor screens on the market are built using SMD technology. However, this trend is now extending to the outdoor market.

The best modern available white LEDs (as of late 2007) produce about 60-90, maybe 98 lumens of light per watt of electricity delivered to the LEDs when the LEDs are supplied "typical" current or that at which their characteristics are specified. Many others that are in recent LED products achieve merely 20-45 lumens/watt. A laboratory prototype of a white LED achieving 150 lumens/watt has been announced on 12/20/2006 [Kli2008].

LEDs offer benefits in terms of maintenance and safety. The typical working lifetime of a device, including the bulb, is ten years, which is much longer than the lifetimes of most other light sources. LEDs give off less heat than incandescent light bulbs and are less fragile than fluorescent lamps. Since individual devices are smaller than a centimetre in length, LED-based light sources used for illumination and outdoor signals are built using clusters of tens of devices, e.g. incandescent light bulbs for traffic signals and pedestrian crosswalks are gradually being replaced by LED clusters.

Because of the favourable economics, cities have led the charge on using LEDs in traffic lights and other round-the-clock situations in which the initial cost of the solid state device is still quite high relative to other light sources such as compact fluorescent bulbs. But it will be a while before consumers can justify the higher costs of LEDs as energy-saving replacements for older household fixtures. A room light is on about four to six hours a day and that yields a payback period on the order of three to six years, which is still too long time for consumers.

General public lighting operators are, however, more favourable to undertake the investment. “Banedanmark”, the Danish rail system operator, plans in three years to replace all fluorescent lamps on station platforms with LED’s. The new luminaries will be using LED technology that is tailored to fit the existing installations on the platforms. By doing so, they expect a 40 percent reduction in the electricity bills and a positive benefit on the CO_2 accounts. Platform lightning constitute 15 percent of Banedanmark’s total electricity consumption so installing LED lightning is making a substantial step forward towards the goal of saving 1.7 percent annually on power consumption. Moreover, diodes also live five times as long as fluorescent tubes. The next step is to examine whether the LEDs can also be used in pathways and parking spots, where the long lifetime will produce very significant savings [ING2008].

10.5 Conclusion

Lighting is by far the major end-use category in the non-domestic sector consumption (public sector, education, healthcare, services and commerce) responsible for about 175 TWh or 26% of total electricity consumption in that sector.

10.5.1 Environmental impact in a system and life-cycle perspective

According to the RoHS directive (2002/95/EC) tri phosphor lamps may contain 5 mg of mercury per lamp and halo phosphate lamps may contain 10 mg mercury per lamp. The tri phosphor lamps on the European market contain 3 mg of mercury per lamp. These lamps are more expensive, but they have significantly longer life-time than the halo phosphate, which gives approximately the same price per hour use. Hence, there is a great potential for lowering the energy consumption of mercury in florescent tubes by replacing the halo phosphate with tri phosphor lamps. It is possible to lower the content of mercury in the tri phosphor lamps even further (below 3 mg) and to increase the life-time, but that needs some time for technical development.

10.5.2 Environmental perspective from new technologies

The development and up-take of LED technology is a very promising technology for lowering the electricity consumption in both residential and public lighting. LED technology is also promising, because it's relatively non-toxic components. Unlike fluorescents, LEDs do not contain mercury or a significant amount of other toxic materials.

11 Residential room conditioning appliances (aircon and ventilation) (Lot 10)

11.1 Background

Although at European level the penetration of small air-conditioners is still small (about 4% of residential space), in some countries such as Italy and Spain the penetration of small air-conditioners reached in 2005 significant penetration levels similar to the US where there is a penetration of about 20%. Total residential air-conditioners' electricity consumption in EU-25 in year 2005 was estimated to be between 7-10 TWh per year.

11.2 Environmental screening based on the Ecoinvent database

The environmental screening for Residential room conditioning appliances (aircon and ventilation) is based on the Ecoinvent processes:

- Ventilation of dwellings, decentralized, 6 x 120 m3/h, steel ducts, with GHE (Ground Heat Exchanger).
- Ventilation of dwellings, decentralized, 6 x 120 m3/h, PE ducts, with GHE
- Ventilation of dwellings, central, 1 x 720 m3/h, steel ducts, with GHE
- Ventilation of dwellings, central, 1 x 720 m3/h, PE ducts, with GHE
- Ventilation of dwellings, decentralized, 6 x 120 m3/h, steel ducts, without GHE
- Ventilation of dwellings, decentralized, 6 x 120 m3/h, PE ducts, without GHE

Some of the main assumptions for the Ecoinvent data are:

- The ventilation systems are all for multi family houses (6 flats).
- A ventilator power requirement of 0.4 Wh/m3
- A power requirement for the control system of 10 watts
- Operating time of installations over the whole years (12 months)
- The reduces thermal gain without an ground heat exchanger as well as the additional power requirement for frost protection were taken into account.
- The service lifetime of the ventilation system is assumed to be 50 years.
- The calculations are based on Swiss electricity mix.

Further details can be found in the Ecoinvent report by Hässig and Primas [Häs2007].

In this screening it is assumed that the main principles and hence the environmental profile for "single family houses" are quite similar to the "multi family ventilation systems" modelled by Ecoinvent.

However, it is not reasonable to assume that air-condition systems have the same environmental profile as ventilation systems, as the air-condition systems contain refrigerants. As there are no air-condition systems in the Ecoinvent database, the "Heat, at air-water heat pump, 10kW" process has been used as a proxy for air-conditioning. Moreover, Ecoinvent has used the refrigerant "R134a" in the modelling.

Figure 11.1 to Figure 11.6 show the screenings of the ventilation systems. It should be kept in mind that all data for ventilation systems are based on the Swiss electricity mix instead of the European electricity mix used for most other Ecoinvent processes. When using Swiss electricity mix, the electricity related emissions are considerably underestimated compared to the European electricity mix (see chapter 1). Hence, when analysing the data one should keep in mind that the environmental impacts from the electricity consumption is tremendously underestimated (but for "Non-renewable energy" and "Mineral extraction"). Bearing this in mind, it can be concluded that for ventilation systems:

- The electricity consumption during use is by far the most significant contributor to the environmental impacts from ventilation systems.
- The ventilation system and the ventilation equipment also contribute notably to the environmental impacts.
- Furthermore, the steel silencer contributes to some extent to the environmental impacts.

An analysis of the ventilation system and the ventilation equipment has been carried out and the results are shown in Figure 11.7 to Figure 11.9. From these (and from comparing analysis, not shown here) it can be seen that the steel ducts contribute more the overall environmental impacts than PE ducts. Furthermore, the main contributions from the ventilation equipment come from the zinc coating and the production of aluminium and copper.

Ecoinvent write in their conclusion (if using this anywhere please refer to the original Ecoinvent report by Hässig and Primas [Häs2007]:

"An ecologically optimised ventilation unit would have approximately the following features:

- A ventilation system with a central ventilator, an ground heat exchanger and polythene tubes run in the concrete ceiling for distributing the air in the dwelling
- A rugged ventilator with a long service life thanks to the good replaceability of its components
- Heat exchangers with a heat recovery rate of 85 to 90%
- Ventilators with low power consumption thanks to the use of optimally designed DC or EC motors (total of 0.3 watt per m3/h or less).
- An air distribution with a low pressure drop
- Tight dimensioning of air quantity and demand-oriented controlling
- Operation of the ventilation unit only during the heating period"

Figure 11.10 show the screening of the Ecoinvent process "Heat, at air-water heat pump 10kW" as an approximation for air-conditioning systems. From the figure it can be seen that the electricity consumption during use is the absolutely largest contributor to the environmental impacts. However, the heat pump it self also has significant impacts. The refrigerant, which in this case is R134a, contributes significantly to photochemical ozone formation (impacts on vegetation). An analysis of the production of R134a (not shown) demonstrates that it is mainly the consumption of trichloroethylene, tetrachloroethylene and hydrogen fluoride and emissions at the refrigerant plant that contributes to the photochemical ozone formation (impacts on vegetation). An analysis of the pump (not shown) illustrates that especially the production of copper and steel for the pump contribute to the environmental impacts.

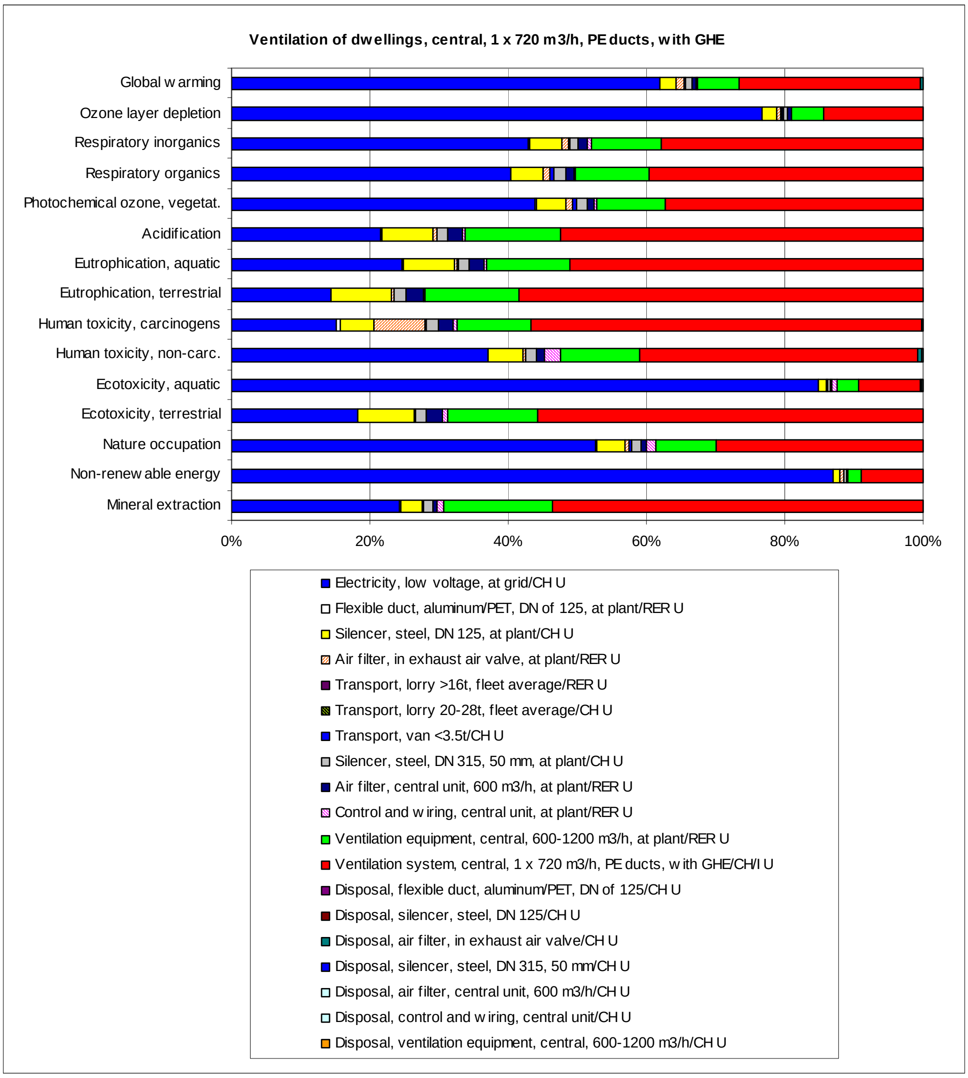

Figure 11.1 Environmental impacts from the ventilation of dwellings (central, 1 x 720 m3/h, PE ducts, with GHE)

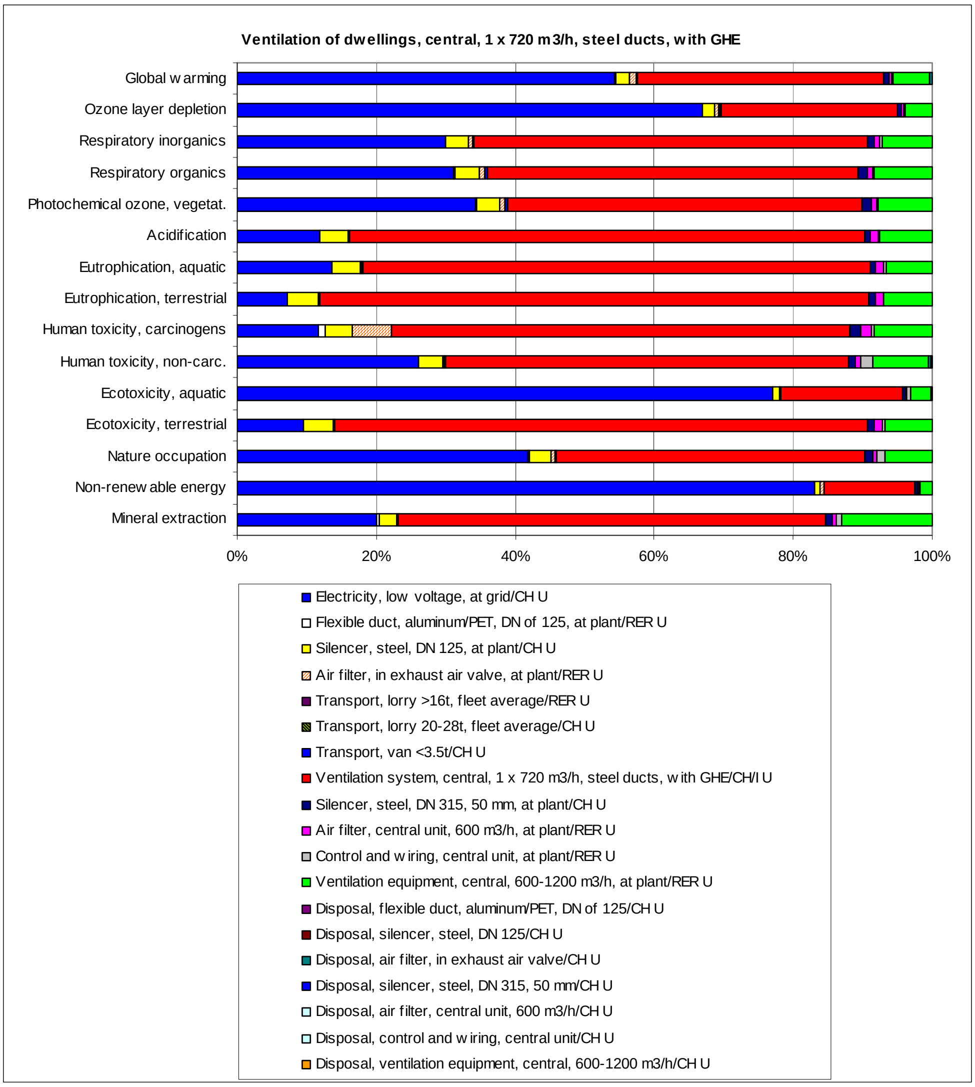

Figure 11.2 Environmental impacts from the ventilation of dwellings (central, 1 x 720 m3/h, steel ducts, with GHE).

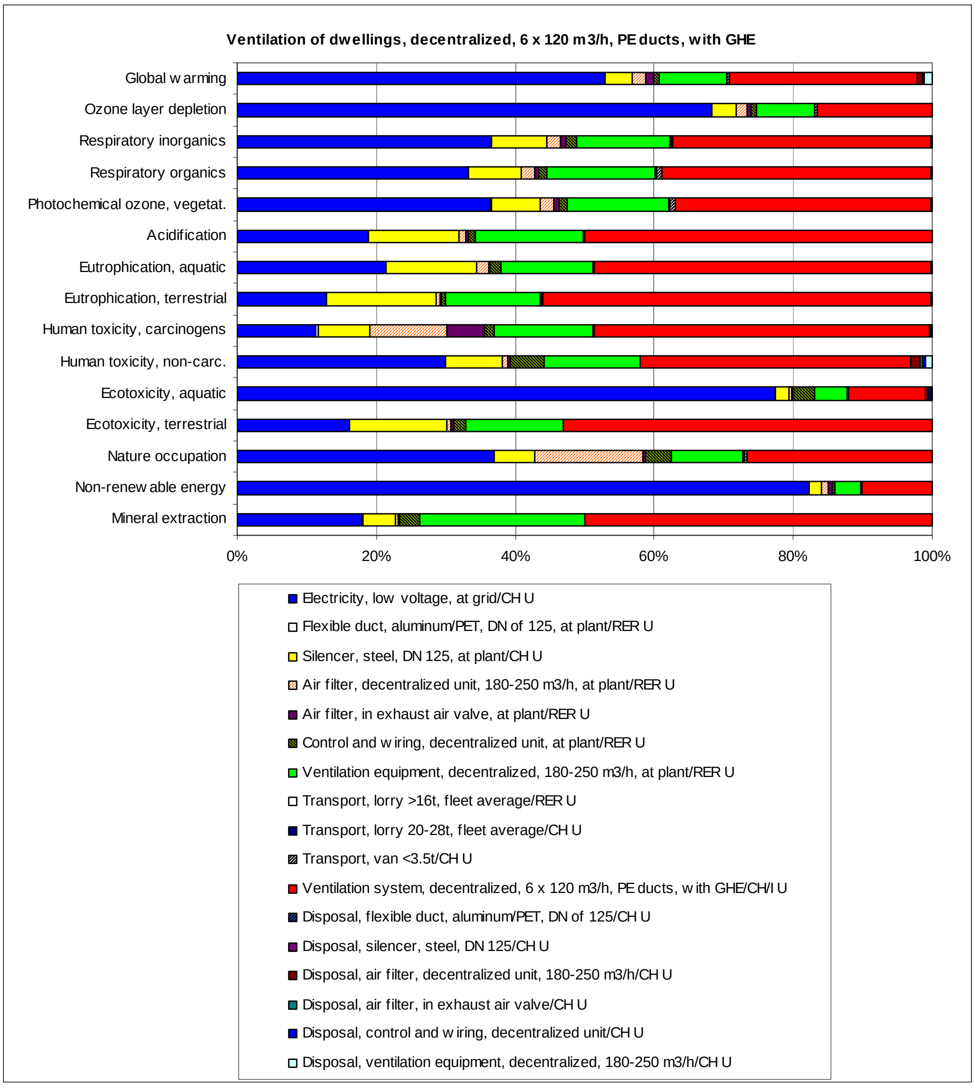

Figure 11.3 Environmental impacts from the ventilation of dwellings, decentralized, 6 x 120 m3/h, PE ducts, with GHE

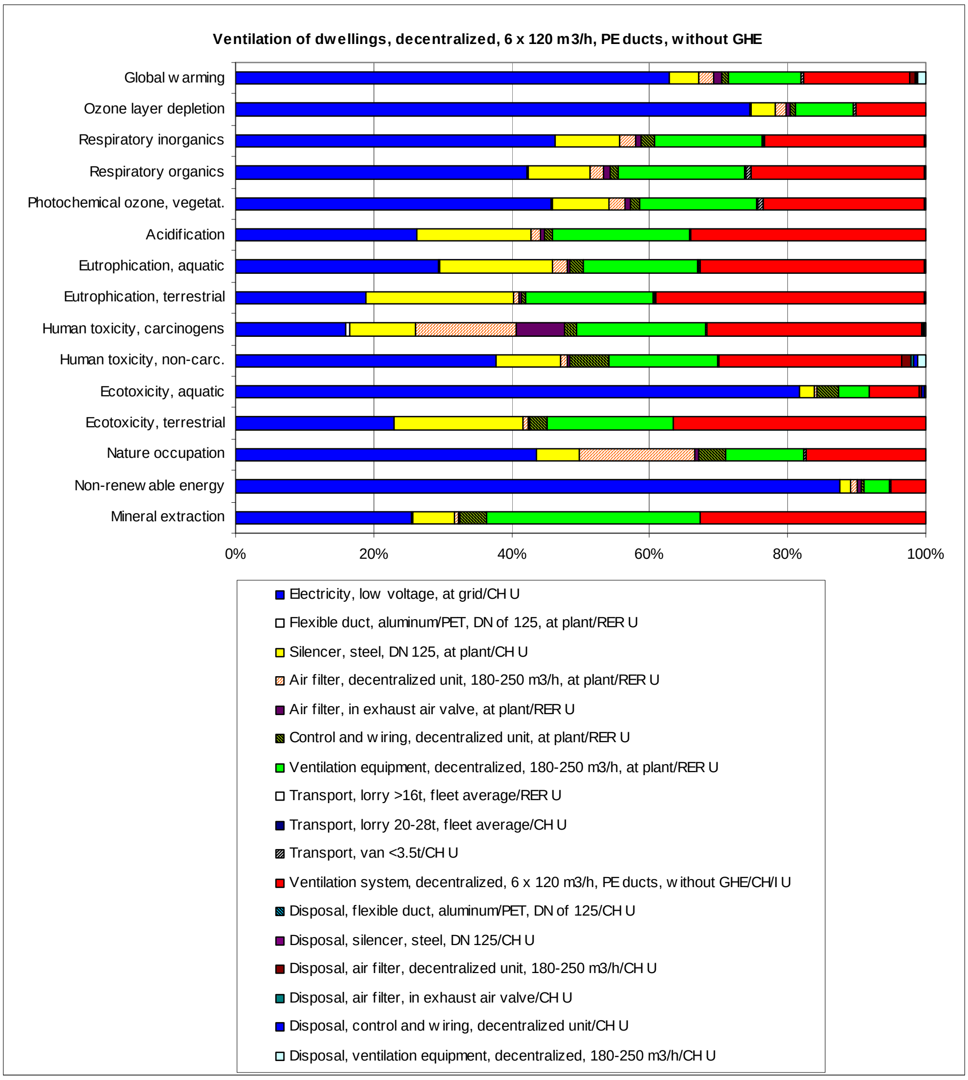

Figure 11.4 Environmental impacts from the ventilation of dwellings, decentralized, 6 x 120 m3/h, PE ducts, without GHE

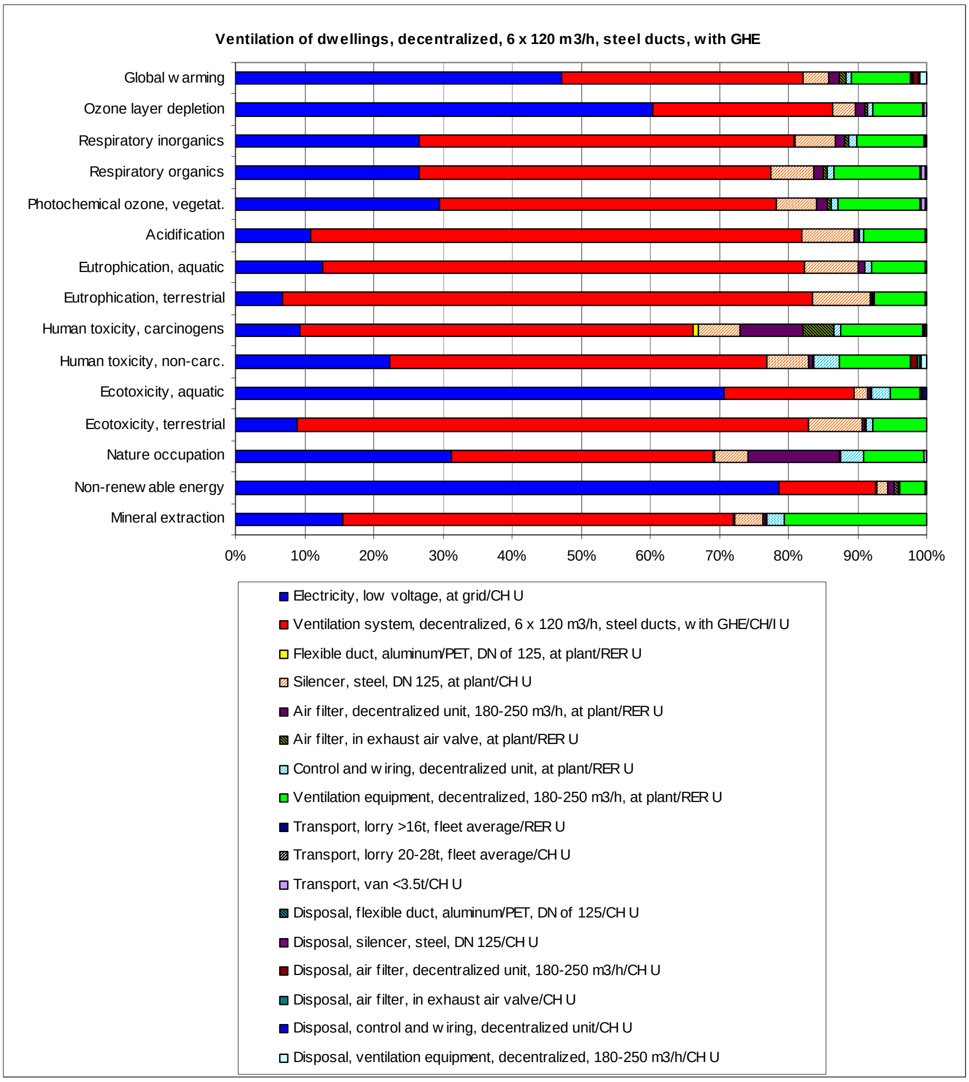

Figure 11.5 Environmental impacts from the ventilation of dwellings, decentralized, 6 x 120 m3/h, steel ducts, with GHE

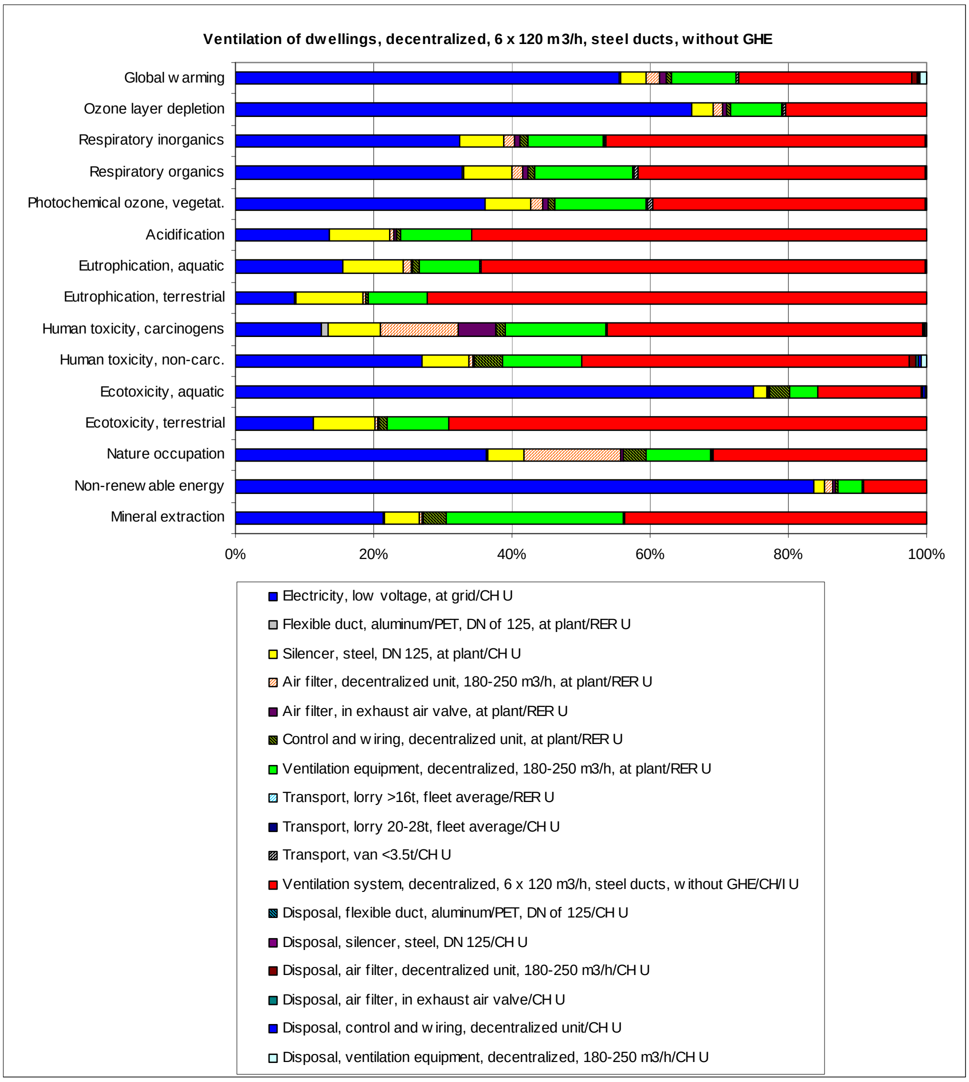

Figure 11.6 Environmental impacts from the ventilation of dwellings, decentralized, 6 x 120 m3/h, steel ducts, without GHE

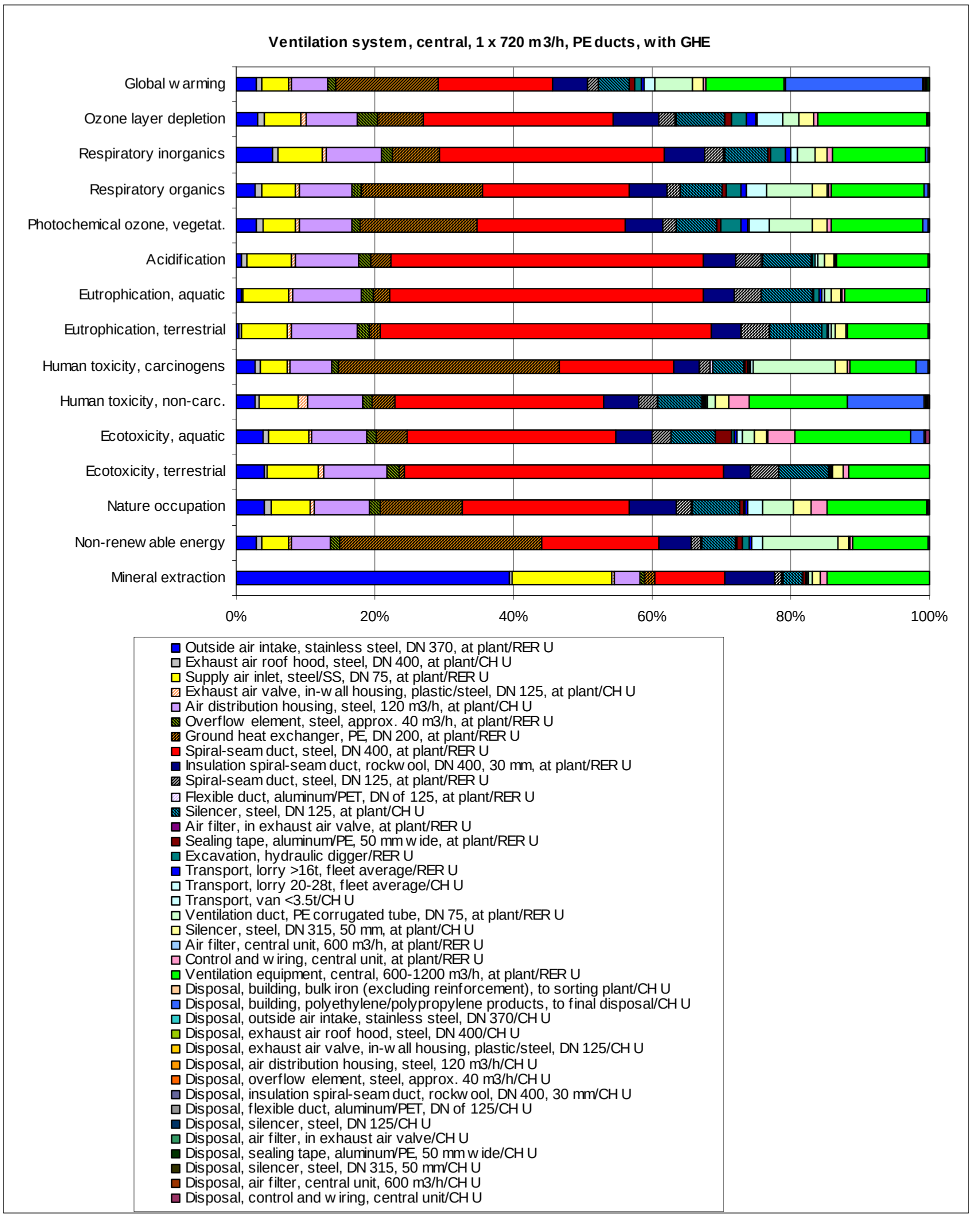

Figure 11.7 Environmental impacts from the Ventilation system, central, 1 x 720 m3/h, PE ducts, with GHE

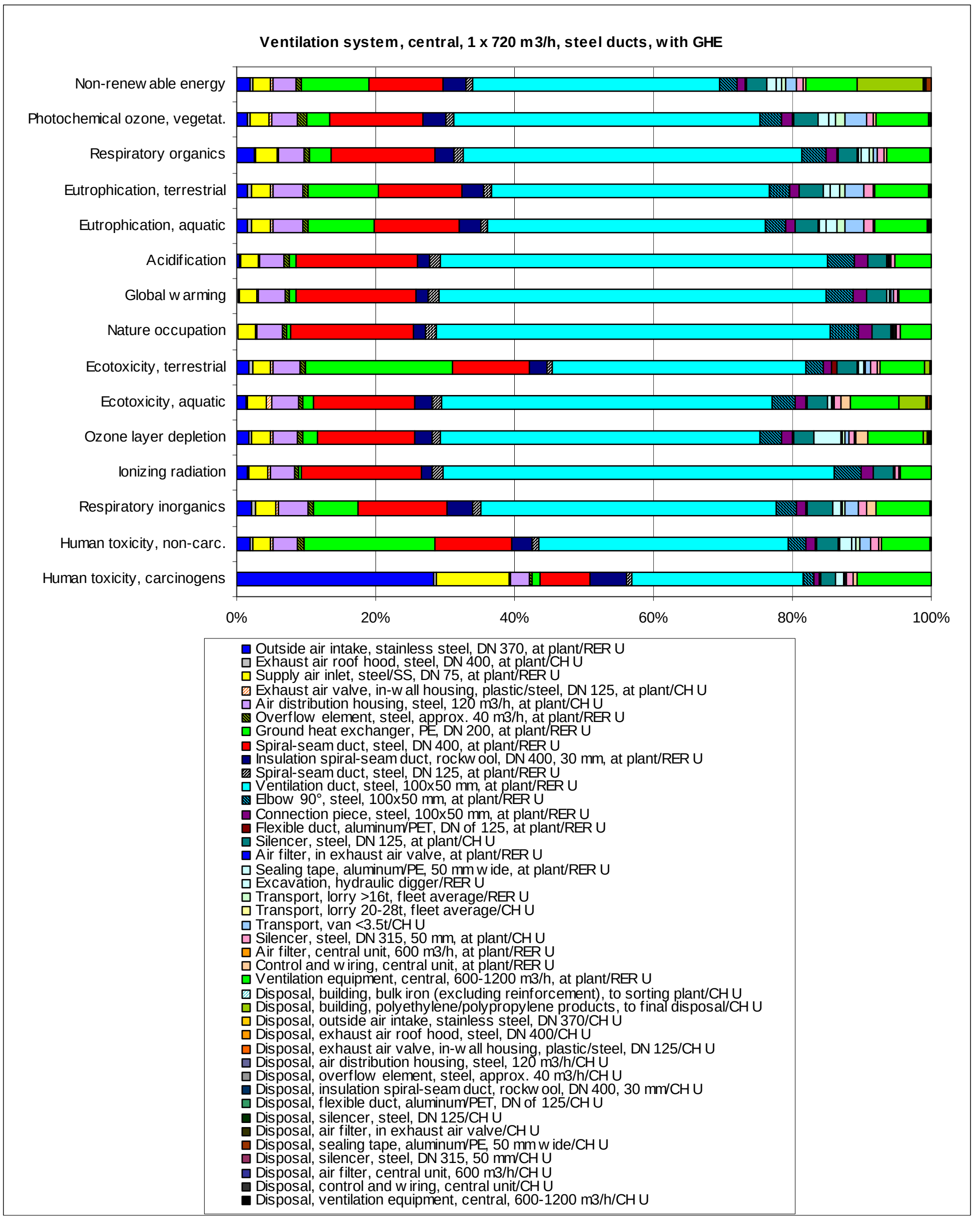

Figure 11.8 Environmental impacts from the Ventilation system, central, 1 x 720 m3/h, steel ducts, with GHE

Figure 11.9 Environmental impacts from the Ventilation equipment, central, 600-1200 m3/h, at plant.

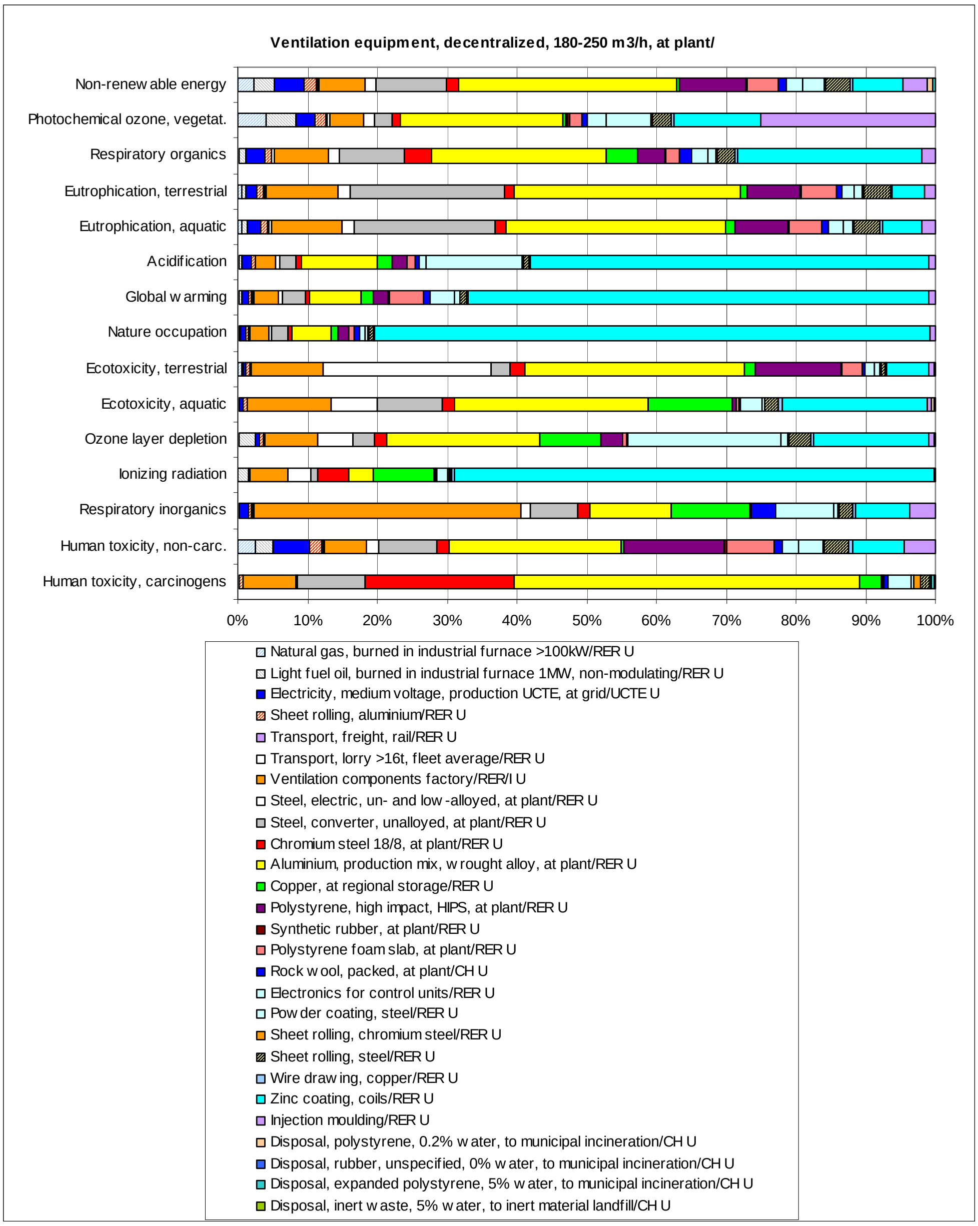

Figure 11.10 Environmental impacts from the Ventilation equipment, central, 600-1200 m3/h, at plant.

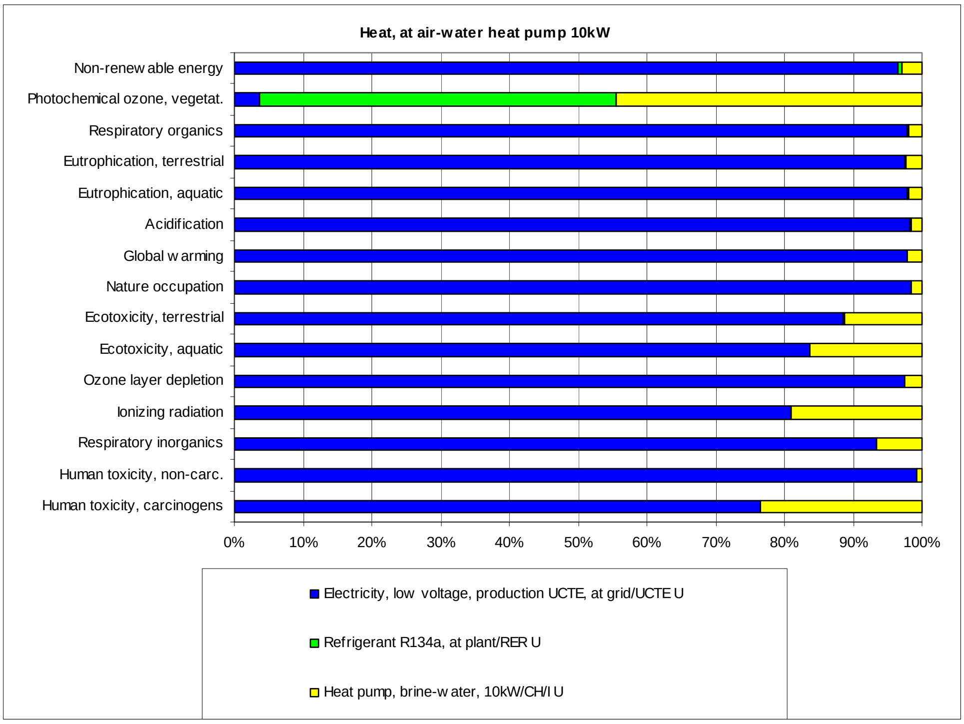

Figure 11.11 Environmental impacts from the Ecoinvent process “Heat, at air-water heat pump 10kW“.

11.3 Ecolabel requirements

For room air-conditioners (up to 12 kW output power), the Labelling Directive (2002/31/EC) has been adopted by the European Commission and was published in March 2002. [EU2002a]

The full mandatory application of this Directive was fixed for 30 June 2003. However, the relevant test standard needed to serve as the reference document was missing; the new revised standard EN 14511 covering all products in the scope of the Directive has not been finalised before May 2004. The European Commission in agreement with the Labelling Committee decided to postpone the application till just before the summer 2004. The A class limit for the split, non ducted, air-cooled air conditioners up to 12kW is set at EER[4] of 3,2; some new models have been introduced on the market with EER above 4, the best models on the market having an EER of 5,51. This indicates that the A class level is not very ambitious. In addition, there are still several E and D class models on the European market, with EER at around 2,5. [EU2002a]

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[4] EER = Energy Efficiency Ratio. This is the ratio between the output cooling (thermal) power and the input electrical power in the cooling mode. The EER is used to define the energy classes for the energy labelling. For reversible air-conditioners (working as heat pump) the efficiency indicator is the COP (coefficient of performance) which is defined as the EER during the heating mode.

Eurovent Certification certifies the performance ratings of air-conditioning and refrigeration products according to European and international standards. Eurovent certification is divided in 17 different Programmes, each of them corresponding to one type (eventually one range) of refrigeration or air-conditioning product.

11.4 Technology and market trends

Trends indicate that there continues to be an increase in demand for air-conditioning. With it comes a need for new technology. Today air-conditioning is a way of life in the U.S., Asia and Southern Europe. According to the US based Air-Conditioning and Refrigeration Institute (ARI), nearly 50% of all U.S. homes have air-conditioning and in 1996, 81% of all new homes constructed were equipped with central air-conditioning. It is generally believed that the growth will continue.

An interesting anomaly resulting from climate change is the new design conditions that are evolving for buildings as climate zones shift. Also previously inhabitable regions are being developed due to air conditioning technology. Since 1940, eight of the 10 fastest growing cities in the U.S. are located in the Southeast and Southwest parts of the country. This is the direct result of air-conditioning.

In Southern Europe (Italy, Spain, Portugal, Greece and Southern France) one of the main drivers to increases in electricity consumption and more important to electricity peak demand is the fast penetration of small residential air-conditioners (less then 12 kW output cooling power) and their extensive use during the summer months.

With rising fuel costs, it makes sense to have air-conditioning only in rooms where people are present. That could be done with motion sensors build into the Intelligent House. Georgia Institute of Technology, US have come up with a cheaper alternative by tracking small disturbances in the air flow from people opening and shutting doors. Recently, manufacturers work also to add functions to the original room temperature control function, such as air purity.

For room air-conditioners (up to 12 kW) a marked improvement of the EER can be seen in Figure 11.12. This improvement is attributed to the technological development, mainly in Japan, where there are very ambitious energy efficiency targets. The publication of the EER and the energy label in the Eurovent Certification Scheme[5] has also contributed to the increase in EER of marketable products. EER values exceeding 20 is now theoretically possible by increasing in efficiency of the compressor, the heat exchanger, and the ventilator.

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[5] available at: www.eurovent-certification.com

Eurovent-Cecomaf has self-committed to withdraw from the market the models in G class. Implementation of this started in January 2004 with the elimination of Class G products. [Sah2006]

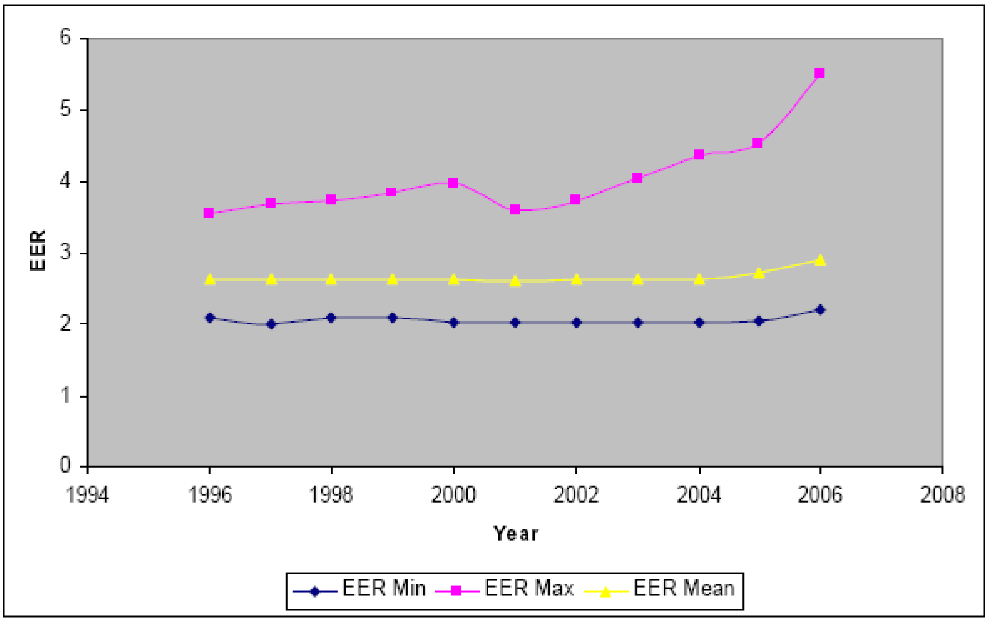

Figure 11.12 Evolution of the EER (minimum, maximum and model weighted average) for split, non ducted, air-cooled Air conditioners up to 12 kW (Source: Eurovent [EU2006a], [Bec2006])

Researchers at Pacific Northwest National Laboratory are demonstrating lightweight and man-portable cooling technology, which potentially could lead to wearable air conditioners. The principles of micro technology and the very high rates of heat and mass transfer at this miniature scale have enabled man-portable cooling systems weighting about two kilos. Instead of using electricity to power a mechanical compressor, heat from burning fuel is used to power the cooling, thereby replacing bulky, heavy batteries with much lighter fuels. [Piq2004]

Staying cool without lowering the air conditioner thermostat may come in the form of air-conditioned clothing, an idea that was unveiled by Kuchofuku Inc. and first went into full-fledged production in April 2005. Air-conditioned clothes have two small fans about 10 centimetres in diameter attached to the right and left sides of the back of the clothing, just above the waist. The fans draw in a large amount of air and help to vaporize sweat. As the perspiration evaporates, heat is dissipated, bringing down the wearer's body temperature.

11.5 Conclusion

The electricity consumption during use is by far the most significant contributor to the environmental impacts from ventilation systems.

11.5.1 Environmental impact in a system and life-cycle perspective

The production and construction of the ventilation system itself also contribute notably to the environmental impacts. Furthermore, the steel silencer contributes to some extent to the environmental impacts. Their contributions mainly come from the energy consumption for the production and the extraction of resources for the ventilation systems.

For extraction of resources, especially extraction of nickel, aluminium, copper, iron, tin and chromium is of importance. The extraction of zinc, copper, aluminium and iron also gives significant contributions to human toxicity and eco-toxicity.

Some of the refrigerants contribute to the global warming (HFC and PFC). Some refrigerants might also have other environmental impacts, like toxicity.

11.5.2 Environmental perspective from new technologies

Hässig and Primas concludes in their original Ecoinvent report: [Häs2007]

> "An ecologically optimised ventilation unit would have approximately the following features:
>
> - A ventilation system with a central ventilator, an ground heat exchanger and polythene tubes run in the concrete ceiling for distributing the air in the dwelling
> - A rugged ventilator with a long service life thanks to the good replaceability of its components
> - Heat exchangers with a heat recovery rate of 85 to 90%
> - Ventilators with low power consumption thanks to the use of optimally designed DC or EC motors (total of 0.3 watt per m3/h or less).
> - An air distribution with a low pressure drop
> - Tight dimensioning of air quantity and demand-oriented controlling
> - Operation of the ventilation unit only during the heating period"

In line with the paradigm of "Central production – local control", the authors tends to favour solutions based on large, central units (e.g. for apartment blocks) incorporating environmental clean and renewable energy sources.

12 Electric motors 1-150 kW, water pumps (commercial buildings, drinking water, food, agriculture), circulators in buildings, ventilation fans (non-residential) (Lot 11)

12.1 Background

This product group covers the following 4 product categories:

- Electric motors 1-150kW
- Water pumps (in commercial buildings, drinking water pumping, food industry, agriculture)
- Circulators in buildings
- Ventilation fans (non-residential buildings)

12.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for this theme, an environmental screening has not been performed for this product group.

12.3 Ecolabel requirements

It has not been possible to identify relevant Ecolabel criteria for this product group.

In March 2005, four European pump manufacturers announced an agreement on what is currently a voluntary energy-labelling scheme to Europe. The four companies who signed up to the scheme were: Grundfos Pumps (who initiated the scheme); Wilo; Smedegaard and Circulating Pumps who between them cover approximately 80% of the European market for circulator pumps.

The result is based on the pumps Energy Efficiency Index (EEI). The classification relates to independent circulator pumps with integrated pumps and motors.

12.4 Technology and market trends

The general technology trends for motors, pumps, fans and ventilation equipment is described in the EuP Preparatory report. Since pump technology is a Danish stronghold, the authors have added some comments to the technological development in this area.

Pump technology accounts for 20% of the world's annual electricity consumption, so energy- efficient products offer great scope for savings. Pumps are the single largest user of electricity in industrial and commercial applications in the UK consuming 47.24 TWh of electricity, which in turn represents some 32% of all electric motor consumption in industry and commerce.

The UK government's Department of the Environment, Food and Rural Affairs (DEFRA) have set specific targets for the savings they want to see from pumps: 1,033 GWhr by 2010 (2%) and 4,265 GWhr by 2020 (9%).

Circulator pumps are used for heating, ventilation and air-conditioning in domestic houses, office buildings, hotels, etc. In the industry the pumps are used in processes as well as in the area of plant maintenance and in the water-supply and waste-water segment. With an annual production of more than 10 million pump units, the Danish company Grundfos is one of the world's leading pump manufacturers. Circulator pumps, submersible pumps, and centrifugal pumps are the three major product groups. Today, Grundfos is the world's largest manufacturer of circulator pumps, covering approximately 50 per cent of the world market for these pumps.

Intelligent pumps fitted with electronics allow for considerable reductions in energy consumption of up to 50%. The technology behind these advances emanates from the development of permanent magnet motors, as these dramatically increase motor efficiency. They operate by drawing on the energy to drive the motor from magnets in the rotor, not just the mains. This allows these pumps to operate at optimal efficiency at any output. The integrated sensor monitors conditions in the system and a frequency converter then regulates the motor speed accordingly, so only the minimum power is used. The electronic circuitry used to control the pump typically consist of nano-coated MEMS (micro electro-mechanical systems) silicone pressure sensors, control circuitry on silicon substrates.

Put into place to support the Energy Labelling system the Energy Project show significant results right across Europe, with estimates that the amount of energy saved as a result of the installation of increased efficiency circulators in the 120 million private European residences, commercial buildings and light industry combined to make a saving of an astonishing 400 million kWh in the first year. This saving equates to the annual energy consumption of 88,000 homes.

Combined with a design specifically aimed at optimising energy efficiency, this has earned the Grundfos MAGNA series a class 'A' rating in the European energy labelling scheme. Many other manufacturers have since joined the variable speed portfolio and all applications that are suitable candidates for variable speed pump technology now benefit from having a wide range of options available to them. According to Grundfos, all Grundfos pumps installed in 2001 alone resulted in a total power saving equivalent to the annual consumption of 283,000 households in the western world. This equates a drop in CO_2 emissions of approximately 796,000 tons.

12.5 Conclusion

12.5.1 Environmental impact in a system and life-cycle perspective

This product group is a horizontal group that should be seen in the system approach that the authors find is a more reasonable approach to assess the environmental impact.

In view of the paradigm of “Central production – local control”, the need for intelligent and controllable motors is evident. They perform the necessary building blocks for executing the local control. The trend in intelligent pumps thus fully illustrates the need and the possibilities that exist for energy savings, when the control of energy consumption is done locally and in the context, in which the consumption takes place.

13 Refrigerators and freezers, including chillers, display cabinets and vending machines (Lot 12 and 13)

13.1 Background

Refrigerators and freezers, also known as “cold appliances”, have been the first and the most studied EuP in the European Union with the goal to reduce their energy consumption.

In this Memorandum, the two product groups commercial and residential refrigerators and freezers are discussed together in spite of that they constitute two different studies in the EuP scheme.

13.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for this theme, an environmental screening has not been performed for this product group.

13.3 Ecolabel requirements

The major European policy measures already in place are the mandatory energy labelling (Directive 94/2/EC), including the Amended Directive of 2003 (2003/66/EC) to introduce the A+ and A++ classes [EU 2003], and the CECED unilateral agreement [CEC2005].

For domestic refrigerators the energy efficiency index (EEI) is defined in the Directive and the EEI was set at 102 for the average model on the market in year 1992, as reported by the GEA study.

The main focus of the European Ecolabel criteria is put on to:

- Energy consumption
- The refrigerants in the refrigerating circuit and foaming agents used for the insulation of the appliance shall have no ozone depletion potential.
- Reduction of global warming potential of refrigerants and foaming agents
- Life time extension by the availability of compatible replacement parts and service shall be guaranteed for 12 years from the time that production ceases.
- The manufacturer shall offer take-back for recycling.

Recently, the European Association of Household Appliance Manufacturers (CECED) issued in October 2002 a Voluntary Commitment on reducing energy consumption of household refrigerators, freezers and their combinations.

The CECED unilateral agreement contains the following commitments. Participating manufacturers have stopped producing for, and importing in, the Community Market electric compressor based household refrigerating appliances having an energy efficiency index 75 (corresponding to energy label class C) and above (except for chest freezers), and for electric compressor based chest freezers having an energy efficiency index 90 (corresponding to energy label class D) and above, by 31st December 2004.

The agreement also includes a ”fleet target”: Each participant will reduce its own production - weighted average energy efficiency index- to a value of 55 for production and importation into the EU market by the year 2006. [Arn2006]

13.4 Technology and market trends

The efficiency improvement trend continued for refrigerators and freezers. For domestic refrigerators the energy efficiency index (EEI) was set at 102 for the average model on the market in year 1992, as reported by the GEA study. Among the combined refrigerator-freezer, the best models on the market in the year 2005 were models rated A++ with an EEI below 30; as example a model with 215 fresh food volume and 60 l of freezer (4*) volume has an annual consumption of 137,0 kWh/year . For the same size a C class model just meeting the efficiency requirements would use 522 kWh/year (a factor four energy reduction!). There are still a limited number of models in A++ class (EEI below 30), and still difficult to find them in shops, while there is already several models in A+ class.

The graph from Figure 13.1 shows the improvement of the EEI from year 1992 to 2005. On average the efficiency improvement over 13 years has been a remarkable 40%.

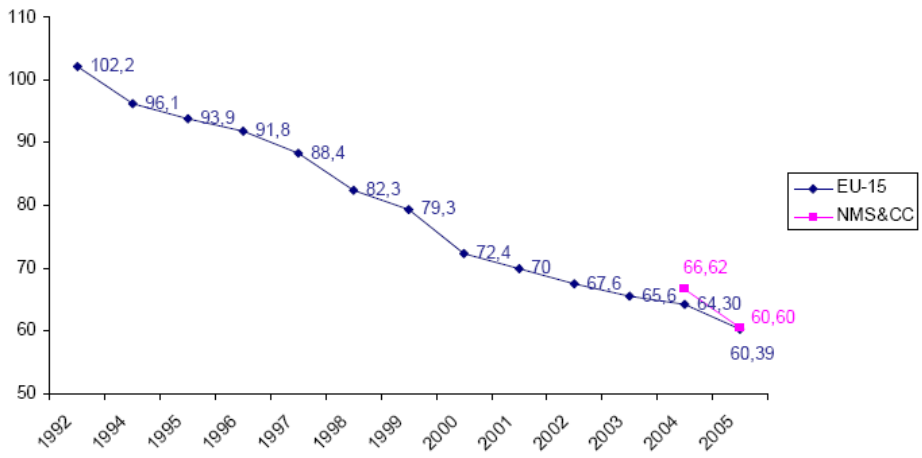

Figure 13.1 Evolution of the EEI (new model sale weighted average) for cold appliances (Source:[Ber2007])

The sale data for 2005 for cold appliances show that in some markets (and in particular in the Netherlands and Germany) the A+ appliances are starting to have an important market share (14.8 % market share of A+ class in Germany), while at European level the share of A class has reached 60 % of the sales, with 9% in A+ class. In all countries the share of A and A+ appliances has strongly increased in 2005 compared with previous years.

Large differences still exist between countries due to different national and regional policies and programmes. The lowest share of sales of A class appliances is in the west European countries covered by the GfK panel 2004 is in Spain (36.1%), and the highest share in the Netherlands (71.1% in A class plus 19.2% in A+ class) , this remarkable high share is due in particular to incentives for very high efficient appliances. Also worth noticing is that the share of A class appliances in new refrigerators sales is higher in the New Member States (again comparing only among the countries covered by the GfK panel). The strongest progress in the period 2002 to 2005 happened in the UK mainly due to the Energy Efficiency Commitment[6] under which about 1 million efficient cold appliances have been sold per year.

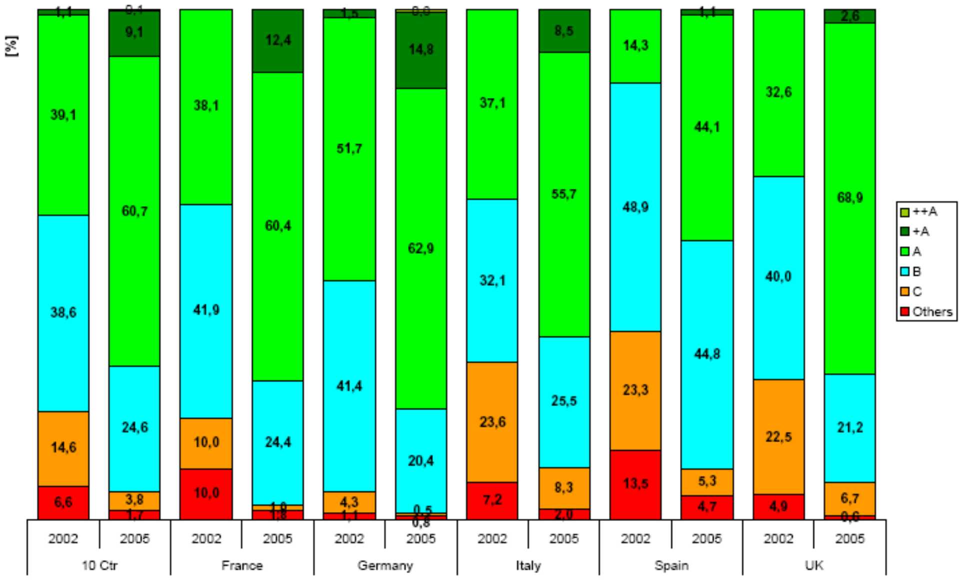

Figure 13.2 Sales of cold appliances: Comparison for the 5 large countries of sales in 2002 and2005
by energy class (Source: GfK, [GfK 2004], [Sor2005], from [Ber2007])

13.5 Conclusion

13.5.1 Environmental impact in a system and life-cycle perspective

The energy consumption during use is absolutely the most important environmental impact for this product group. Due to the generally relative long life-time of the products within this product group, the manufacturing of the products mean relative less.

[6] Energy Efficiency Commitment (EEC) runs in 3-year cycles from 2002 to 2011. EEC-1 program required that all gas and electricity suppliers with 15,000 or more domestic customers deliver a certain quantity of ‘fuel standardised energy benefits’ by encouraging or assisting customers to take energy-efficiency measures in their homes.

The environmental aspects of the refrigerants are important. Especially the global warming impacts of HFC and PFC are important, but also other environmental aspects of the refrigerants might be important (e.g. toxicity).

Waste handling of old refrigerators is very important. When buying a new A+ / A++ appliance the consumer should get a credit for returning the old appliance in order to ensure that it disappears from the market to prevent that the consumers continue to use it for example at home in their garage.

Reliable return systems have to be set up in order to prevent the old appliances from being shipped illegally to emerging markets like India, Pakistan or China where treatment standards are negligible. Access to the above scheme should be made dependent on supplying an old appliance.

13.5.2 Environmental perspective from new technologies

New refrigerators have much higher energy efficiency than do older and the authors suggest that it might not be a good idea to promote extended life-time for this product group.

But the number of refrigerators per household is only 1.15 in Germany in 2003 and 1.36 in Denmark in 2004 indicating that rapid replacement could become a real problem. The environmental benefit of buying new A+ or A++ appliances disappears if the old appliances are not forced out of use.

13.5.3 Regulation

The European Ecolabel for refrigerators ended 31 May 2008 and new regulations must be put into force. [EC2004]

14 Domestic dishwashers and washing machines (Lot 14)

14.1 Background

The background working documents on the EuP preparatory study on Domestic dishwashers and washing machines can be found on www.ecowet-domestic.org/. The project is ongoing.

As with refrigerators and freezers, dishwashers and washing machines, also known as “wet appliances”, have been among the most studied EuP in the European Union with the goal to reduce their energy consumption.

14.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for this theme, an environmental screening has not been performed for this product group.

14.3 Ecolabel requirements

The major European policy measures already in place are the mandatory energy labelling (Directive 97/17/EC amended by Directive 1999/9/EC) [EU 1999] and also the CECED
Unilateral Commitment [CEC 2004], which is now expired.

The CECED agreement foresaw that participating manufacturers commonly agreed to stop producing and importing in the EU dishwashers which belong to the energy efficiency class D (for >10 place settings) or E respectively (for <10 place settings) from 31 December 2003. On 31 December 2004 the dishwasher unilateral agreement expired.

The Nordic Ecolabelling criteria for washing machines and dishwashers [NE2004] focus on:

- Energy consumption
- Refrigerants and foaming agents: No ozone depletion potentials and a maximum for the global warming potential.
- Design for recycling
- Take-back and recycling
- Marking of plastic parts
- Flame retardants in plastic parts
- Life time extension (availability of compatible replacement parts and service)

14.4 Technology and market trends

For dishwashers there was only a relatively small efficiency progress between year 2001 and 2005. In the year 2003 the average consumption per test cycle wash of a 12 place setting dishwasher was 1,197 kWh down 10% from the average consumption in 2001. The best model on the market (already for some years) has an EEI of 1,05 kWh per wash cycle. This indicates that even with the present technology there is not anymore large energy saving potential (this also means that there is no possibility to introduce an A+ class).

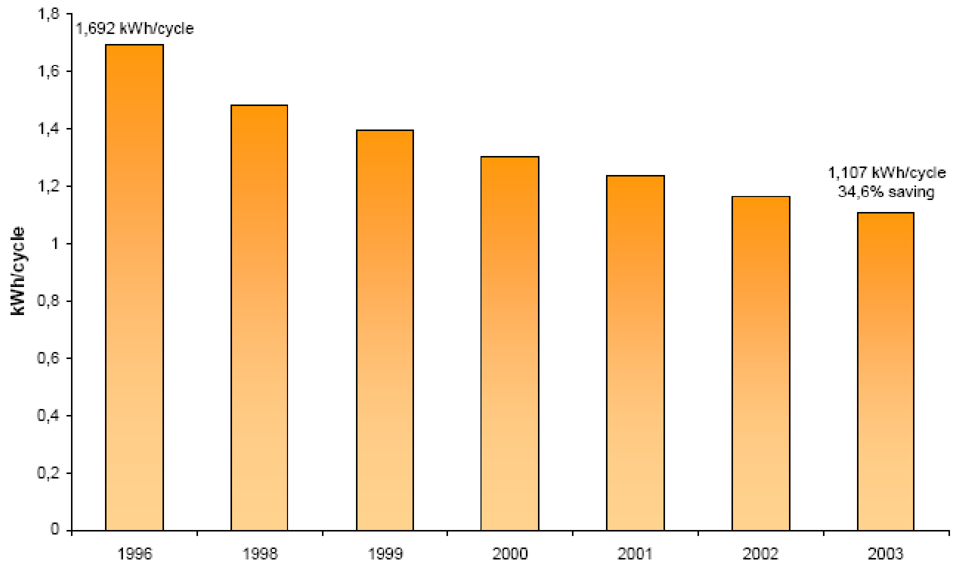

Figure 14.1 EU-15 Dishwasher energy efficiency index progress, in kWh/cycle (Source: CECED)

The sales of dishwashers by energy class follow a similar patter to the one of the washing machines, with the class A already above the 50% threshold. The lowest share of sales of A class appliances in 2005 was in Spain 69% (still up from 31 % in 2002), with the highest share 94% in Belgium. Remarkable progress in energy efficiency of new models took between 2002 and 2005 in all EU-15 countries, especially in the UK and Italy. Very impressive also is the high A class market share in some of the New Member States.

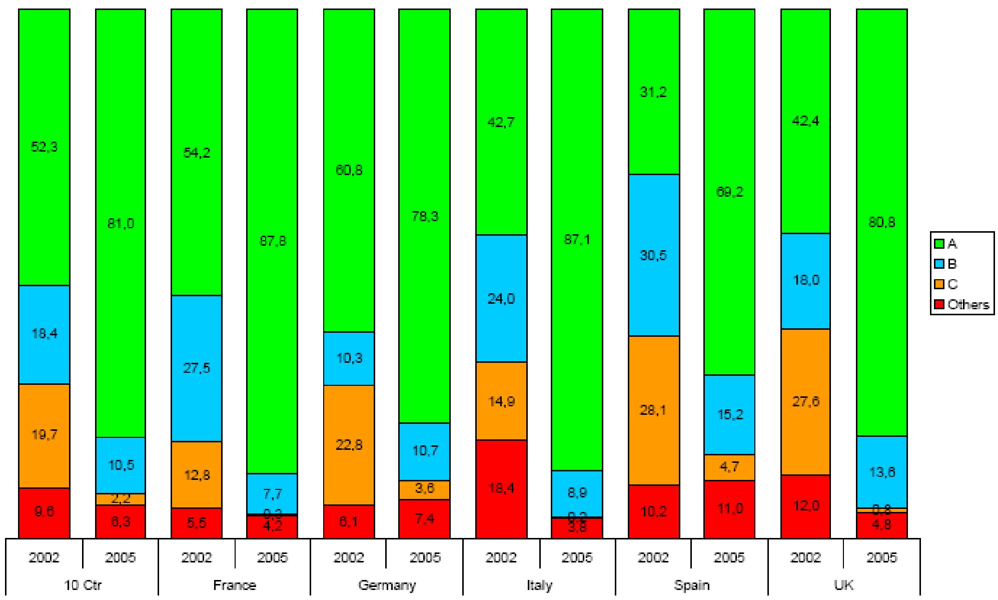

Figure 14.2 Sales of dishwashers: comparison between 2002 and 2005
for the 5 major EU-15 countries, by energy class (Source: GfK [GfK2004), from [Ber2007])

As far as the sales of washing machines are concerned, the share of A class appliances was already above 50% in 2002, in 2005 in some Member States (Germany, the Netherlands, and Belgium) there is a large penetration of A+

appliances (not defined in the labelling Directive but agreed among CECED manufacturers), and the combination of A and A+ in these markets is approaching the 100% market. The most remarkable market change from 2002 for washing machines has happened in the UK due to the Energy Efficiency Commitment (about 800.000 washing machines have been subsidised each year under EEC). It is also interesting noting that the class B is almost disappeared from the market, but there is an increased share of not labelled appliances. Class A appliances are seen by consumers as a high quality product (most of A class appliances are AAA, associating to the low energy consumption, high spin speed and good washing performances).
For washing machines the EEI is expressed as the energy used per kg of soiled cloths in a standard 60°C cotton cycle (kWh/kg).

In 2005 there was not any improvement in the share of sales of A and A+ washing machines in the EU-15 (only in the countries covered by GfK), while in the New Member Sates the combined share of A and A+ models continued to grow.

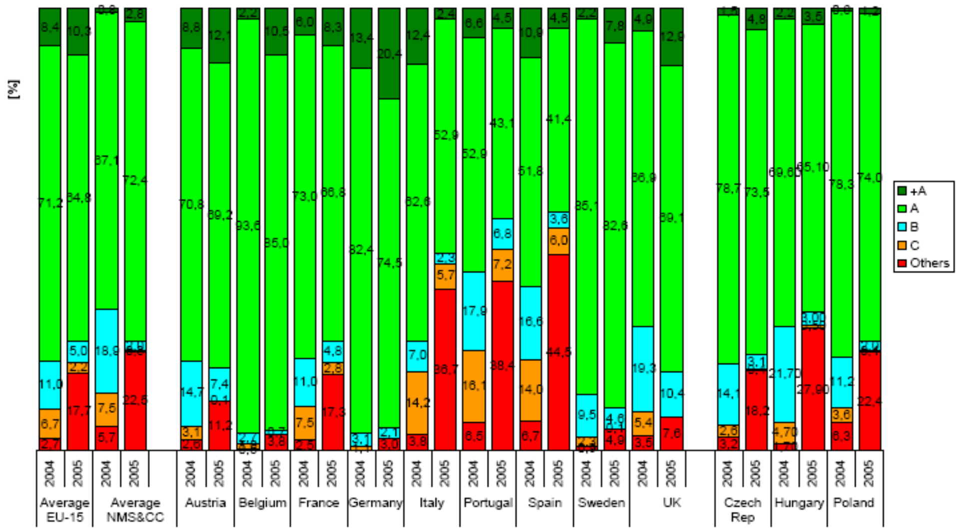

Figure 14.3 Sales of washing machines: comparison for 2004-2005 sales, by energy class (Source: GfK, [Sor2005], from [Ber2007])

Various forms of intelligent washing machines have been demonstrated for several years. The intelligent washing machine will read intelligent labels in clothes and retrieve information about the size, colour and type of fabric as well as washing instructions. Based on the assumption that clothes are all tagged with RFID chips, washing machines will read them for appropriate wash instructions, set the temperature, wash cycles, etc.

Many manufacturers work on reducing energy consumption by enabling washing of normal clothes in water with lower temperatures. One of the features of the Samsung Silvercare washing machine is to effectively and safely wash fabrics that cannot be washed in hot water. This is made possible by applying electrolysation to dissolve nano-scale silver particles in cold water. Research has shown that an average family can save around 130 annually by washing in cold water.

Sanyo Electric Co. is marketing a household washing machine called Aqua that can use air to wash clothes. It is the first drum-type household washing machine to use air, specifically ozone, to keep clothes clean. With "air wash," air containing ozone is sprayed on items inside the machine's drum. After about 30 minutes, any odours or bacteria on the items have been broken down. The machine also includes a system that recycles water. Water used in the final rinse cycle is stored in a tank inside the machine. Ozone is then injected into the water, cleaning it and killing any bacteria, so that the water can be used the next time a load of washing is done. The machine has a variety of other unique cycles, including the non-detergent course, which can remove light dirt without the use of detergents, and the mold-guard course, which uses the anti-bacterial powers of ozone to protect clothes against black mold. There is also the Ozone steam course, employing steam containing ozone to do a thorough job of removing dirt. The Aqua is said to require only about half the amount of water compared to ordinary washing machines.

From the design labs at Electrolux comes the KaionWAVE washing concept for laundry of the future. The washing system uses ultraviolet-C light for cleaning nano-coated fabrics, a durable and stain resistant fabric that will be used to make the clothing. The nano-coated fabrics are cleaned with the ultraviolet-C light and free radical oxygen. The ultraviolet-C light can penetrate through every article of fabric to kill bacteria and viruses, while the free radical oxygen acts as a powerful oxidizing agent that can break down dirt into carbon dioxide and water, thus sanitizing the fabric. Functioning as both a washer and a dryer, no water or chemicals are necessary.

14.5 Conclusion

14.5.1 Environmental impact in a system and life-cycle perspective

The energy consumption during use is absolutely the most important environmental impact for this product group. For washing machines, washing at lower degrees can significantly reduce the energy consumption by using enzyme based washing powder. Hence, great focus should be put on the ability of washing at low degrees or even in cold water.

However, also the consumption of detergents and water is important. As the consumer often “over dose” detergents, automatic dosing systems should be implemented.

Due to the generally relative long life-time of the products within this product group, the manufacturing of the products mean relative less.

14.5.2 Environmental perspective from new technologies

Intelligent washing machines will not only be able to save energy (washing at off-peak hours) but will also use much lower detergents and other ingredients, by matching the consumption to the content of the wash.

Water-less washing machines are in the experimental stage, but the environmental impact of the materials used for rinsing the clothes (e.g. nano-scale silver and ozone) is unknown and should be followed closely.

14.5.3 Regulation

The Nordic Ecolabelling criteria for dishwashers and washing machines will expire in October 2008. Initiatives are assumed to be underway with the aim to update and publish new criteria.

15 Solid fuel small combustion installation (in particular for heating) (Lot 15)

15.1 Background

The background documents on the EuP preparatory study on Solid fuel small combustion installations (in particular for heating) can be found on www.ecosolidfuel.org.

The project is ongoing. According to the preliminary documents on the website, the working group will focus on the size of the combustion installations, the combustion efficiency (and the climate change aspects of the combustion). Furthermore, the growing concerns of small particles are mentioned.

15.2 Environmental screening based on the Ecoinvent database

The Ecoinvent database contains a range of processes that are relevant for the product group “Solid fuel small combustion installation (in particular for heating) (Lot 15)“. The following processes have been analysed in this screening:

- Heat, anthracite, at stove 5-15kW
- Heat, hard coal briquette, at stove 5-15kW
- Heat, hard coal coke, at stove 5-15kW
- Heat, lignite briquette, at stove 5-15kW/RER U
- Heat, hardwood logs, at wood heater 6kW
- Heat, softwood logs, at wood heater 6kW
- Heat, wood pellets, at furnace 15kW

When analysing the results (see Figure 15.1 to Figure 15.7) the results are quit clear:

- The combustion of anthracite, hard coal briquettes, hard coal coke and lignite briquettes is the absolute largest contributor to most of the environmental impacts.
- For wood, the contribution to global warming is negative for the forest production due to the forest uptake of CO2 during growth.
- The extraction and production of the coal products are also significant.
- The production of the stove itself (and the materials for this) has relatively small significance for most of the environmental impacts.
- However, the production of the stove itself has significant contributions to the impact category “Mineral extraction”, mainly due to the consumption of iron, nickel, aluminium and copper
- When weighting the environmental impacts (not shown), the contributions to Global Warming is the most significant, however, the contributions to “Respiratory Inorganics” and “Photochemical ozone (impacts on vegetation)” are also considerable.

- The contributions to "Respiratory Inorganics" are dominated by sulphur dioxide, nitrogen oxides and "small particles". For the wood products, it is mainly "small particles"
- The contributions to "Photochemical ozone (impacts on vegetation)" are totally dominated by the emissions of carbon monoxide (CO).

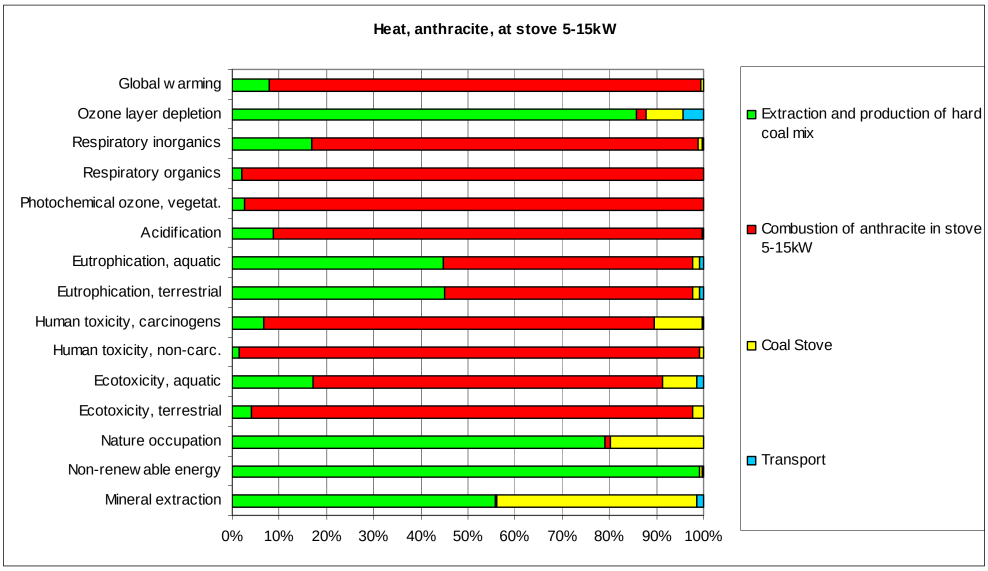

Figure 15.1 Environmental impacts from the production and use of a stove (including the combustion of anthracite) (Heat, anthracite, at stove 5-15kW).

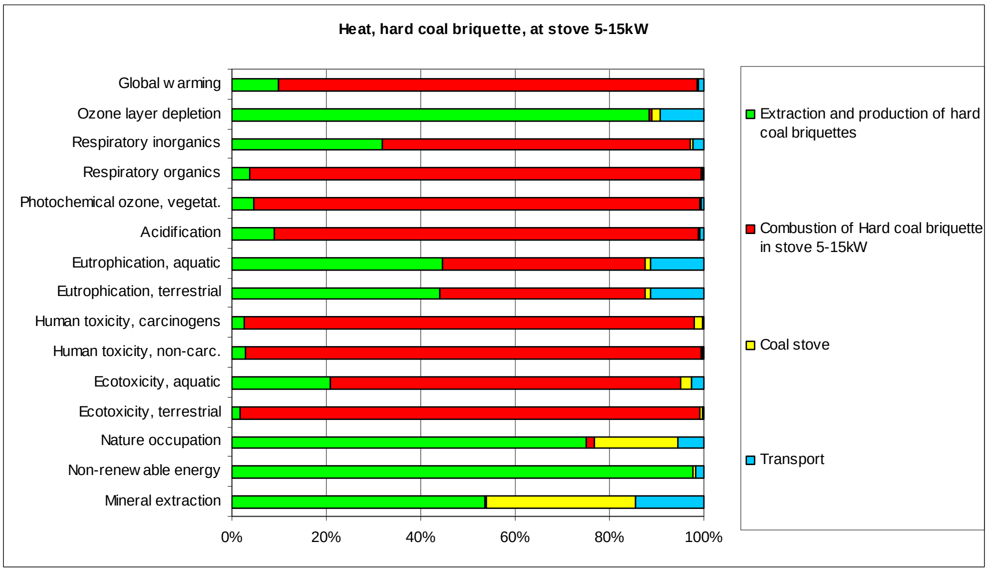

Figure 15.2 Environmental impacts from the production and use of a stove (including the combustion of hard coal briquettes) (Heat, hard coal briquette, at stove 5-15kW).

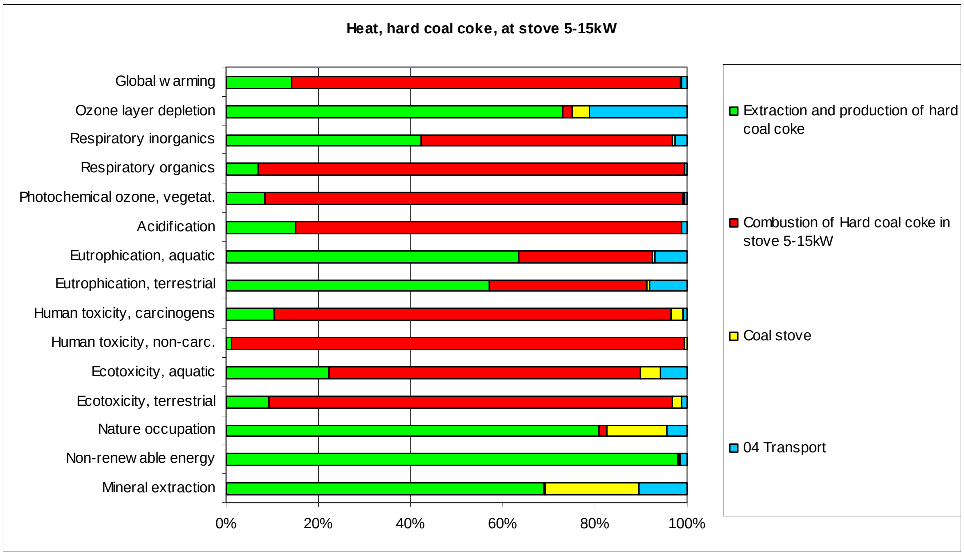

Figure 15.3 Environmental impacts from the production and use of a stove (including the combustion of hard coal coke) (Heat, hard coal coke, at stove 5-15kW).

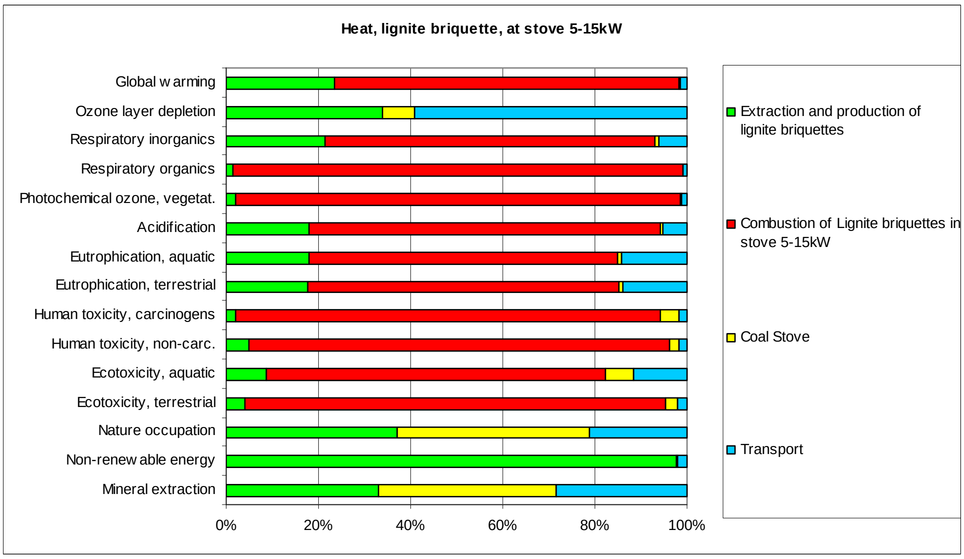

Figure 15.4 Environmental impacts from the production and use of a stove (including the combustion of lignite briquettes) (Heat, lignite briquette, at stove 5-15kW).

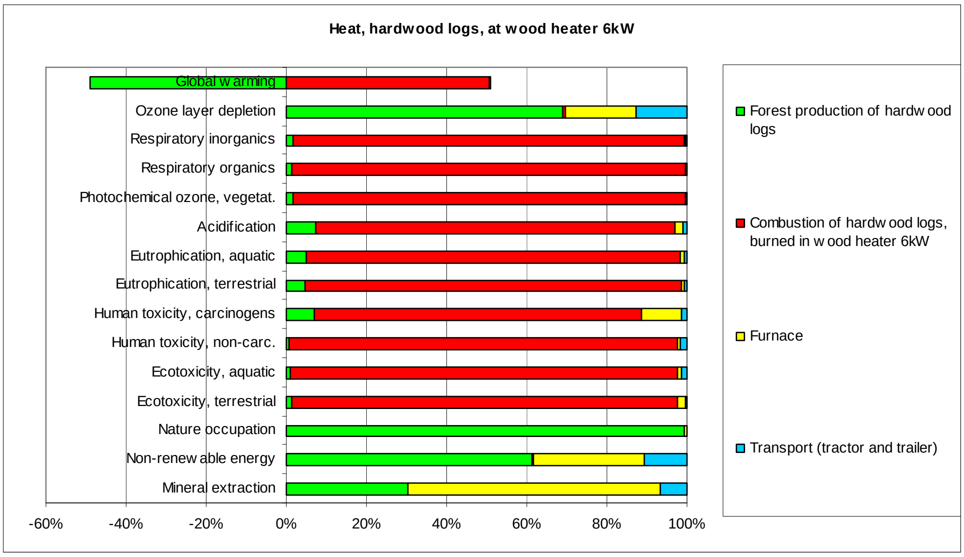

Figure 15.5 Environmental impacts from the production and use of a stove (including the combustion of hardwood logs) (Heat, hardwood logs, at wood heater 6kW).

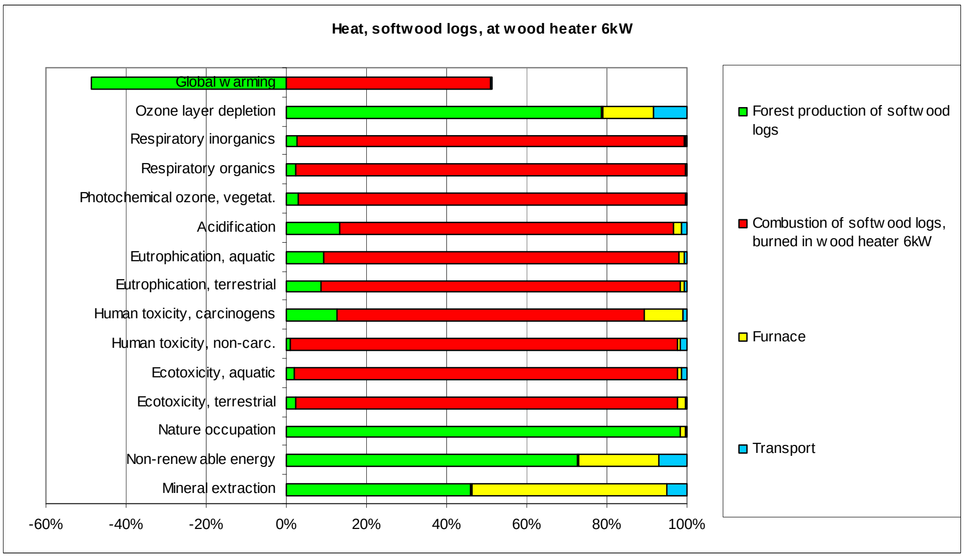

Figure 15.6 Environmental impacts from the production and use of a stove (including the combustion of softwood logs) (Heat, softwood logs, at wood heater 6kW).

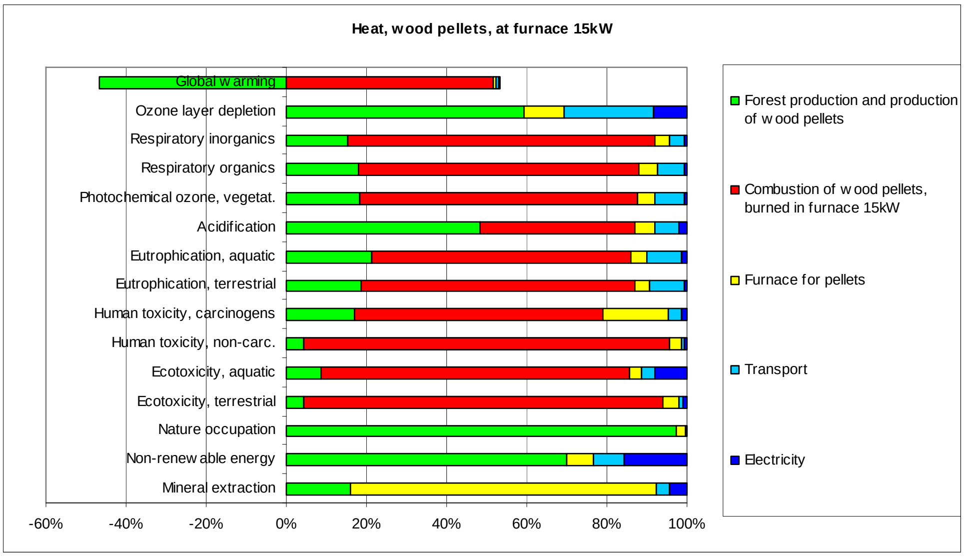

Figure 15.7 Environmental impacts from the production and use of a stove (including the combustion of the wood pellets) (Heat, wood pellets, at furnace 15kW).

15.3 Ecolabel requirements

In the Nordic Ecolabelling programme there is a criteria document for Swan-labelling of Closed Fireplaces [NE2006].

In the Ecolabel document the definition is:

"A closed fireplace is located in the room that is to be heated, and may also distribute heat as a supplementary function via a water or ventilation system. It is fired on solid biofuel, that is wood, wood pellets or, in some cases, an alternative biofuel. In everyday speech, closed fireplaces are known as stoves, tiled stoves, inset fireplaces and even sauna stoves. The fuel can be fed manually or automatically. Wood is generally fed manually while pellets are fed automatically. A closed fireplace contains the fire. Air is supplied through special ducts and the flow can often be controlled. As a rule, a closed fireplace does not provide the majority of a building's heating requirement; rather it usually supplements another heat source. In energy efficient houses, however, a closed fireplace may well cover all heating needs".

The main focus points of the Swan Ecolabel criteria document are:

- Air emissions of organic carbon, CO and particles (limit values).
- Energy efficiency
- Additives in plastic parts: Heavy metals (Cadmium (Cd), Lead (Pb), Mercury (Hg) or their compounds), phthalates and flame retardants (especially polybrominated biphenyls (PBB), polybrominated diphenyl ethers and high-chlorinated short-chained chloroparaffins).
- Additives in paints and other surface treatment agents: Heavy metals (lead, cadmium, chromium, mercury or their compounds.) and organic solvents.
- Additives in metal coating (chromium, nickel or their compounds).

15.4 Technology and market trends

The product group uses a wide range of fuels such as mineral, manufactured mineral and biomass.

It is possible to use torrefaction, a process usually associated with coffee production, to increase the energy content of some crops by up to 20 per cent. Torrefaction is a mild temperature pyrolysis process that removes moisture, causes partial endothermic decomposition of cell wall composites and alters the chemical structure of wood polymers causing biomass to develop more favourable fuel properties. Not only would it lead to an increase of the energy extracted from some of these crops, it would also lead to solid products, easier to store and transport than raw biomass. Engineers have used reed canary grass, wheat straw and willow for their study. [Piq2008].

15.5 Conclusion

15.5.1 Environmental impact in a system and life-cycle perspective

The physical installations have only minor environmental impacts relative to the impacts from the combustion taking place in them. Accordingly, only little attention needs to be put on the materials used for manufacture of the stoves and furnaces.

Air emissions of small particles, which is probably the most important environmental aspect of this product group in addition to air emissions of NOx, SO_2 and CO.

The emissions of small particles and CO are very depending on an optimal combustion, which is to a large degree depending on the design of the installation and the knowledge of the user.

15.5.2 Regulation

As the EuP preparatory study focus on improving the combustion efficiency and reducing emissions of NO_x, SO_2, CO and small particles, which will cover the most important issues regarding the environmental impacts from solid fuel small combustion installations.

16 Laundry driers (Lot 16)

16.1 Background

The EuP project group for laundry driers is new and there are no background documents available at present.

16.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for this theme, an environmental screening has not been performed for this product group.

16.3 Ecolabel requirements

It has not been possible to identify relevant Ecolabel criteria for this product group.

The best laundry driers in Europe include the most energy efficient household electric tumble driers. In order to be selected, the energy class according to the EU energy label must be A. In general, only heat pump tumble driers attain Class A. Two tumble drier categories are presented on top ten: Driers for residential use designed for one apartment and driers for semi professional use, designed for several apartments, with a load of about 5 times the load of residential driers.

16.4 Technology and market trends

Dryers are the appliance where little progresses in energy efficiency have been achieved with the mandatory energy label (Directive 95/13/EC) [EU1995]. In theory, gas heated (which are not labelled) and heat pump dryers (most of them are in A class and tend to be much more expensive than conventional models), which use much less primary energy, are already on the market, but have almost no market share (with the exception of gas dryers in the UK). Transforming the dryer market to A-label machines will save a lot of energy (for the Netherlands alone calculated savings would be in the magnitude of 0,8 PJ per year). [EIS2006]

Laundry (tumble) drier use in European countries has increased considerably: in 2005, 4.9 million tumble driers for residential use were sold in the EU. Strong differences exist between Western Europe (4.84 million) and Eastern Europe (0.06 million), as well as between northern and southern countries. The market in Northern Europe is, however, not expected to show large growth rates in the coming years, partly due to saturation as shown in Figure 16.1.

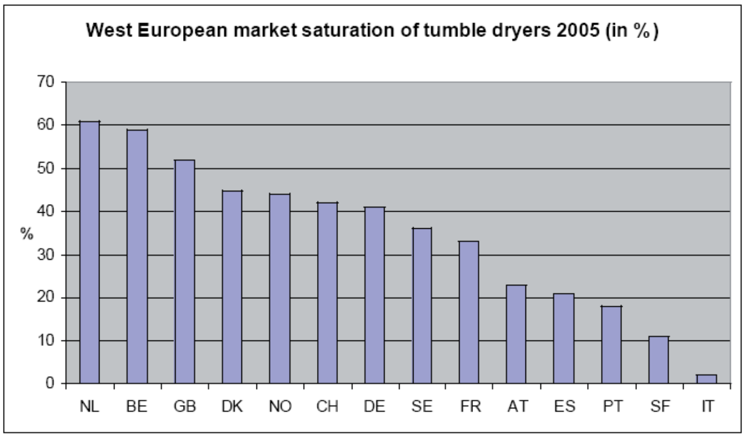

Figure 16.1 West European Market saturation of tumble dryers 2005 (Source: [Bus2007])

High-efficiency heat pump driers consume only about half the electricity of conventional condenser driers. Their efficiency exceeds the EU A-label threshold by far, while usual resistance heating machines are hardly better than energy label Class C. There are an estimated 40 million tumble driers in European households. Replacing the entire stock by high-efficiency heat pump driers represents a savings potential of approximately 15 TWh per year. This corresponds to annual savings of more than 6 million tons of carbon dioxide (assuming an electricity generation mix with a CO_2 intensity of 400 g CO_2/kWh).

The technical and market development of heat pump driers on the Swiss market was described in a paper by Bush and Nipkow [Bus2006]. In 2001, the first heat pump drier in Switzerland was launched. In the meantime, many open questions about heat pump driers could be clarified, and laboratory tests and evaluations of consumer satisfaction have lead to improvements in the handling and overall performance of all models available on the Swiss market.

Heat pump tumble driers result in significant energy savings, and, with market shares below 5 %, the potential aggregated energy savings in Europe are huge. Furthermore, wasted heat and humidity loss in the operation room are significantly lower compared to air condenser driers, and there is no smelling and steaming exhaust air as with conventional air vented driers. Life cycle costs are hardly higher than with conventional driers and even significantly lower in the case of semi-professional use – due to 50 % energy savings.

The city of Zurich launched a rebate program in 2005 to encourage the purchase of heat pump driers and thereby their market uptake on the national level. From 2004 to 2005, the market share of heat pump driers in Switzerland increased from 1.7 % to 4.4 %.

16.5 Conclusion

Dryers are the appliance where little progresses in energy efficiency have been achieved with the mandatory energy label. Gas heated (which are not labelled) and heat pump dryers (most of them are in A class), which use much less primary energy should be promoted.

16.5.1 Environmental perspective from new technologies

Heat pump tumble driers result in significant energy savings as they consume only about half the electricity of conventional condenser driers.

17 Vacuum cleaners (Lot 17)

17.1 Background

The EuP project group for Vacuum Cleaners is still working and there are no background documents available at present.

17.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for vacuum cleaners, an environmental screening has not been performed for this product group.

17.3 Ecolabel requirements

It has not been possible to identify relevant Ecolabel criteria for this product group.

There are two major standards applicable to vacuum cleaners in Europe. EN 60 335 is relevant to safety and also gives the method by which input power is defined. Nominal Input power is the arithmetic average of maximum input power (watts) and Minimum input power (watts). Maximum input power is measured when the airflow is at the highest, sometimes called “open airflow”. Minimum Airflow is measured when airflow is zero, sometimes called sealed suction. The rating label of the vacuum cleaner will display the Nominal input watts and allows for a tolerance of 10 percent.

EN 60312 is relevant to performance and contains many test methods to measure performance relative to cleaning on different surfaces and with different types of soiling. It also contains test methods for indicating product life and also air flow characteristics known as Suction Power or Airwatts.

17.4 Technology and market trends

The maximum airflow efficiency (maximum suction power divided by the input power at the same point) of today’s vacuum cleaner is normally quite low, rarely above 50% and often around 35%. So input power is, in many cases, converted mostly to heat and some 2000 watt vacuum cleaners are more or less 1200 watt fan heaters!

This is typical for all types of vacuum cleaners as is a resultant of inefficiencies in the vacuum producing fan where high airflows are moved through tight turns and restrictions whilst passing through the fan chamber. The motor alone is much more efficient, usually above 90% as it converts electrical power into rotational mechanical power.

The EuP project group for has conducted a survey to identify the most important trends that the market players see for the future. In the context of the EuP, the main requirements for future product design were (not surprisingly): Efficient cleaning with lower energy, more efficient motors, and more hygienic vacuum cleaners.

Other requirements for product functionalities included [EVC2008]:

- Recyclability / use of recycled materials
- Mandatory zero watt consumption in off- mode
- Limits on hazardous substances
- Better harmonisation of bag design
- Optimised floor heads & motor driven nozzles
- Increased fan efficiency
- Battery development
- Decreased weight of vacuum cleaners
- Noise level reductions
- Energy optimised suction nozzles and air handling efficiency
- Reduced pressure drops – hose/ nozzle design
- Cordless

In the area of industrial vacuum cleaners, technology has changed a lot in the past 10 years. Instead of just one vacuum cleaner to choose from, facility managers can select from scores of models from manufacturers all over the world that make cleaning more efficient, greener, more productive and safer. A closer look at some of the most common features and trends follows. [Sch2007]

Cleaning power. By the mid-1920s, vacuum cleaner manufacturers were struggling to make their machines ever more powerful, usually by building larger, heavier, and noisier motors that increased the suction. However, the goal today is to increase the volume of airflow moving through the machine. Some new upright vacuum cleaners have as much as 16 m^3 per minute, providing enough lift for exceptionally powerful cleaning performance.

Dual-Fan Technology. Many conventional upright vacuum cleaners have two motors: one to drive the roller brush and another to provide the suction power for the machine. Others have just one motor playing two roles. However, some more advanced vacuum cleaners now feature dual-fan technology, which takes advantage of the benefits of both systems. Instead of one fan, two fans are used, which increases the suction power of the machine without the added weight – and noise – of a second motor.

HEPA Filtration. In the past 15 years, the term “HEPA” (high-efficiency particulate air) evolved from a high-filtration system to a media buzzword. But HEPA filtration has become essential in facilities where protecting indoor air quality and trapping allergens and contaminants are vital. Nearly 100 percent of all airborne particulates are trapped by installing a HEPA filter over a vacuum cleaner’s exhaust. But one problem some upright vacuum cleaners still have is that as the machine is used and the HEPA filter is soiled, airflow can become restricted and the machine performs less efficiently. Some manufacturers have developed new technologies to ensure maximum airflow with HEPA filtration systems helping to alleviate this problem.

Multistage Filtration. Filtration systems on vacuum cleaners often cause confusion for facility managers and cleaning professionals. A multistage filtration system uses multiple filtering systems, including more advanced filter bags, to help trap airborne particulates. It should be viewed as a pre-filter, helping to remove larger particulates and leaving the smaller soils and contaminants to the HEPA filter.

Ergonomics. The term “ergonomic” references machines that had a “good fit” with the people that used them, but there is more to it with an ergonomic vacuum cleaner. Two of the most ergonomic features of a more advanced vacuum cleaner are the design of the handle and the weight of the machine. The handle should be designed to comfortably fit into the user’s hand and the entire machine must be lightweight. Some newer uprights weigh only about eight pounds. A machine this light is usually easy for users to operate, making it a good fit in most cleaning situations.

17.5 Conclusion

17.5.1 Environmental impact in a system and life-cycle perspective

Vacuum cleaners are basically to be regarded as mobile heating units. Airflow efficiencies vacuum cleaner is rarely above 50% and often around 35%. So input power is, in many cases, converted mostly to heat. Moreover, the improper use and lack of maintenance of filters and dust bags by users aggravates the problem. The dust bags are a major sources of particle pollution, which can cause allergic reactions among private and professional users, as well as a permanent residential repository of various hazardous substances.

17.5.2 Environmental perspective from new technologies

In order to improve both energy efficiency and emission of small particles, vacuum cleaners, and in particularly their filters, should be regularly cleaned and maintained. Users should not be able to operate machines when filters must be changed.

18 Simple Converter Boxes for digital television (Lot ?)

18.1 Background

There is no EuP project group for Simple Converter Boxes. The EuP project group for Complex set-top Boxes is still working and there are no background documents available at present.

In 1997, a working group lead by the European Commission identified the digital service system (simple set-top boxes) as the domestic electronic device with one of the largest potential to increase energy consumption in European households. Research into proposed development showed that by 2010, simple set-top boxes could push domestic electronic energy consumption in Europe above that of refrigerators and freezers. With potentially over 200 million of these boxes across the EU - equivalent to one per household – the annual electricity requirement for digital service systems with full functionality and poor power management could be around 60TWh.

18.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for “Simple Converter Boxes for digital television”, an environmental screening has not been performed for this product group.

18.3 Ecolabel requirements

It has not been possible to find Ecolabel criteria for “Complex set top boxes”.

To limit the potential growth in energy consumption from simple set-top boxes a voluntary programme was introduced, the European Code of Conduct for Digital TV Services, developed by a working group which includes all the stakeholders[7]. The Code of Conduct sets out the basic principles to be followed by all parties involved in digital TV services, operating in the European Community in respect of energy efficient equipment. Figure 18.1 show the power consumption of new set-top boxes sold in the EU by companies that have signed the Code of Conduct requirements. Simple set-top boxes not designed to be efficient may always be on with a power consumption of 20W or more.

[7] All the information can be found at http://energyefficiency.jrc.cec.eu.int/html/standby_initiative_digital%20tv%20services.htm

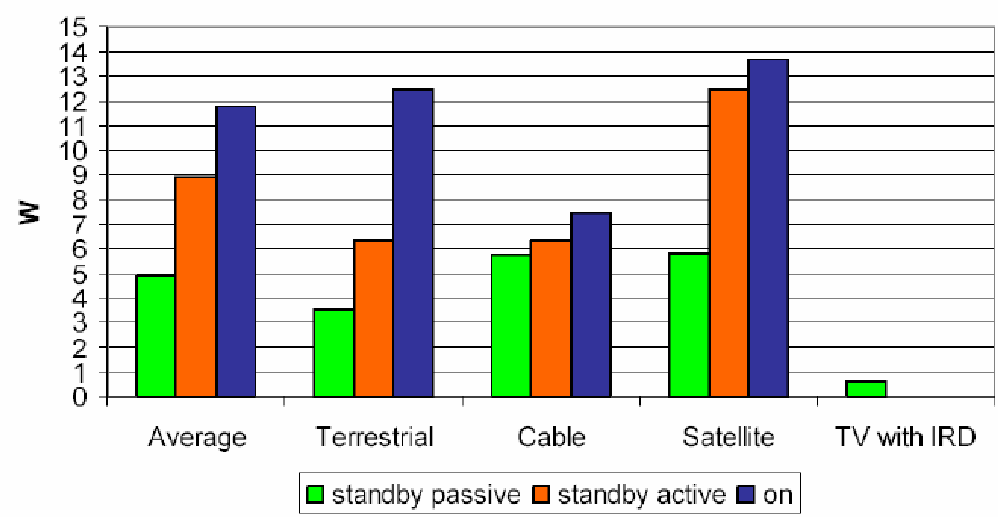

Figure 18.1 Power consumption for individual set-top boxes 2005. Source: [HAR2006]

It is also important to notice in Figure 18.2 that both the standby and on-mode power have decreased in the period 2001 to 2005 despite a strong improvement in performance and features.

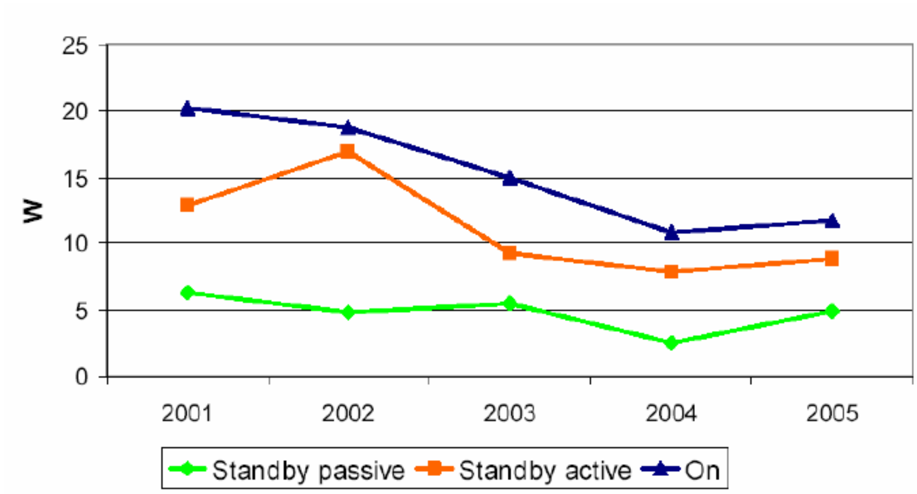

Figure 18.2 Power consumption for simple set-top boxes 2001-2005. Source: [HAR2006].

18.4 Technology and market trends

A major driver for the increase in electricity consumption is the move to digital TV and broadband communication. In order to utilise the benefits of digital TV, one needs a new flat screen (LCD) TV, which is capable of displaying the digital TV signals directly, or one needs an external converter box that converts the received digital signal into an analogue signal, which can be displayed on the analogue TV set. The converter is usually an external electronic device (set top box) with the sole purpose of converting TV signals. It is in most cases always on, although some boxes may have some kind of rudimentary stand-by function.

The European Union is rapidly moving toward the switch to digital TV and the phase-out of analogue broadcasting. This means that the current stock of analogue TVs will need set-top converter boxes in order to function. In 2004 and 2005 millions of these boxes were sold in European countries.

At the same time, digital TV is competing on the market with more sophisticated services and offers. When the convergence between Information Communication Technology equipment and Consumer Electronics takes off, the simple set-top converter boxes needs to be replaced with more advances set-top boxes, which will have a big impact on energy consumption as the new set-top boxes gets more complex and more powerful (see the subsequent section on complex set-top boxes).

Digital Terrestrial TV and cable TV is designed for broadcasting (one-to-many). The format of transmission is determined by international standards, most of which are developed by the European and International Telecommunication Standardisation Bodies such as the Moving Picture Experts Group (MPEG) of the ISO/IEC standardisation bodies. The MPEG-2 Transport, video and audio standards for broadcast-quality television were the first standards introduced. MPEG-2 is used for over-the-air digital television, digital satellite TV services, and with slight modifications, as the files that carry the images on DVDs. MPEG-4 was introduced in 1998 and designated a new standard for audio and video coding formats for television broadcasts. MPEG-4 is more efficient and more robust than is MPEG-2 and is today the choice for new television services and broadcasters.

According to the Canalys research company the number of households with digital TV in Western European countries was already over the 50 million during the first half of 2005. This high number has been reached through the switch from analogue to digital by pay-TV providers and the set up of free-to-air services in many Member States. The European Commission has indicated a switchover target of 2010, and the stronger than anticipated success of digital TV in several countries - including France, Germany and Sweden – means that many European countries would be meeting the target. [Til2005]

The United Kingdom has one of the highest DTT penetration rates in Europe with over 6 million households relying on the DTT platform as their main television reception platform. Other recent reports announced that 10 million Digital Terrestrial Transmission (DTT) set-top boxes have been sold in the United Kingdom. The UK is aiming for analogue switch-off in 2012.

In France, digital TV services (TNT) were launched 31 March 2005 and by the end of October 2006, 65 percent of households were covered by digital terrestrial broadcast (DVB-T). The free (public) channels in France transmit using the MPEG-2 standard, whereas the commercial channels transmit in MPEG-4. In France approximately 1.7 million DTT set-top boxes were sold as of the end of 2005.

The DTT platform has also progressed strongly in the Nordic countries.

In Denmark, the analogue terrestrial broadcast network will be phased out until November 2009. Digital broadcasting has started and is growing rapidly as consumers are buying TV sets with either build in converters or external set top converter boxes. However, the Danish standard today is MPEG-2 whereas is has politically been decided to require the more advanced standard MPEG-4 to be introduced in 2010 as part of the public service obligations. This means that consumers will have to replace once again their set-top boxes or add a new set-top box capable of receiving TV signals in MPEG-4 format. This will mean additional (and unnecessary) power consumption and increased EEE waste. Especially the latter is a course of concern, since the size of set-top boxes is so small that a large share of them is likely to enter the household waste stream.

Sweden, which was one of the first countries to launch a digital terrestrial service, is expected to be one of the first to switch off analogue transmissions in 2008. In Sweden, DTT is currently the fastest growing digital platform. Nearly 600,000 households access the available free-to-air and pay DTT services. Finland currently holds the highest DTT penetration rates in Europe with nearly 30% of its population accessing DTT services.

In Germany over 60% of the population can now access digital terrestrial TV services. It is estimated that over 4.5 million DTT receivers have been sold in Germany (other reports quote about 3.5 millions) [EIS2008]. Germany has taken a regional approach to analogue switch-off, with the last region not scheduled to make the move until 2010. These dates, much more than consumer demand, will shape digital TV adoption in Germany where pay-TV cable providers still serve most of their customers by multi-channel analogue transmission. [Til2005].

In Italy, free-to-air digital TV had a strong growth, partially due to the government subsidies available on terrestrial digital set-top boxes. Italy it is estimated that over 3 million set-top boxes have been sold in 2004 and 2005. In Spain at the end of 2005, 1 million households could access DTT services.

DTT growth has been slower in Belgium, the Netherlands and Switzerland where cable reception dominates the television market. The Czech Republic launched its DTT services in October 2005 and 150,000 DTT set-top boxes have been sold. DTT launches have been announced in Estonia, Slovakia and Lithuania. Ongoing DTT trials are in place in Croatia, Estonia, Hungary, Lithuania, Macedonia, Poland, Serbia-Montenegro, Slovakia and Slovenia.

Together with cumulative DTT set-top boxes sales throughout Europe, it is estimated that over 20 million DTT set-top boxes have now been sold. The number of DTT households in Europe increased from 8.2 million at the end of 2004 to 11.6 million by mid 2005. [Mou2006]

The energy consequence is a burgeoning growth in the demand for set top boxes as we move towards the shut down of analogue broadcasts. Given that there are likely to be some 2 billion installed televisions world wide (of which very few will have digital tuners), the world demand for digital set top box converters could conceivably something like 1.5 billion over the next 10 years. China itself estimates the need for some 500 million digital to analogue converters [ACE2004]. The worrying aspect is that many of these products use significant amounts of power and there is no protocol for them to automatically power down when a connected analogue device is not in use.

18.5 Conclusion

18.5.1 Environmental impact in a system and life-cycle perspective

Conversion to digital broadcasts is perhaps the most significant issue with regard to future environmental impact and energy consumption associated with televisions. The main consequence of concern is the legacy of installed analogue televisions and how they will operate in a digital broadcast future. The short and simple answer is the digital converter.

18.5.2 Environmental perspective from new technologies

Increased energy consumption from the increased use of simple converter boxes is not the only environmental impact foreseen. Adding millions of electronic devices to the market every year poses a major challenge to the electronic waste, since these devices are all physically small and will easily find their way into the household waste stream. Further, the increased use of resources such as copper and zinc.

Another result is the increased WEEE from old analogue television sets being replaces by new units, mostly because of convenience on behalf of the consumer (to avoid set-top boxes or because it is desirable to move to flat screen technology).

However, the authors believe that the long term trend from simple set-top boxes to more complex types in the networked homes, will reduce the problem in this particular product group (albeit it is just moved to another product group).

19 Complex set top boxes (Lot 18)

19.1 Background

While digital TV is already radically changing the European TV markets, and is competing with more sophisticated services and offers, resulting in even more complex set-top boxes, which show a worrying trend in rising energy consumption levels.

These trends are accelerated by the convergence between Information Communication Technology equipment and consumer electronics and will have a big impact on energy consumption (more than one system always on in each dwelling, and increasing electricity demand for each device as it gets more powerful). In addition to the digital TV services supplied through satellite, terrestrial and cable (fibre or coax), there are new service providers starting to offer digital TV and video-on-demand through the telephone lines with DSL modems or using power line technology.

The EuP project group for Complex set-top Boxes is still working and there are no background documents available at present.

19.2 Environmental screening based on the Ecoinvent database

As there are no data in the Ecoinvent database for this theme, an environmental screening has not been performed for this product group.

19.3 Ecolabel requirements

It has not been possible to identify relevant Ecolabel criteria for this product group.

19.4 Technology and market trends

It is estimated that over the years, Telephone Companies have invested a total of $200 billion in present telecom networks worldwide. Telcos are engaged in a perpetual evolution of their services and networks, fighting to stay alive and gain market share in an increasingly regulated and yet extremely competitive environment. A whole range of business opportunities provide an impetus for new revenues - business services such as Internet and extranets, IP Virtual Private Networks (VPN), Voice-over-IP telephone, IP videoconference, as well as residential services such as triple play (information, voice communication and TV/Radio entertainment), IP-TV and home automation. The Telcos are thus a prime promoter of more advanced services that all require more complex and powerful entry points (residential gateways) in the households.

Residential gateways are basically intelligent routers that connect an operator’s broadband network with the home, establishing a network connecting access devices throughout the home. The services enabled by such residential gateway platform include broadband data, voice and video, as well as value-added offerings, such as home networking, Internet firewalls, smart home applications (like healthcare monitoring, home management and security), virtual private networking and interactive television.

Analysts say about five million consumers around the world subscribe to IPTV (TV offered through internet) today, though the numbers are concentrated in places like Hong Kong, France, Belgium and Iceland.

However, the present telecommunication infrastructure may be totally inadequate already in the very near future, if the new business opportunities from IPTV are to be realised. IPTV must be able to match the high standard of competition in the TV marketplace from satellite and cable operators. Even a small amount of packet loss can lead to a badly distorted and pixilated image, which will substantially degrade the viewing experience and drive the viewers away from IPTV services into other types of media services. Telco's (and researchers) are therefore seriously working on upgrading the backbone infrastructure in anticipation of the future rush in IP services, but it will take approximately 3-5 years before the standards and technological foundation are in place and another 10-15 years before the majority of the backbone has been upgraded.

Today, France is the European leader in IPTV, which has attracted close to one million subscribers to at least a half-dozen competing services. Eric Abensur, a vice president of France Télécom's Orange division in Britain, predicts that there would be more than 100 million IPTV customers globally by 2010 [IHT2007].

As the demand for broadband connectivity continues to increase, it will be impossible to bundle voice, data services, television, home control, etc. into a single easy-to implement broadband solution as is known from the simple set-top boxes, DSL modems, etc. A much more powerful device is needed to manage, communicate, store and deliver the monumental number of new services.

Today, these complex set-top boxes (ore residential gateways as they are more accurately referred to) are being developed and marketed by several companies from Europe, Asia and the US.

US giant Cisco, the world's largest maker of networking devices, is also stepping up its attack on big new markets, including the most alluring of them all: the consumer. Its 2003 purchase of Linksys has made Cisco the market leader in the home wireless router business, and in late 2005, Cisco acquired the cable TV set-top box powerhouse Scientific-Atlanta as well as the Danish KiSS technologies [BW2007]

To Cisco, home routers and set-top boxes is only the beginning. The company has already begun to announce some stand-alone products, including a line of home phones, webcams for monitoring the kids, and storage devices for creating DVD-less movie libraries. Moreover, Cisco wants to become the epicenter of what is called the "Connected Home" where consumers use Cisco software to manage how all of these devices, not to mention TVs, PCs, interact. Using the KiSS technology, networked DVD players in the house let owners grab content such as family photos and home movies off a PC and show them on any TV screen available.

Siemens markets the PyliX Intelligent Services Gateway; a single-box solution that combines external communication services and home networking together with smart applications to be hosted on the gateway. Via its variety of interfaces, it connects with in-house appliances, enabling even non-IP based devices to be connected with the Internet. The gateway features a powerful processor and 256MB of electronic RAM storage. It is powered by an external power supply and is rated with a peak power consumption of 24 W. No data are released as to its annual power consumption, but it is estimated to be in the order of 2-3 kWh annually.

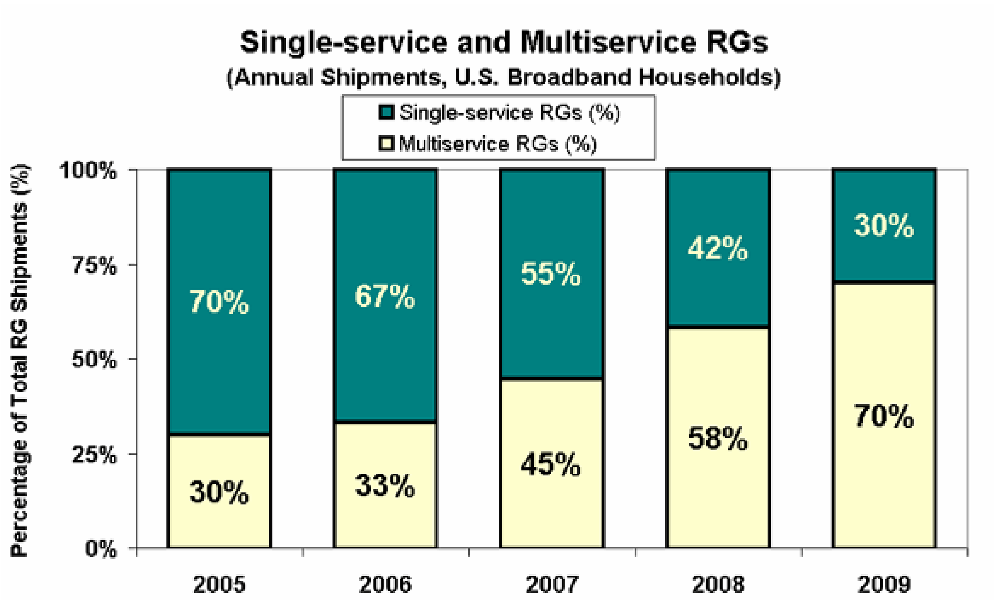

Figure 19.1 Home networks and residential gateways analysis. Source: [PARK 2005].

According to Kurt Scherf, Vice President, Principal Analyst with Parks Associates, there is an early shift toward home networking as a key variable for motivating additional services in the home. Figure 19.1 shows that the share of complex set-top boxes (multi service residential gateways) is growing significantly in the US and already this year (2008), it is estimated to be larger than the single service simple set-top box. [PARK2005].

19.5 Conclusion

19.5.1 Environmental impact in a system and life-cycle perspective

The networked home, the Internet of things and services, ubiquitous computing, converging media or whichever name is assigned to this technological development, is by far the most dominant megatrend in communication technologies with the power and potential to change the way we live, work and socialise.

In the long term, the environmental impact is difficult to predict, since it is highly depending on the appearance of supporting technologies such as battery technology, wireless communication, sensor networks, etc. However, the networked home is a prerequisite for realising the intelligent distribution and control of energy consumption and its environmental impact must be seen and evaluated in a systemic view.

19.5.2 Environmental perspective from new technologies

Increased energy consumption from the increased use of complex converter boxes is not the only environmental impact foreseen. Adding millions of electronic devices to the market every year poses a major challenge to the electronic waste, since these devices are all physically small and will easily find their way into the household waste stream. However, modular design, possibilities for updates and backward compatibility can alleviate some of the waste problems and should be promoted.

20 EuP preparatory project groups

Not all energy-using products will have obligations under the EuP framework, only those meeting criteria with significant environmental impact and volume of trade in the internal market which have clear potential for improvement, for example where market forces fail to make progress in the absence of a legal requirement.

The European Commission has decided that the first step in considering whether and which eco-design requirements should be set for a particular product is a preparatory study. This is to recommend ways to improve the environmental performance of the product.

The Commission launched an invitation to tender for 14 preparatory studies corresponding to families of EuPs on 7 July 2005. The Commission has since launched an additional study on Simple Converter Boxes for digital television, and a further 5 preparatory studies in 2007 relating to the following product groups:

- solid fuel small combustion installations (in particular for heating)
- laundry dryers
- vacuum cleaners
- complex set top boxes (with conditional access and/or functions that are always on)
- domestic lighting

The studies should provide the Commission with the necessary information to prepare for the next phases (carried out by the Commission) - the impact assessment, the consultation with the Eco-design Forum and a possible draft implementing measure.

Details on the work of each study may be found on the website for the study as listed below:

	Study	Website	Status*
1	Boilers and combi-boilers (gas/oil/electric)	www.ecoboiler.org/	Reported
2	Water heaters (gas/oil/electric)	www.ecohotwater.org/	Reported
3	Personal Computers (desktops & laptops) and computer monitors	www.ecocomputer.org/	Reported
4	Imaging equipment: copiers, faxes, printers, scanners, multifunctional devices	www.ecoimaging.org/	Reported
5	Consumer electronics: televisions	www.ecotelevision.org/	Reported

	Study	Website	Status*
6	Standby and off-mode losses of EuPs	www.ecostandby.org/	Reported
7	Battery chargers and external power supplies	www.ecocharger.org/	Reported
8	Office lighting	www.eup4light.net	Reported
9	(Public) Street lighting	www.eup4light.net	Reported
10	Residential room conditioning appliances (aircon and ventilation)	www.ecoaircon.eu/	Ongoing Working document published*
11	Electric motors 1-150 kW, water pumps (commercial buildings, drinking water, food, agriculture), circulators in buildings, ventilation fans (non-residential)	www.ecomotors.org	Reported
12	Commercial refrigerators and freezers, including chillers, display cabinets and vending machines	www.ecofreezercom.org	Reported
13	Domestic refrigerators and freezers	www.ecocold-domestic.org/	Ongoing Working document published*
14	Domestic dishwashers and washing machines.	www.ecowet-domestic.org/	Ongoing Working document published*
15	Simple converter boxes for digital television (Simple STBs)	www.ecostb.com	Ongoing Working document published*
16	Solid fuel small combustion installations (in particular for heating)	http://www.ecosolidfuel.org/	Ongoing Working document published*
17	Laundry dryers	http://www.ecodryers.org/	Ongoing Working document published*
18	Vacuum cleaners	www.ecovacuum.org	Ongoing Working document published*

	Study	Website	Status*
19	Complex set top boxes (with conditional access and/or functions that are always on)	http://www.ecocomplexstb.org/	Ongoing Working document published*
20	Domestic lighting	www.eup4light.net	The EC has published working documents for Domestic lighting part 1, including incandescent bulbs

*Status:
“Reported” – Report has been made; European Commission considering implementation options
"Working document published" A working document on possible implementing measures drafted and published on Commission website

Source: BERR: UK Department for Business Enterprise & Regulatory Reform, http://www.berr.gov.uk, amended and updated by the authors.

21 List of Figures and Tables

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