Institut für
Finanzwissenschaft
und Infrastrukturpolitik

Institute of
Public Finance and
Infrastructure Policy

A-1040 Wien, Resselgasse 5
#43-1-58801-26701
#43-1-58801-26799
www.ifip.tuwien.ac.at

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Roger Pierrard

Relief potentials for green products

Final Report of Work Package 9 of the European Research project

RELIEF

Technische
Universität
Wien

Vienna
University of
Technology

TECHNISCHE UNIVERSITÄT WIEN

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Relief potentials for green products

Work Package Nine - Final Report

Final Revision

By Roger Pierrard

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CONTENT

1 Foreword

Within the work package nine of the RELIEF project mainly three tasks had to be accomplished, they were:

- The inquiry for market data, related to the selected products (electricity, personal computers, copiers, furniture, buses, foodstuffs and water saving sanitary devices) in the RELIEF project,
- The extrapolation of the relief potentials per functional unit of the products, based on the results of the environmental methodology developed in work package five and the investigated market data on a European level,
- The calculation according to the socio-economic method developed in work package six.

The present report exclusively refers to the first two tasks. The results of the calculation according to the socio-economic method is completely included as chapter 11 in the RELIEF book-publication “BUYING INTO THE ENVIRONMENT” which is available since spring 2003. Within the same book also a contribution related to the calculation of the European relief potentials (chapter 9) is included. This article was edited on the basis of a previous draft version of the present report.

The purpose of this report is twofold. On the one hand an overview of the calculated European relief potentials assuming a change in procurement practice for the selected RELIEF products shall be given. On the other hand it constitutes a comprehensive collection of the relevant environmental and market data for the calculation of the European relief potentials.

2 Methodology

The methodology for calculating the relief potential per functional unit developed in work package 5 of the RELIEF-project, fundamentally bases on the comparison of products, having different environmental impacts, located in different environmental impact categories (IC), in different stages of their lifecycle.

The environmental impacts per functional unit (FU) by itself possess only a limited significance concerning the actual effects of a change in procurement practice towards environmentally friendly products. Thus, the consideration of the effective achievable amount of functional units available to be substituted by an environmental more suitable product on the European market on the one hand, and the amount of functional units which, influenced by public procurers, may be substituted by an environmentally friendly product on the other hand offers a comprehensive picture on the importance to effectuate a change in procurement practice aiming at the reduction of environmental consequences of products.

Since the relief potential is already the result of a comparison of a green product with a specific product the basic calculation to obtain a relief potential (RP) for a specific environmental impact category per functional unit may be condensed in the following Formula 1 :

Formula 1 $$\left(\frac{RP}{FU}\right)_{IC} = \left(\frac{\text{Environmental Impacts}_{\text{Green Product}}}{FU} - \frac{\text{Environmental Impacts}_{\text{Non-Green Product}}}{FU}\right)_{IC}$$

Therefore the main issue of the present report consists in up-scaling the relief potential per functional unit to the European level and to figure out the importance of public procurement for initialising a change. The basis for the calculation is shown in Formula 2.

Formula 2 $$RP_{IC}^{total} = \left(\frac{RP_{IC}}{FU}\right) \cdot \text{Amount of Functional Units}$$

The following Formula 3 thus may be seen as the fundamental equation for the up-scaling of the relief potential per functional unit and the calculation of an European relief potential.

Formula 3 $$TEI = \left(\sum_i \alpha_i \cdot \beta_i \cdot x\right) + \alpha_g \cdot \beta_g \cdot x$$

with:

TEI	=	Total environmental impacts
a	=	Environmental impacts per functional unit
ß	=	Market share (%/100)
x	=	Total amount of functional units available on the market per year
i	=	Non-green product(s)
g	=	Green product

The availability of market data is a major constraint in calculating the European relief potential of "green" products. One first result of the present work was the insight that nearly every product needs a different approach for determining the relevant amount of functional units influenced by the procurement decisions of public purchasers or transacted on the European level. Therefore in the following section 2.1 discusses the basic possibilities for calculating the relief potential of "green" products in Europe.

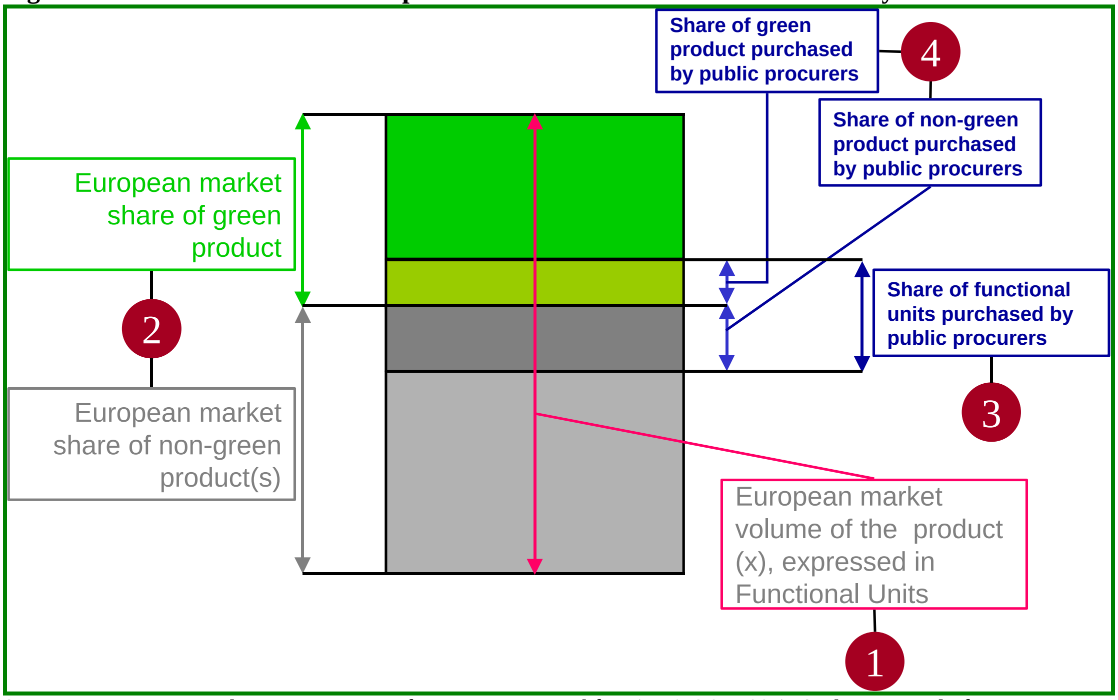
Subsequently the general Formula 3 is adjusted to the presented calculation options.

2.1 General options for the European calculation

The following Figure 1 provides a overview on the four main options to calculate the relief potential at the European level. The main parameter for the calculation possibility of the different kinds of relief potentials is the availability of the market data.

The whole European market for a product may be divided in a share for the "green" product and one for the "non-green" or "brown" product. Furthermore, a share of a product mainly purchased by public authorities can be defined. This may then be subdivided in one part for which public authorities already purchase the "green" alternative and in an other part for which they don't. Related to these four shares of a specific product and his alternatives four different European relief potentials may be calculated.

Figure 1 - Possibilities for the European calculation related to data availability



Source: Presentation at the RELIEF scientific meeting in Frankfurt (15./16.01:2002), Author's own draft

2.2 Calculation of the European relief potential – Option 1

The first calculation option results a relief potential, which may be called: „**Theoretical European Market Relief Potential**“. It is the relief potential under the assumption that the actual 0 % share of the green product(s) on the European market is increased to 100 %.

<u>Required information:</u>

- Total amount of functional units purchased in Europe per year

For this calculation option the previous Formula 3 then changes to:

Formula 4 $$TEI = \left(\sum_i \alpha_i + \alpha_g\right) \cdot x$$

with: TEI = Total environmental impacts for either green or non-green product
α = Environmental impacts per functional unit
x = Total amount of functional units

The Theoretical European Market Relief Potential is then calculated according to the following Formula 5:

Formula 5 $$RP^{TEM} = \left(\alpha_i - \sum_i \alpha_i\right) \cdot x$$

with: RP^{TEM} = Theoretical European Market Relief Potential
α = Environmental impacts per functional unit
x = Total amount of functional units
i = Non-green product
g = Green product

2.3 Calculation of the European relief potential – Option 2

The second calculation option results a relief potential, which may be called: „**Achievable European Market Relief Potential**". It is the relief potential under the assumption that the actual European market share of the green product(s) is increased to 100 %. In other words the already achieved relief potential is known and subtracted.

Required information:

- Environmental impacts per functional unit.
- Total amount of functional units purchased in Europe per year.
- The European market share(s) of the green product(s).

For this calculation option the previous Formula 3 then changes to:

Formula 6 $$TEI = \left(\left(\sum_i \alpha_i \cdot \beta_i\right) + \alpha_g \cdot \beta_g\right) \cdot x$$

with:	TEI	=	Total environmental impacts
	α	=	Environmental impacts per functional unit
	β	=	Market share of green/non-green product (%/100)
	x	=	Total amount of functional units purchased in Europe per year
	i	=	Non-green product(s)
	g	=	Green product
	x	=	Total amount of functional units

The Achievable European Market Relief Potential is then calculated according to the following Formula 7:

Formula 7 $$RP^{AEM} = \left(\alpha_g \cdot \beta_g - \left(\sum_i \alpha_i \cdot \beta_i\right)\right) \cdot x$$

with:	RP^{AEM}	=	Achievable European Market Relief Potential
	α	=	Environmental impacts per functional unit
	β	=	Market share of green/non-green product (%/100)
	x	=	Total amount of functional units purchased in Europe per year
	i	=	Non-green product(s)
	g	=	Green product
	x	=	Total amount of functional units

2.4 Calculation of the European relief potential – Option 3

The third calculation option results a relief potential, which may be called: „**Theoretical european public procurement relief potential**". It is the relief potential under the assumption that the total amount of functional units purchased by public procurers on the European level is known. Furthermore it is assumed, that this total amount of functional units is increased from 0 % share of green product(s) to 100 %.

Required information:

- Environmental impacts per functional unit.
- Total amount of functional units purchased by public procurers in Europe per year.

For this calculation option the previous Formula 3 then changes to:

Formula 8 $$TEI = \left(\sum_i \alpha_i + \alpha_g\right) \cdot y$$

with:	TEI	=	Total environmental impacts for either green or non-green product
	α	=	Environmental impacts per functional unit
	y	=	Total amount of functional units purchased by public procurers

The Theoretical European Public Procurement relief potential is then calculated according to the following Formula 9:

Formula 9 $$RP^{TEPP} = \left(\alpha_g - \sum_i \alpha_i\right) \cdot y$$

with: RP^{TEEP} = Theoretical European public procurement t relief potential
α = Environmental impacts per functional unit
y = Total amount of functional units purchased by public procurers
i = Non-green product
g = Green product

2.5 Calculation of the European relief potential – Option 4

The fourth calculation option results a relief potential, which may be called: „**Achievable European Public Procurement Relief Potential**“. It is the relief potential under the assumption that the total amount of functional units and the included share of green functional units purchased by public procurers on the European level is known. In other words it is the achievable relief potential through public procurement on the European level.

Required information:

- Environmental impacts per functional unit.
- Total amount of functional units purchased by public procurers in Europe per year.
- The share of green functional units purchased by public procurers in Europe per year.

For this calculation option the previous Formula 3 then changes to:

Formula 10 $$TEI = \left(\left(\sum_i \alpha_i \cdot \gamma_i\right) + \alpha_g \cdot \gamma_g\right) \cdot y$$

with: TEI = Total environmental impacts
α = Environmental impacts per functional unit
γ = Share of public procurement of the green/non-green product (%/100)
i = Non-green product(s)
g = Green product
y = Total amount of functional units purchased by public procurers

The Achievable European Public Procurement Relief Potential is then calculated according to the following Formula 7:

Formula 11 $$P^{AEPP} = \left(\alpha_g \cdot \gamma_g - \left(\sum_i \alpha_i \cdot \gamma_i\right)\right) \cdot y$$

with: RP^{AEPP} = Achievable European public procurement relief potential
α = Environmental impacts per functional unit
γ = Share of public procurement of the green/non-green product (%/100)
i = Non-green product(s)
g = Green product
y = Total amount of functional units purchased by public procurers

2.6 Conclusions on the possibility of calculating the European relief potential

Unfortunately for most of the products analysed, it is impossible to determine the European share of the "green" product. Also the investigation of the share of the "green" product already purchased by public authorities on the European level is a very time consuming task, which would have exceeded the framework of the present work by far.

Within the RELIEF project therefore the scientific partners decided to focus on the calculation of the "Theoretical European Market Relief Potential" as well as the "Theoretical European public procurement relief potential". Opposite to the theoretical calculation approach presented in the previous sections 2.2 to 2.5 the share that the green product has already on the market was generally included in the definition of an average product. For example in the case of electricity, the share that green electricity already has on the market contributes to slightly lower environmental impacts of "average electricity". Also for PC-systems it was assumed that the "brown" product is one, complying at least with minimum Energy-Star-label requirements, because the market survey showed that almost any PC's lacking an Energy-Star-label are available on the market anymore. For busses the "brown" products considered also comply with the actual EURO-standards.

Sometimes though, the consideration of the amount of functional units of the "green" product already available on the market was not possible. Thus the calculated theoretical relief potentials might more ore less exceed the actual figures.

Anyhow the general approach for all the calculations is to

1. Determine the amount of total functional units traded on the European market
2. Determine the amount of functional units corresponding to the share of the public sector on this market.

The two resulting figures are then multiplied with the relief potential per functional unit. The relief potential per functional unit is always calculated by subtracting the environmental impacts (related to one functional unit) of the green product from those of the product being object of investigation. Among the variety of products being the objects of investigation the green product was identified the one having the least environmental impacts in most of the considered environmental impact categories.

Finally the calculated European relief potentials are expressed in person equivalents to enable a comparison of the relief potentials related to specific environmental impact categories. The relevant environmental impact categories were already selected in work package 2 of the RELIEF-project. It was agreed upon the use of the LCA environmental impact categories. Nevertheless not every product contributes to each and every impact category. Therefore the relief potentials are calculated for the impact categories: global warming, ozone depletion, acidification, photochemical oxidant formation, nitrification, resource consumption, waste formation and human toxicity via air.

A person equivalent (PE) represents the potential contribution from a single person during one year to a specific environmental impact. The introduction of a common scale regarding the environmental impact categories may be seen as the principal task of the calculation of person equivalents. Impacts having a global influence are expressed with help of global person equivalents referring to an average global citizen, impacts having a regional influence e. g. within the European Union refer to an average European citizen. Many more persons contribute to global impacts than to regional or local impacts. Therefore the normalisation references for globally relevant impact categories like global warming or stratospheric ozone depletion are calculated in a different way than those for regionally relevant impact categories like nitrification or acidification. As an example, for global warming the overall anthropogenic contributions are evenly distributed on all human beings and thus result an average contribution per person expressed in tons of CO_2-equivalents. For regional impacts like formation of photochemical ozone, the contribution originating from a specific geographical area, e. g. the European Union, is evenly distributed on all human beings living in the respective geographical area, what yields the normalisation reference for the average person within the considered geographical area. Consequently this approach is in accordance with the geographic scale of the considered impact.

In the present calculation results within this report the normalisation factors shown in Table 1 were used to calculate the relief potentials expressed in person-equivalents.

Table 1 - Factors coming into use for the calculation of the person-equivalents

		Normalisation reference	
Impact category	Unit per capita and per year	World	EU-15
Global warming	ton CO_2-equivalent	**8.2**	**---**
Stratospheric ozone depletion	kg CFC11-equivalents	**0.08**	**---**
Photochemical oxidant formation	kg C_2H_4-equivalents	**22**	**25**
Acidification	kg SO_2-equivalents	**59**	**74**
Nutrient enrichment (Nitrogen)	kg N-equivalents	**19**	**24**
Nutrient enrichment (Phosphorous)	kg P-equivalents	**0.3**	**0.4**
Nutrient enrichment (NO_3^-)	kg NO_3--equivalents	**95**	**119**
Nutrient enrichment (PO_4^{3-})	kg PO_4^{3-}-equivalents	**n. a.**	**1.2**
Nutrient enrichment (PO_4^{3-})*	kg PO_4^{3-}-equivalents	**n. a.**	**11.3**
Human toxicity via air	m^3 air	**2,450,000,000**	**3,060,000,000**
Human toxicity via water	m^3 water	**41,800**	**52,200**
Human toxicity via soil	m^3 soil	**102**	**127**
Eco-toxicity, chronic, water	m^3 water	**282,000**	**352,000**
Eco-toxicity, water, acute	m^3 water	**23,300**	**29,100**
Eco-toxicity, chronic, soil	m^3 soil	**771,000**	**964,000**

Source: Anders Schmidt, personal communication[1]

To enable a better comparison between the calculated relief potentials for the single products they are calculated on an annual basis. The relief potential over the whole lifetime of the product may be easily calculated by linear extrapolation. The calculated relief potentials expressed in person equivalents are only comparable within the same environmental impact category. Although the relief potential for each environmental impact category is expressed in the same unit namely "person equivalents" it is impermissible to compare or calculate a trade-off between the figures of different environmental impact categories.

1 The figures originates from a Danish report (Stranddorf, Hoffmann and Schmidt) being about to be published. The figures have been calculated by using mainly statistical information from 1994.

3 Market data - quality and availability

As already denoted, the necessary market data for the calculation of the different relief potentials are often not available. The data sources used for the present work were mainly data from international or European organisations like FAO, IEA, OECD, EEA, EUROSTAT, but also data from the national statistical offices of the European countries as well as international and national market studies from producers organisations, market research institutions and databases came into use.

The different data sources provide information, having a different usefulness concerning the calculation of the relief potential. In general the statistical data may be subdivided in production statistics, consumption statistics, statistics from product specific market surveys and information retrieved by direct surveys among producers or producer organisations.

Production statistics as they are provided for instance from EUROSTAT, International Energy Agency (IEA), the Organisation for Economic Cooperation and Development (OECD), the Food and Agricultural Organisation (FAO), and mainly also from national statistical offices may be based on production values or on the produced amounts. For the calculation of the relief potential of course statistical data based on the manufactured amount of a product are of high concern.

The relief potential is related to procurement activities and therefore data on product consumption is the most useful. Thus production statistics will be valuable if it is possible to calculate a consumption figure, which will only be possible if data on imports and exports are also available in the production statistics. A main disadvantage of production statistics, especially provided from EUROSTAT or OECD is that data mostly do not consider single products but product groups aggregating many different products.

Market surveys and direct surveys among producers predominantly provide consumption statistics. These data sources also mostly refer to single products, which is most suitable for calculating the relief potentials.

The assessment of the data quality from the different data sources is a extremely difficult task, and in most of the cases simply impossible. For calculating the relief potentials the collection and use of market data was performed according to the following basic principles:

- Collection of data concerning the same topic from different sources to ensure the opportunity to assess the quality and accuracy of the used data,
- Preferable use of data from accepted European or international sources for the last available time period,
- Preferable use of data from only one source for the calculations,
- Preferable use of data from national statistical offices in case of non-existence of data on the international or European level.

For each product for which the relief potential was calculated the data sources coming into use are indicated in the respective chapters. Also the share of the public sector was determined by different approaches, specific for every product, and will be described in the corresponding sections.

A more special approach was examined by Prof. Dr. Jens Horbach (cf. Horbach 2002) to determine the market share with the help of the European Input-Output-Tables. The results of this work is given in the following Table 2.

Table 2 - Share of public sector, results for EU(15) for the year 1995

Product-group according to the NACE-CLIO Classification	Share of public sector, domestic consumption [%]	Share of public sector, total consumption incl. Exports and intermediate use [%]	Import quotas [%] $\left(\frac{\text{imported amount}}{\text{total consumption}}\right)$
Agriculture, forestry and fishery products; Food, beverages, tobacco; Lodging and catering services	2.99	1.77	5.35
Fuel and power products	12.98	3.94	---
Office and data processing machines	11.82	7.64	24.75
Transport equipment	7.19	4.93	19.65

Source: Horbach, 2002

The estimation of the amount of products consumed by the public sector is then performed according to the following Formula 12:

Formula 12 $$A = DP \cdot Sh_{TC} + IQ \cdot DP \cdot Sh_{TC}$$

with: A = Amount of functional units related to the public sector
DP = Domestic Production (Production + Exports)
Sh_{TC} = Share of public sector on total consumption
IQ = Import quota (%/100)

According to Horbach, it was not reasonable to calculate the export quota for electricity, because the product group "fuel and power products" contains all other forms of energy too, and the import quota for electricity is probably much lower than the one for all forms of energy.

The main problem using the above presented method consists in the fact that the product groups used in the input-output tables are highly aggregated. Thus office and data processing machines not only covers computers but also all kind of other devices, like copiers, fax machines etc. and the product group Transport equipment also includes Trolley busses, cars, trucks, and other vehicles. As the calculated market shares are based on IO-Tables, they consequently are based on the values of the products and not on the amounts of product units produced, what may cause more or less large errors in the calculation of the relief potentials related to the public sector.

For electricity and computers other approaches to estimate the share of the public sector were used in the present work, they are described in the appropriate sections.

For the product groups copier and buses a survey among the most important producers was performed by Prof. Dr. Michael von Hauff, mainly to investigate the share of the production which enters the public sector. A satisfying result was only yielded for the product group buses, where the share of the production, which is sold to public procures could be determined to be about 48 %.

The calculated relief potentials remain to a certain extent theoretical values mainly because, despite the fact that the already achieved improvements regarding environmental impacts of the actual share of the green product implicitly considered within the definition of the average product, the determination of the actual market share of the correspondent green products was not feasible. Thus the present relief potentials represent more or less the maximum achievable order of magnitude arising from a change in procurement activities.

4 Electricity

4.1 Environmental basics

The functional unit for electrical power is one kWh of produced electricity. The main environmental impacts occur during the production stage of electrical power, therefore the product specification focuses on the different possibilities for production of one kWh from different non-regenerative and regenerative primary energy sources.

Table 3 shows the environmental impacts within the selected impact categories for the generation of one kWh of electricity. The environmental data for the average European electricity and the brown electricity from lignite combustion is withdrawn from the GEMIS[2] database. The data for European average green electricity is calculated based on the GEMIS data for hydropower, wind power, solar power, biomass power and geothermal power and the respective percentage of these energy sources within the European renewables mix. The average European electricity mix from renewable sources consists of 86 % hydro-power, 3 % wind-power, 0.02 % solar-power 9 % power from biomass and 1 % geothermal power (cf. EEA, 1998).

The European directive "2001/77/EG on the promotion of electricity produced from renewable energy sources in the internal electricity market", defines green electricity as "***electricity produced from renewable energy sources*** *shall mean electricity produced by plants using only renewable energy sources, as well as the proportion of electricity produced from renewable energy sources in hybrid plants also using conventional energy sources and including renewable electricity used for filling storage systems, and excluding electricity produced as a result of storage systems*", and indicates that **renewable energy sources** are: "*renewable non-fossil energy sources (wind, solar, geothermal, wave, tidal, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases)*". As **biomass** "*the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste*" shall be considered.

The indicated composition of the average European green electricity mix complies to this definition, but it has to be admitted that within the 86 % of hydropower also large hydropower plants are included. Eco-labels for the product green electricity in general use a more strict definition for green electricity and exclude electricity generated by large hydropower plants.

The EUGENE[3] label for instance requires: "*Hydropower plants may be eligible if they operate in such a way as to protect the environment. The hydropower plant must fulfil basic ecological requirements at local scale, so that the river system's principal ecological functions are preserved. The power plant may be required to invest a fixed payment per kilowatt hour of green electricity sold, for restoring, protecting or upgrading the environment in the catchment area used by the plant in question*" and "*New or expanded power plants can only be labelled as green if the hydropower facility leads to a substantial improvement of the local and regional ecological quality (in excess of legal compliance)*". Thus all large hydropower plants for instance with a barrage are excluded as an energy source for green electricity.

[2] Gesamt Emissions Modell Integrierter Systeme

[3] European Green Electricity Network

This strict definition of green electricity was rejected for the present calculations mainly for two reasons:

1. European wide, scientifically based criteria to be fulfilled by hydropower plants in order to get the allowance of naming their product green electricity are currently under development.
2. The environmental data for electricity is mainly derived from the GEMIS database, which includes only figures for large hydropower, which may be mistrusted if used for small hydropower plants exclusively.

For reasons of fairness it was therefore decided to consider the whole amount of electricity generated from hydropower within the European Union.

Table 3 - Environmental impacts of 1 kWh depending to the production process

Environmental Impact Category	Average Electricity-Mix EU-15	Brown electricity (Lignite)	Average green electricity EU-15	
Global warming	455	909	42	CO_2-eq. [g/kWh]
Acidification	2.39	14.03	0.26	SO_2-eq. [g/kWh]
Photochemical oxidant formation	0.04	0.01	0.04	C_2H_4-eq. [g/kWh]
Nutrification	1.41	0.91	0.24	NO_3^--eq. [g/kWh]
Resource Consumption	2.80	2.43	1.57	[kWh/kWh]
Waste	46.31	57.17	1.10	[g/kWh]

Source: GEMIS, 2002; Author's own calculation, 2002

4.2 Total amount of functional units on the European level

The market data used for the calculation of the relief potential in the following sections are based on the European consumption of electricity. The estimation of the public share for consumption is based on national energy reports and information retrieved by the RELIEF scientific partners from national statistical offices (cf. section 4.4).

Table 4 - Observed consumption of electricity in GWh for the EU(15) countries

	1997	1998	1999
Austria	49,817	50,819	50,902
Belgium	73,321	75,527	76,050
Denmark	32,474	32,669	32,647
Finland	71,206	73,607	75,011
France	381,618	393,307	401,037
Germany	482,877	487,477	488,449
Greece	38,875	40,979	42,273
Ireland	16,783	17,768	18,916
Italy	253,674	260,809	267,284
Luxembourg	5,135	5,290	5,510
Netherlands	92,000	95,554	97,559
Portugal	32,439	34,412	36,741
Spain	163,440	169,673	181,652
Sweden	127,455	128,393	128,698
United Kingdom	317,486	325,041	329,940
Total	**2,138,600**	**2,191,325**	**2,232,669**

Source: International Energy Agency (IEA) Data Services, Electricity Information 2001: Consumption/Trade (Electricity and Heat Supply and Consumption) http.//data.iea.org/ieastore/

Table 4 shows the electricity consumption of the single member states of the European Union for the years 1997, 1998 and 1999. The data from 1999 is used for the calculation of the relief potential.

4.3 Theoretical European market relief potential (RP^{TEM}) for electricity

From Table 4 it can be seen that the 15 EU-countries consumed 2,232,669 GWh, which corresponds to $2,232,669 \times 10^6$ kWh in 1999. This figure is the basic variable (total amount of functional units on the European market) for the calculation of the RP^{TEM} presented in the following Table 5 and Table 6. They show the relief potential for the European market for each of the considered environmental impact categories. For those environmental impact categories, for which actual conversion factors were available also the person equivalents were calculated. For those impact categories, which contribute to global environmental impacts, the global person equivalent and for the other ones, contributing to local impacts, the European person-equivalent was calculated.

Table 5 - Theoretical European Market Relief potential for average green electricity compared to average electricity

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-922,639,465	t CO_2-eq.	-112,517,008	Global
Acidification	-4,756,228	t SO_2-eq.	-64,273,348	Europe
Photochemical Oxidant Formation	10,610	t C_2H_4-eq.	424,381	Europe
Nutrification	-2,617,406	t NO_3^--eq.	-21,995,007	Europe
Resource consumption (Energy)	-2,750,604	GWh	Calc. not possible	--
Waste Formation	-100,928,022	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 6 - Theoretical European Market Relief potential for average green electricity compared to brown electricity

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-1,935,927,800	t CO_2-eq.	-236,088,756	Global
Acidification	-30,757,121	t SO_2-eq.	-415,636,765	Europe
Photochemical Oxidant Formation	62,312	t C_2H_4-eq.	2,492,498	Europe
Nutrification	-1,509,828	t NO_3^--eq	-12,687,630	Europe
Resource consumption (Energy)	-1,927,206	GWh	Calc. not possible	--
Waste Formation	-125,171,802	t	Calc. not possible	--

Source: Author's own calculation, 2002

Negative values in Table 5 and Table 6 indicate a reduction of the environmental impacts within the according environmental impact category while comparing the different kinds of electricity. Positive values on the other hand indicate an increase of environmental impacts.

4.4 Amount of functional units related to public procurement on the European level

The estimation on the share of public consumption of electricity for the member states of the EU was difficult. The first idea, to investigate the consumption according to the NACE (Nomenclature Génerale des Activités Economiques dans l`Union Européenne) classification was not fully successful, because for most of the countries such data were not available.

The following Table 7 indicates the percentage of public electricity consumption related to the total energy consumption of several European countries. These values were calculated either on the basis of national energy reports, or on data investigated by the RELIEF partners in the respective countries. The calculations on the basis of energy reports was performed in that way, that only those segments of the public sector were considered which correspond as far as possible to the NACE sections 75, 80, 85 and 93[4].

[4] 75 Public administration and defence; compulsory social security
80 Education

The indication of data quality is subdivided in two parts, one which deals with the consistency of the used national energy-reports-data with the data from the IEA databases, and one which deals with the knowledge about which branches of the public sector are included in the figures and which not.

Table 7 - Percentage of public consumption on total electricity consumption in 1999

	Percentage	Quality of original total consumption data compared to IEA-data	Quality of data referring to public branches considered
Austria	3,7	good	good (NACE)
Belgium	n. a.		
Denmark	7,3	good	poor
Finland	6,2	good	poor
France	n. a.		
Germany	7,8	good	poor
Greece**	4,8	middle	poor
Ireland	n. a.		
Italy	6,6	good	good (NACE)
Luxembourg	n. a.		
Netherlands	5,6	unknown*	good (NACE)
Portugal	7,1	good	poor
Spain	n. a.		
Sweden	n. a.		
United Kingdom	7,0	good	poor

* Data from IVM, no total consumption was indicated.
** Data from 1997

Source: Author's own calculation, 2002

For the countries for which the share of public electricity consumption could be calculated, the total of the electricity consumption covers approximately 62 % of the total electricity consumption of all EU(15) countries as presented in Table 4 for the year 1999. For those countries for which it was not possible to calculate a public share, a figure of 6,2 % was adopted (which corresponds to the average of the other countries).

Table 8 - European Public consumption of electricity for 1999

	Share of public consumption from total consumption [%]	Pubic consumption [GWh]
Austria	3.7	1,883
Belgium	6.2	4,740
Denmark	7.3	2,383
Finland	6.2	4,651
France	6.2	24,998
Germany	7.8	38,099
Greece	4.8	2,029
Ireland	6.2	1,179
Italy	6.6	17,641
Luxembourg	6.2	343
Netherlands	5.6	5,463
Portugal	7.1	2,609
Spain	6.2	11,323
Sweden	6.2	8,022
United Kingdom	7.0	23,096
Total		**148,460**

Source: Author's own calculation, 2002

85 Health and social work
93 Other services activities

The total consumption of the public sector in EU for the year 1999 is then calculated as the total of the specific country public sector consumption multiplied with the public share value. The results of these calculations are presented in Table 8.

From Table 4 and Table 8 follows that in 1999 the public consumption of electrical power in the European Union was about 6.65 % of the total consumption.

4.5 Theoretical European public procurement relief potential (RP^{TEPP}) for electricity

The total of functional units consumed by the public sector in Europe is according to Table 8 assumed to be 148,460 GWh which correspond to 148,460x10^6 kWh.

The following Table 9 and Table 10 show the calculated relief potentials related to public procurement in the EU countries. Again negative values indicate a decrease of environmental impacts in a specific impact category and positive values indicate the opposite.

Table 9 - Theoretical European Public Procurement Relief potential for average green electricity compared to average electricity

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-61,350,363	t CO_2-eq.	-7,481,752	Global
Acidification	-316,263	t SO_2-eq.	-4,273,818	Europe
Photochemical Oxidant Formation	705	t C_2H_4-eq.	28,219	Europe
Nutrification	-174,043	t NO_3^--eq	-1,462,545	Europe
Resource consumption (Energy)	-182,900	GWh	Calc. not possible	--
Waste Formation	-6,711,149	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 10 - Theoretical European Public Procurement Relief potential for average green electricity compared to brown electricity

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-128,728,369	t CO_2-eq.	-15,698,582	Global
Acidification	-2,045,176	t SO_2-eq.	-27,637,520	Europe
Photochemical Oxidant Formation	4,143	t C_2H_4-eq.	165,737	Europe
Nutrification	-100,395	t NO_3^--eq	-843,656	Europe
Resource consumption (Energy)	-128,148	GWh	Calc. not possible	--
Waste Formation	-8,323,225	t	Calc. not possible	--

Source: Author's own calculation, 2002

5 Personal Computers

5.1 Environmental basics

The functional unit for computers is one personal computer system consisting of a CPU and a monitor. The main environmental impacts of computers occur during their use stage, mainly as a result of their consumption of electrical power. The product specification therefore focuses on the presence and quality of energy-saving capabilities.

5.1.1 General assumptions

To calculate the RELIEF potential it is necessary to set up a more or less representative average use pattern. The most optimal solution is to look at the specific needs when buying each computer and the expected use pattern to gain the optimal RELIEF potential. However, for the calculation of the relief potential a likely use pattern for an average computer is assumed. Table 11 gives an overview about these assumptions.

Table 11 - Assumptions for the use and the energy consumption of personal computers

Use characteristics		
Daily "on time"	8	hours
Active mode	5	hours
Sleep mode	1.25	hours
Deep sleep mode	1.75	hours
Annual work days	230	days
Monitor (CRT)		
Use mode	100	W
Sleep mode (Min. req. for Energy-Star)	15	W
Sleep mode (Good Energy-Star)	1	W
Deep sleep mode (Min. req. for Energy-Star)	5	W
Deep sleep mode (Good Energy-Star)	1	W
Lower energy CRT (active mode)	65	W
Monitor (TFT)		
Lower energy TFT (active mode)	27	W
CPU		
Use mode	60	W
Sleep mode (Min. req. for Energy-Star)	30	W
Sleep mode (Good Energy-Star)	3	W
Lower energy (Central unit)	42	W

Source: Jeppe Frydendal, Anders Schmidt, RELIEF PC-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

The calculation of the relief potential was performed by comparing the different "types" of PC's shown in Table 12.

Table 12 - Different types of PC's under consideration

Normal system (CRT display) following the minimum Energy Star requirements	Normal system (CRT display) with good Energy Star properties
Lower energy system (CRT display) following the minimum Energy Star requirements	Lower energy system (CRT display) with good Energy Star properties
Lower energy system (TFT display) following the minimum Energy Star requirements	Lower energy system (TFT display) with good Energy Star properties

Source: Jeppe Frydendal, Anders Schmidt, RELIEF PC-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

Table 13 shows the compared combinations. The PC with the less energy consuming CPU and the TFT screen which complies to good energy star requirements was assigned to be the green product.

Table 13 - Comparison of different personal computer systems

Options	Green Product vs. Brown Product
Option 1	Less energy w/TFT Good Eng.Star req. vs. Normal w/CRT Min. Eng.Star req.
Option 2	Less energy w/TFT Good Eng.Star req. vs. Normal w/CRT Good Eng.Star req.
Option 3	Less energy w/TFT Good Eng.Star req. vs. Less energy w/CRT Min. Eng.Star req.
Option 4	Less energy w/TFT Good Eng.Star req. vs. Less energy w/CRT Good Eng.Star req.
Option 5	Less energy w/TFT Good Eng.Star req. vs. Less energy w/TFT Min. Eng.Star req.

Source: Author's own draft, 2002

5.1.2 Environmental impact of the single alternatives

The calculated relief potentials for the product alternatives are based on the environmental data given in Table 14, Table 15 and Table 16. They show the contribution of each "type" of PC to the considered environmental impact categories during one year and under the preconditions given in Table 11.

Table 14 - Environmental impacts of PC's with normal energy consuming CPU's and different CRT-monitors

	Type:	Normal w/CRT	Normal w/CRT
Environmental Impacts	Energy saving:	Min. Eng.Star req.	Good Eng.Star
Global warming	g CO_2-eq.	96,065	85,019
Acidification	g SO_2-eq.	504	446
Photochemical oxidant formation	g C_2H_4-eq.	9	8
Nutrification	g NO_3^--eq.	297	263
Resource consumption (Energy)	kWh	591	523
Waste formation	g	9,772	8,649

Source: Jeppe Frydendal, Anders Schmidt, RELIEF PC-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

Table 15 - Environmental impacts of PC's with less energy consuming CPU's and different CRT-monitors

	Type:	Less energy w/CRT	Less energy w/CRT
Environmental Impacts	Energy saving:	Min. Eng.Star req.	Good Eng.Star
Global warming	g CO_2-eq.	68,319	57,273
Acidification	g SO_2-eq.	359	301
Photochemical oxidant formation	g C_2H_4-eq.	7	5
Nutrification	g NO_3^--eq.	211	177
Resource consumption (Energy)	kWh	420	352
Waste formation	g	6,950	5,826

Source: Jeppe Frydendal, Anders Schmidt, RELIEF PC-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

Table 16 - Environmental impacts of PC's with less energy consuming CPU's and different TFT-monitors

	Type:	Less energy w/TFT	Less energy w/TFT
Environmental Impacts	Energy saving:	Min. Eng.Star req.	Good Eng.Star
Global warming	g CO_2-eq.	48,425	37,379
Acidification	g SO_2-eq.	254	196
Photochemical oxidant formation	g C_2H_4-eq.	5	4
Nutrification	g NO_3^--eq.	150	116
Resource consumption (Energy)	kWh	298	230
Waste formation	g	4,926	3,802

Source: Jeppe Frydendal, Anders Schmidt, RELIEF PC-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

5.2 Total amount of functional units on the European level

Unfortunately only little statistics concerning personal computer systems is available. The EUROSTAT production statistics comprises all kinds of data processing machines on a highly aggregated level and therefore was not suitable for the calculations of the relief potential. The only available data on IT-equipment on a suitable level of detail was found in the "European Information Technology Observatory (EITO)"[5] which is an established yearbook for the information and communications technology industry in Europe. It is supported by the European Commission, Directorate General Enterprise and Information Society and by the Directorate for Science, Technology and Industry of the OECD.

The following Table 17 shows the sold units of PC-systems in the EU for the years 1998, 1999 and 2000. The calculations are based on the figures of 2000.

Table 17 - Personal computer systems, units sold in the European Union

	1998	1999	2000
Portable	3,355,196	3,864,335	4,530,327
Desktop	17,948,627	20,193,047	22,901,584
PC's (portable + Desktop)	**21,303,823**	**24,057,382**	**27,431,912**

Source: Eito, 2001

The total amount of functional units for PC-systems sold on the European market in 2000 was 27,431,912 units (desktops and portables). This is the main input variable for the calculation of the RP^{TEM}. The results of the calculations are presented in section 5.3.

For the year 2000 the percentage of portables related to the total amount of sold units was about 16 %. Apart from the fact that portable computers, as far as laptop- or notebook-computers are concerned, are exclusively equipped with a TFT-screen, it can not automatically be concluded that they comply the highest requirements concerning the energy saving capabilities. Workstations and servers were not considered because their share within the total amount of units (portables, desktops and workstations/servers) sold in the EU in the year 2000 was less than 5 %.

5.3 Theoretical European market relief potential (RP^{TEM}) for personal computers

The following Table 18 to Table 22 indicate the calculation results for the five options presented in Table 13.

Table 18 - Theoretical European Market Relief potential for Option 1

	Less energy w/TFT Good Eng.Star req. vs. Normal w/CRT Min. Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-1,609,877	t CO_2-eq.	-196,326	Global
Acidification	-8,450	t SO_2-eq.	-114,183	Europe
Photochemical Oxidant Formation	-153	t C_2H_4-eq.	-6,132	Europe
Nutrification	-4,979	t NO_3^--eq	-41,842	Europe
Resource consumption (Energy)	-9,903	GWh	Calc. not possible	--
Waste Formation	-163,767	t	Calc. not possible	--

Source: Author's own calculation, 2002

5 http://www.cebit.de/24854

Table 19 - Theoretical European Market Relief potential for Option 2

	Less energy w/TFT Good Eng.Star req. vs. Normal w/CRT Good Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-1,306,858	t CO_2-eq.	-159,373	Global
Acidification	-6,859	t SO_2-eq.	-92,691	Europe
Photochemical Oxidant Formation	-124	t C_2H_4-eq.	-4,978	Europe
Nutrification	-4,042	t NO_3^--eq	-33,966	Europe
Resource consumption (Energy)	-8,039	GWh	Calc. not possible	--
Waste Formation	-132,942	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 20 - Theoretical European Market Relief potential for Option 3

	Less energy w/TFT Good Eng.Star req. vs. Less energy w/CRT Min. Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-848,740	t CO_2-eq.	-103,505	Global
Acidification	-4,455	t SO_2-eq.	-60,198	Europe
Photochemical Oxidant Formation	-81	t C_2H_4-eq.	-3,233	Europe
Nutrification	-2,625	t NO_3^--eq	-22,059	Europe
Resource consumption (Energy)	-5,221	GWh	Calc. not possible	--
Waste Formation	-86,339	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 21 - Theoretical European Market Relief potential for Option 4

	Less energy w/TFT Good Eng.Star req. vs. Less energy w/CRT Good Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-545,721	t CO_2-eq.	-66,551	Global
Acidification	-2,864	t SO_2-eq.	-38,706	Europe
Photochemical Oxidant Formation	-52	t C_2H_4-eq.	-2,079	Europe
Nutrification	-1,688	t NO_3^--eq	-14,184	Europe
Resource consumption (Energy)	-3,357	GWh	Calc. not possible	--
Waste Formation	-55,514	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 22 - Theoretical European Market Relief potential for Option 5

	Less energy w/TFT Good Eng.Star req. vs. Less energy w/TFT Min. Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-303,019	t CO_2-eq.	-36,954	Global
Acidification	-1,590	t SO_2-eq.	-21,492	Europe
Photochemical Oxidant Formation	-29	t C_2H_4-eq.	-1,154	Europe
Nutrification	-937	t NO_3^--eq	-7,876	Europe
Resource consumption (Energy)	-1,864	GWh	Calc. not possible	--
Waste Formation	-30,825	t	Calc. not possible	--

Source: Author's own calculation, 2002

The calculation results display the reduction in environmental impacts that the substitution of a specific “type” of PC with the green alternative (less energy consuming CPU with TFT-screen complying with good energy star requirements) would have in one year of operation. This value can be multiplied by the amount of years the computer is assumed to stay in operation.

Negative values in Table 18 to Table 22 indicate a reduction of the environmental impacts within the according environmental impact category while comparing the different kinds of PC’s.

5.4 Amount of functional units related to public procurement on the European level

Statistical data on the share of procurement or the stock of personal computer systems within the public sector weren't available for non of the European countries. Therefore the calculation of the amount of functional units related to procurement activities in the public sector is based on population statistics.

The number of public employees for the European countries were retrieved from OECD-databases (cf. OECD, 2001). The Estimation of the share of white collar workers within the public sector was performed with help of the EUROBAROMETER survey 41.0[6], which origins from 1994, unfortunately no newer data were available. The numbers of PC's per white collar worker were taken from the EITO yearbook and the assumption was made that these figures are the same in private as well as in public sector. Despite the fact that personal computers have relatively short use stages and often a replacement rate of 3 years or even less is assumed, the calculation of the RP^{TEPP} assumes a replacement rate of 5 years. Own investigations showed, that especially in the public sector the replacement rates are often longer than in private businesses and that in public sector often is aimed at a prolongation of the use stage. The assumption of a replacement every 5 years also considers the fact that more and more computers are produced which may have a CPU upgrade at least once during their use stage. Thus the number of annual purchased PC's by the public sector could be calculated according to the following Formula 13.

Formula 13

$$Y_{PC,i} = \frac{N_{PE,i} \cdot \eta_{W,i} \cdot AN_{W,i}}{\mu}$$

with:
- $Y_{PC,i}$ = Number of purchased PC systems per year, per country
- $N_{PE,i}$ = Number of public employees, per country
- $\eta_{W,i}$ = Share of white collar workers in the public sector, per country
- $AN_{W,i}$ = Average number of personal computers per white collar worker, per country
- μ = Rate of replacement
- i = Country i = 1...15

Table 23 - Data for the calculation of the yearly purchased number of business PC's in the public sector

	Number of public employees[1)]	Estimated White Collar Workers [% of Public employees]* [2)]	Number of white collar workers in the public sector	Number of business PCs per 100 white collar workers[3)]	Number of business PC's in public sector	Number of purchased PC's per year**
Austria	572,399	80.0	457,992	75	343,494	68,699
Belgium	686,999	78.8	560,587	65	364,382	72,876
Denmark	770,000	78.2	601,867	84	505,568	101,114
Finland	542,200	80.0	433,829	82	355,740	71,148
France	5,581,750	84.1	4,694,395	64	3,004,413	600,883
Germany	4,796,000	87.9	4,228,731	62	2,621,813	524,363
Greece	466,200	90.8	423,495	50	211,747	42,349
Ireland	168,400	63.4	106,732	134	143,021	28,604
Italy	3,573,600	88.8	3,171,570	57	1,807,795	361,559
Luxembourg°	23,400	81.1	18,985	-	-	-
Netherlands	704,400	94.7	667,108	80	533,687	106,737
Portugal	772,450	70.6	545,259	27	147,220	29,444
Spain	1,891,800	61.5	1,163,107	64	744,388	148,878
Sweden	1,278,200	80.0	1,022,723	102	1,043,177	208,635
United Kingdom	3,681,430	80.0	2,945,144	80	2,356,115	471,223
Total	**25,509,228**		**21,041,524**		**14,182,561**	**2,836,512**

* Numbers for Austria, Finland and Sweden calculated as the average of the other 12 EU member states.
** Assumption: PC is replaced after 5 years
° Number of business PC's for Luxembourg is included in the number of Belgium

Source: Author's own calculation, 2002
1) OECD Business Sector Data Base (BSDB); OECD Statistical Compendium Edition 01/2001 (CD)
2) EUROBAROMETER 41,0, 1994
3) Eito, 2001

6 These data were kindly provided by Meinhard Moschner, University of Cologne, Germany (Zentralarchiv für Empirische Sozialforschung an der Universitaet zu Köln)

The number of 2,834,281 (cf. Table 23) annually purchased personal computer units through the public sector in Europe results a public share of 10.3 %. This figure was used to calculate the RP^{TEPP} in the following section 5.5.

5.5 Theoretical European public procurement relief potential (RP^{TEPP}) for personal computers

The following Table 24 to Table 28 indicate the calculation results for the five options presented in Table 13.

Table 24 - Theoretical European Public Procurement Relief potential for Option 1

	Less energy w/TFT Good Eng.Star req. vs. Normal w/CRT Min. Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-166,464	t CO_2-eq.	-20,301	Global
Acidification	-874	t SO_2-eq.	-11,807	Europe
Photochemical Oxidant Formation	-16	t C_2H_4-eq.	-634	Europe
Nutrification	-515	t NO_3^--eq	-4,327	Europe
Resource consumption (Energy)	-1,024	GWh	Calc. not possible	--
Waste Formation	-16,934	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 25 - Theoretical European Public Procurement Relief potential for Option 2

	Less energy w/TFT Good Eng.Star req. vs. Normal w/CRT Good Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-135,132	t CO_2-eq.	-16,479	Global
Acidification	-709	t SO_2-eq.	-9,584	Europe
Photochemical Oxidant Formation	-13	t C_2H_4-eq.	-515	Europe
Nutrification	-418	t NO_3^--eq	-3,512	Europe
Resource consumption (Energy)	-831	GWh	Calc. not possible	--
Waste Formation	-13,746	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 26 - Theoretical European Public Procurement Relief potential for Option 3

	Less energy w/TFT Good Eng.Star req. vs. Less energy w/CRT Min. Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-87,761	t CO_2-eq.	-10,703	Global
Acidification	-461	t SO_2-eq.	-6,225	Europe
Photochemical Oxidant Formation	-8	t C_2H_4-eq.	-334	Europe
Nutrification	-271	t NO_3^--eq	-2,281	Europe
Resource consumption (Energy)	-540	GWh	Calc. not possible	--
Waste Formation	-8,928	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 27 - Theoretical European Public Procurement Relief potential for Option 4

	Less energy w/TFT Good Eng.Star req. vs. Less energy w/CRT Good Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-56,429	t CO_2-eq.	-6,882	Global
Acidification	-296	t SO_2-eq.	-4,002	Europe
Photochemical Oxidant Formation	-5	t C_2H_4-eq.	-215	Europe
Nutrification	-175	t NO_3^--eq	-1,467	Europe
Resource consumption (Energy)	-347	GWh	Calc. not possible	--
Waste Formation	-5,740	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 28 - Theoretical European Public Procurement Relief potential for Option 5

	Less energy w/TFT Good Eng.Star req. vs. Less energy w/TFT Min. Eng.Star req.			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-31,333	t CO_2-eq.	-3,821	Global
Acidification	-164	t SO_2-eq.	-2,222	Europe
Photochemical Oxidant Formation	-3	t C_2H_4-eq.	-119	Europe
Nutrification	-97	t NO_3^--eq	-814	Europe
Resource consumption (Energy)	-193	GWh	Calc. not possible	--
Waste Formation	-3,187	t	Calc. not possible	--

Source: Author's own calculation, 2002

As already mentioned earlier, the calculated relief potentials for PC-systems are on an annual basis. The assumption was made that the lifetime of a PC in the public sector is about 5 years, the presented results may be multiplied by five to obtain the relief potential over the whole lifetime of the devices.

Negative values in Table 24 to Table 28 indicate a reduction of the environmental impacts within the according environmental impact category while comparing the different kinds of PC's.

6 Copiers

6.1 Environmental basics

The functional unit for copiers is one copier. From available LCA's, the use stage may be identified the most important. Most of the contributions are specifically related to energy consumption, e.g. for global warming about 90% of the contribution comes from this. The same pattern can be seen for acidification (90%), nutrification (89%), and waste (96%). Thus it is assumed that the main environmental impacts of copiers occur during their use stage as a result of their consumption of electrical power as well as paper. The product specification therefore focuses on the presence and quality of energy and paper-saving capabilities.

6.1.1 General assumptions

The same as for computers also for copiers the use pattern for the copier play a mayor role. In order to consider the most likely case a medium performance of the copier is assumed. This means that per work day approx. 1,500 copies are made, the outcome of this is about 2,250,000 copies during a year.

Table 29 - Assumptions for the use and the energy consumption of copiers

Scenarios →	Medium performance - Energy saving disabled	Medium performance - Energy saving enabled	Medium performance - Energy saving enabled + Paper saved	Unit
Online hours a day	24	24	24	h
Online days a year	365	365	365	d
Work days a year	230	230	230	d
Copy speed (Simplex)	40	40	40	copies/minute
Ready/on mode (incl. Copying)	24	9	9	h/work day
Low power mode	0	1	1	h/work day
Auto "off" mode	0	14	14	h/work day
Copying power	1500	1500	1500	W
Ready mode power	300	300	300	W
Low power (Energy Star Req.)	159	159	159	W
Low power (Good Energy Star)	5	5	5	W
Auto "off" (Energy Star Req.)	15	15	15	W
Auto "off" (Good Energy Star)	3	3	3	W
Number of copies per work day	1500	1500	1500	copies
Extra energy per copy	0,50	0,50	0,50	Wh
Copy modes used: Simplex	95%	95%	50%	
Copy modes used: Duplex	5%	5%	50%	
Duplex extra energy	60%	60%	60%	
Paper type	Normal quality (virgin)			

Source: Jeppe Frydendal, Anders Schmidt, RELIEF Copier-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

In the scenario "Energy saving disabled", it is assumed that the energy saving features of the copier are disabled. This would results the same effect as if no energy saving capabilities were available, meaning that the copier will be in on-mode all the time, including nights and weekends.

In the scenario “Energy saving enabled”, it is assumed that the copier enters low-power and auto-off modes as quickly as possible when there is no activity. Although there are differences with respect to the Energy Star criteria for different capacities, it is assumed that low-power mode is entered after 15 minutes and that auto-off is entered after an additional period of 30 minutes. This also means that the copier will be in auto-off mode during the weekend.

In the scenario “Energy saving enabled + Paper saved” in addition to the previous “Energy saving enabled” scenario 50 % of all copies are done in duplex mode (paper is printed on both sides).

The use of the “Duplex”-mode slightly increases the environmental impacts in every environmental impact category, except the category “Resource Consumption (Energy+Paper)” (see Table 32 and Table 33). The explanation for the increase in the impact categories other than “Resource Consumption (Energy+Paper)” is that a “Duplex”-capable copier uses more electrical power in “Duplex”-mode than in “Normal”-mode (page printed only on one side).

The decrease within the category “Resource Consumption (Energy)” is the result of the saved paper. The saving of paper using the “Duplex”-mode also results in savings in terms of money for the procurers but this is not considered in the calculations, the same as the subsequent positive effects of paper saving.

However, the environmental impacts saved through the savings of paper do not balance those of the additional power use related to the “Duplex”-mode, except for the category “Resource Consumption (Energy+Paper)”.

The same as for the other product groups considered in this report, the green product for the product group copiers was selected according to the rule that the green product is the one having the smallest environmental impacts in most of the environmental impact categories (see section 2.6).

Thus, considering the data in Table 32 and Table 33 it was decided to use the copier complying to a “good energy star requirement” but no “Duplex”-use as the green product for the calculations of the relief potentials presented in section 6.3.

Table 30 gives an overview about the copiers for which the relief potentials are calculated. In the following Table 31 shows the compared options.

Table 30- Different types of Copiers under consideration

Copier with no energy saving capabilities, or Energy saving options are disabled, but 50% of all copies are printed on both sides (Duplex).	Copier with no energy saving capabilities, or Energy saving options are disabled but no Duplex-copies.
Copier complying to minimum energy star requirements, Energy saving options are enabled and 50% of all copies are printed on both sides (Duplex).	Copier complying to minimum energy star requirements, Energy saving options are enabled but no Duplex-copies.
Copier complying to good energy star requirements, Energy saving options are enabled, and 50% of all copies are printed on both sides (Duplex).	Copier complying to good energy star requirements, Energy saving options are enabled but no Duplex-copies.

Source: Jeppe Frydendal, Anders Schmidt, RELIEF PC-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

Table 31 – Different options for comparing brown with green copiers

Options	Green Product vs. Brown Product		
Option 1	Scenario "Energy saving enabled" + Copier with **good energy star requirements**	vs.	Scenario "Energy saving enabled + Paper saved" + Copier with **good energy star requirements**
Option 2	Scenario "Energy saving enabled" + Copier with **good energy star requirements**	vs.	Scenario "Energy saving enabled + Paper saved" + Copier with **minimum energy star requirements**
Option 3	Scenario "Energy saving enabled" + Copier with **good energy star requirements**	vs.	Scenario "Energy saving disabled + Paper saved" or Copier with **no energy saving**
Option 4	Scenario "Energy saving enabled" + Copier with **good energy star requirements**	vs.	Scenario "Energy saving enabled" + Copier with **minimum energy star requirements**
Option 5	Scenario "Energy saving enabled" + Copier with **good energy star requirements**	vs.	Scenario "Energy saving disabled " or Copier with **no energy saving**

Source: Author's own draft, 2002

6.1.2 Environmental impact of the single alternatives

Table 32 and Table 33 show the environmental impacts, for the different environmental impact categories for one copier during one year, of the single copier-types presented in Table 30.

Table 32 - Annual environmental impacts of copiers not using the "Duplex"-mode

		Energy saving disabled	Energy saving enabled Min. Energy Star requirements	Energy saving enabled Good Energy Star requirement
Global warming	g CO_2-eq.	1,277,234	424,343	372,929
Acidification	g SO_2-eq.	6,704	2,227	1,957
Photochem ozone	g C_2H_4-eq.	122	40	36
Nutrification	g NO_3^--eq.	3,950	1,312	1,153
Resource consumption (Energy+Paper)	kWh	16,198	14,741	14,653
Waste formation	g	129,929	43,167	37,937
Annual number of copies	copies	345,000	345,000	345,000
Paper use	kg	1,682	1,682	1,682
Paper use (Energy)	kWh	14,016	14,016	14,016

Source: Jeppe Frydendal, Anders Schmidt, RELIEF Copier-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

Table 33 - Annual environmental impacts of copiers using the "Duplex"-mode for 50% of all copies

		Energy saving disabled + Duplex	Energy saving enabled + Duplex Min. Energy Star requirements	Energy saving enabled + Duplex Good Energy Star requirements
Global warming	g CO_2-eq.	1,298,437	445,545	394,131
Acidification	g SO_2-eq.	6,815	2,338	2,069
Photochem ozone	g C_2H_4-eq.	124	42	38
Nutrification	g NO_3^--eq.	4,016	1,378	1,219
Resource consumption (Energy+Paper)	kWh	13,000	11,543	11,455
Waste formation	g	132,086	45,324	40,094
Annual number of copies	copies	345,000	345,000	345,000
Paper use	kg	1,294	1,294	1,294
Paper use (Energy)	kWh	10,781	10,781	10,781

Source: Jeppe Frydendal, Anders Schmidt, RELIEF Copier-Calculator, MS Excel file prepared within the scope of WP5 of the RELIEF project, 2002

6.2 Total amount of functional units on the European level

The same as for computers the figures of the copier-units sold in the EU, presented for the single countries in Table 34, stem from the European Information Technology Observatory (EITO), 2001. The figures from the year 2000 were used to perform the calculation.

Table 34 – Copiers, units sold in the European Union

Copiers	1998	1999	2000	2001	2002
Austria	24.162	24.958	25.640	26.470	27.273
Belgium/Luxembourg	38.974	40.825	42.197	43.382	44.684
Denmark	27.411	28.095	28.775	29.409	30.101
Finland	26.777	28.048	29.325	30.734	32.312
France	210.463	213.291	217.307	220.679	224.340
Germany	386.887	395.187	402.835	410.709	419.294
Greece	13.574	14.136	14.713	15.325	16.006
Ireland	21.683	22.315	23.063	23.734	24.473
Italy	195.797	205.000	213.000	220.000	215.000
Netherlands	94.217	97.007	100.136	103.279	106.747
Portugal	18.016	18.724	19.635	20.530	21.531
Spain	69.711	69.979	70.590	71.602	72.700
Sweden	32.469	33.009	33.825	34.666	35.587
United Kingdom	184.602	190.296	197.596	204.202	211.503
Total	**1.344.743**	**1.380.870**	**1.418.637**	**1.454.721**	**1.481.551**

Source: EITO, 2001

6.3 Theoretical European market relief potential (RP^{TEM}) for copiers

Table 35 to Table 39 show the relief potentials for the total European Union Market for the different copier-options.

Table 35 - Theoretical European Market Relief potential for Option 1

	Option 1			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-30,079	t CO_2-eq.	-3,668	Global
Acidification	-158	t SO_2-eq.	-2,133	Europe
Photochemical Oxidant Formation	-3	t C_2H_4-eq.	-115	Europe
Nutrification	-93	t NO_3^--eq	-782	Europe
Resource consumption (Energy+Paper)	4,537	GWh	Calc. not possible	--
Waste Formation	-3,060	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 36 - Theoretical European Market Relief potential for Option 2

	Option 2			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-103,016	t CO_2-eq.	-12,563	Global
Acidification	-541	t SO_2-eq.	-7,307	Europe
Photochemical Oxidant Formation	-10	t C_2H_4-eq.	-392	Europe
Nutrification	-319	t NO_3^--eq	-2,677	Europe
Resource consumption (Energy+Paper)	4,412	GWh	Calc. not possible	--
Waste Formation	-10,480	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 37 - Theoretical European Market Relief potential for Option 3

	Option 3			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-1,312,960	t CO_2-eq.	-160,117	Global
Acidification	-6,891	t SO_2-eq.	-93,123	Europe
Photochemical Oxidant Formation	-125	t C_2H_4-eq.	-5,001	Europe
Nutrification	-4,061	t NO_3^--eq	-34,125	Europe
Resource consumption (Energy+Paper)	2,345	GWh	Calc. not possible	--
Waste Formation	-133,563	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 38 - Theoretical European Market Relief potential for Option 4

	Option 4			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-72,938	t CO_2-eq.	-8,895	Global
Acidification	-383	t SO_2-eq.	-5,173	Europe
Photochemical Oxidant Formation	-7	t C_2H_4-eq.	-278	Europe
Nutrification	-226	t NO_3^--eq	-1,896	Europe
Resource consumption (Energy+Paper)	-125	GWh	Calc. not possible	--
Waste Formation	-7,420	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 39 - Theoretical European Market Relief potential for Option 5

	Option 5			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-1,282,881	t CO_2-eq.	-156,449	Global
Acidification	-6,733	t SO_2-eq.	-90,990	Europe
Photochemical Oxidant Formation	-122	t C_2H_4-eq.	-4,887	Europe
Nutrification	-3,968	t NO_3^--eq	-33,343	Europe
Resource consumption (Energy+Paper)	-2,192	GWh	Calc. not possible	--
Waste Formation	-130,503	t	Calc. not possible	--

Source: Author's own calculation, 2002

Negative values in Table 35 to Table 39 indicate a reduction of the environmental impacts within the according environmental impact category while comparing the different kinds of copiers. Positive values on the other hand indicate an increase of environmental impacts.

The results for option 1 (see Table 35; use of “Duplex”-mode versus “Normal”-mode, same copier) clearly shows that the green product achieves a higher relief potential in the categories: “Global Warming”, “Acidification”, “Photochemical Oxidant Formation” and “Nutrification”. Only in the category “Resource consumption (Energy+Paper)” the higher cumulated energy requirement related to the use of more paper in “Normal”-mode becomes obvious.

Option 3 (see Table 37; comparison of the green copier with one without energy saving capabilities, or with disabled energy saving capabilities, but with a share of 50 % of the use of the “Duplex”-mode) still shows a positive value (consequential the environmental impacts of the green product are higher than those of the product under investigation) in the environmental impact category “Resource consumption (Energy+Paper)”. This means that the savings in terms of energy by using the energy saving capabilities (of the green product) are exceeded by the energy savings achieved through paper savings by far, although in all other categories significant relief potentials are obtained.

Option 4 and 5 (comparing copiers without using the “Duplex”-mode) show significant relief potentials in the environmental impact category: “Resource consumption (Energy+Paper)” are significant, it is important to bear in mind that the compared products do not save paper howsoever.

6.4 Amount of functional units related to public procurement on the European level

The share of the public sector was determined according to the method of Horbach, a public share of 14,75 % was used for the calculations. Thus the European public sector purchases 209,184 copiers in the year 2000.

6.5 Theoretical European public procurement relief potential (RP^{TEPP}) for copiers

The following Table 40 to Table 44 present the annual relief potentials for copiers purchased by the public sector in Europe in 2000.

Table 40 - Theoretical European Public Procurement Relief potential for Option 1

	Option 1			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-4,435	t CO_2-eq.	-541	Global
Acidification	-23	t SO_2-eq.	-315	Europe
Photochemical Oxidant Formation	0	t C_2H_4-eq.	-17	Europe
Nutrification	-14	t NO_3^--eq	-115	Europe
Resource consumption (Energy+Paper)	669	GWh	Calc. not possible	--
Waste Formation	-451	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 41 - Theoretical European Public Procurement Relief potential for Option 2

	Option 2			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-15,190	t CO_2-eq.	-1,852	Global
Acidification	-80	t SO_2-eq.	-1,077	Europe
Photochemical Oxidant Formation	-1	t C_2H_4-eq.	-58	Europe
Nutrification	-47	t NO_3^--eq	-395	Europe
Resource consumption (Energy+Paper)	651	GWh	Calc. not possible	--
Waste Formation	-1,545	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 42 - Theoretical European Public Procurement Relief potential for Option 3

	Option 3			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-193,602	t CO_2-eq.	-23,610	Global
Acidification	-1,016	t SO_2-eq.	-13,731	Europe
Photochemical Oxidant Formation	-18	t C_2H_4-eq.	-737	Europe
Nutrification	-599	t NO_3^--eq	-5,032	Europe
Resource consumption (Energy+Paper)	346	GWh	Calc. not possible	--
Waste Formation	-19,694	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 43 - Theoretical European Public Procurement Relief potential for Option 4

	Option 4			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-10,755	t CO_2-eq.	-1,312	Global
Acidification	-56	t SO_2-eq.	-763	Europe
Photochemical Oxidant Formation	-1	t C_2H_4-eq.	-41	Europe
Nutrification	-33	t NO_3^--eq	-280	Europe
Resource consumption (Energy+Paper)	-18	GWh	Calc. not possible	--
Waste Formation	-1,094	t	Calc. not possible	--

Source: Author's own calculation, 2002

Table 44 - Theoretical European Public Procurement Relief potential for Option 5

	Option 5			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	-189,167	t CO_2-eq.	-23,069	Global
Acidification	-993	t SO_2-eq.	-13,417	Europe
Photochemical Oxidant Formation	-18	t C_2H_4-eq.	-721	Europe
Nutrification	-585	t NO_3^--eq	-4,917	Europe
Resource consumption (Energy+Paper)	-323	GWh	Calc. not possible	--
Waste Formation	-19,243	t	Calc. not possible	--

Source: Author's own calculation, 2002

Again negative values in Table 40 to Table 44 indicate a reduction of the environmental impacts within the according environmental impact category while comparing the different kinds of copiers. Positive values on the other hand indicate an increase of environmental impacts.

7 Furniture

7.1 Environmental basics

The following matrix shows the relative importance of different environmental impacts in the life cycle of furniture. The matrix is primarily based on the LCA results, but as the same findings are also reflected in eco-labelling criteria and purchasing guidelines, it can be assumed that the matrix is realistic in terms of calculating the relief potential.

Table 45 - Relative importance of different environmental impacts for furniture

Life cycle stage / Level of importance	Raw material acquisition and production of intermediate products	Production of final products	Use	Disposal
High Importance		Human toxicity and creation of photochemical ozone from surface treatment of wood and metal	Reduced indoor air quality from degassing of formaldehyde	
Medium importance	Persistent toxicity and human toxicity from steel production Use of recycled metals and plastics	Persistent toxicity from surface treatment of wood and metal		Recyclability of plastics and metals

Source: A. Schmidt, 2001-b

Thus the main impacts on environment and human health are related to the surface treatment of wood and metals, or more precisely to the content of volatile organic compounds in surface treatment agents and the toxicity of each of the volatile compounds.

Due to missing information on the environmental impacts of different methods for surface treatment of metals, the calculation of the relief potential has to be restricted on surface treatment of wooden components.

Table 46 - Effect factors of the contribution of selected substances to the environmental impact categories

Substance	Photochemical oxidant formation (in low NO_x-areas)[1]	Photochemical oxidant formation (in high NO_x-areas)[2]	Human toxicity via air	Human toxicity via water	Chronic eco-toxicity in water
Xylenes (mixed)	0.4	0.9	6.7E+03	1.1E-03	4.0E+00
Ethanol	0.2	0.3	1.14E+02	2.9E-07	1.1E-03
Isopropanol	0.2	0.2	1.2E+02	7.5E-06	5.1E-02
n-Butanol	0.2	0.4	1.1E+07	1.1E-04	1.5E-02
Isobutanol	0.3	0.3	1.0E+07	2.9E-05	4.2E-03
Butyl acetate	0.3	0.3	4.8E+03	7.0E-03	5. 6E-01
Ethyl acetate	0.3	0.2	5.0E+05	8.9E-06	8.3E-02
Methoxypropanol	0.5	0.5	1.8E+01	0	0
Methoxypropylacetate	0.2	0.1	3.3E+03	0	0
Solvents (average)	0.4	0.4	-	-	-
Surface coating (average)	0.5	0.5	-	-	-

[1] Low NO_x areas are areas with a low concentration of NO_x in the atmosphere, e.g. Scandinavia
[2] High NO_x areas are areas with a high concentration of NO_x in the atmosphere, e.g. Central Europe

Source: A. Schmidt, 2001-b

Considering these aspects the functional unit for furniture was defined to be one square metre of laquered wooden surface.

7.2 Total amount of functional units on the European level

Unfortunately it was not possible to get suitable market data for the calculation of the relief potential. Despite the fact that some figures for office furniture are available in the

EUROSTAT production statistics it was not possible to divide the produced amount into metal and wooden furniture. It was also not possible to determine the share of wooden furniture having a polymer surface and those having a veneer surface. The investigation among producers, performed by Prof. Dr. Michael von Hauff also yielded no result in this concern.

Considering all these aspects it was not possible to produce reasonable estimations of the order of magnitude of the relief potential.

8 Busses

8.1 Environmental basics

The functional unit for busses and coaches is one bus-km. The main environmental impacts from busses occur during their use stage as a result of fuel consumption. Therefore the product specification focuses on the different exhaust gas norms for busses and coaches (EURO-specification).

Table 47 - Contribution per Bus-km to the environmental impact categories

	Per Bus-km	EURO II-Standard	EURO III-Standard	EURO IV-Standard
Global Warming	g CO_2-eq.	1,344.2	1,363.7	1,380.4
Photochemical oxidant formation	g C_2H_4-eq.	0.7	0.6	0.1
Acidification	g SO_2-eq.	6.6	5.3	3.9
Nutrification	g NO_3^--eq,	12.7	10.2	7.5
Human Toxicity via Air	m^3	102,308.7	79,373.5	50,169.4
Resource consumption (Energy)	kWh	5.028	5.111	5.194

Source: A. Schmidt, 2001

Busses complying with EURO IV-specification are compared with such complying with EURO II- and EURO III-specification. The calculation of the relief potential in the following chapters is based on the annual number bus-km driven within the European Union. The estimation of the public share is based on several assumptions and on a survey among bus-producers.

8.2 Total amount of functional units on the European level

Statistical data on bus-km suitable to calculate the relief potential of buses are hardly to find. Therefore the bus-km have to be estimated with help of statistical data on the newly registered busses in Europe.

In general the statistical offices in the single countries mostly do not register data on the types as well as on the purchaser of new registered buses. The EUROSTAT production databases and the Input-Output-Table data mostly refer to “vehicles” which comprises all kinds of cars, trucks, busses etc.

For the calculation of the relief potential it was therefore necessary to refer to data provided by producers. Although within these data no differentiation between line-buses and coaches was made, neither information on the produced numbers of busses complying the single EURO-specifications could be provided. Data on the number of newly registered buses and coaches within the European countries were available from the association of car producers (ACEA)[7].

[7] The Data on newly registered buses were kindly provided by Nuria Comelles, Association des Constructeurs Européens d' Automobiles, ACEA (European Automobile Manufacturers Association), http://www.acea.be/ACEA/index.html

The following Table 48 shows the total of newly registered buses and coaches (over 3.5 t) in Europe during 1999.

Table 48 - New registered busses and coaches in Europe in 1999

Country	Registered Busses and Coaches in 1999
Austria	784
Belgium	896
Denmark	539
Finland	463
France	4,931
Germany	6,182
Greece	543
Ireland	191
Italy	4,884
Luxembourg	117
Netherlands	652
Portugal	602
Spain	3,642
Sweden	1,174
United Kingdom	5,357
Total	**30,957**

Source: Association des Constructeurs Européens d' Automobiles, 2002

8.3 Theoretical European market relief potential (RP^{TEM}) for busses

Based on the results of the producer survey and information from ACEA, it can be assumed, that approximately 50 %[8] of the registered buses are coaches. Furthermore it is assumed that these are used predominantly in the commercial sector, while the other buses are mainly line buses predominantly used in the public sector.

Actually there are no comprehensive statistical data on the annual covered bus-km in Europe available. Therefore the following assumptions to estimate this figure were made:

One bus or coach drives during its use stage of 10 years 1,000,000 km and uses two engines for that purpose. This means that one bus or coach drives 100,000 km per year.

15,479 line-buses were newly registered in Europe during 1999, thus they cover an annual amount of 1,547,850,000 bus-km, this figure is the main variable for the calculation of the RP^{TEM}.

The calculation was performed for both EURO II and EURO III buses, because no data is available, how many buses meeting EURO III standards are already in operation in Europe. From the beginning of 2001, the EURO III standard is mandatory for new vehicles, though.

The Table 49 and Table 50 show the annual relief potential for the line busses. Negative values indicate a decrease of environmental impacts in the specific impact categories and positive values indicate the opposite.

8 Despite the fact that this figure derives from a rather small sample, it is supported by Danish investigations resulting an equal share .

Table 49 - Theoretical European Market Relief potential for busses (EURO IV vs. EURO II)

	EUROIV vs. EUROII			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	55,933	t CO_2-eq.	6,821	Global
Photochemical oxidant formation	-844	t C_2H_4-eq.	-33,753	Europe
Acidification	-4,245	t SO_2-eq.	-57,368	Europe
Nutrification	-8,087	t NO_3^--eq	-67,956	Europe
Human Toxicity	-80,704	km^3 air	-26,374	--
Cumulated Energy Requirements	258	GWh	Calc. not possible	

Source: Author's own calculation, 2002

Table 50 - Theoretical European Market Relief potential for busses (EURO IV vs. EURO III)

	EUROIV vs. EUROIII			
Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	25,812	t CO_2-eq.	3,148	Global
Photochemical oxidant formation	-698	t C_2H_4-eq.	-27,939	Europe
Acidification	-2,220	t SO_2-eq.	-30,002	Europe
Nutrification	-4,179	t NO_3^--eq	-35,119	Europe
Human Toxicity	-45,204	km^3 air	-14,772	--
Cumulated Energy Requirements	129	GWh	Calc. not possible	

Source: Author's own calculation, 2002

8.4 Amount of functional units related to public procurement on the European level

No statistical data were available for the share of the public sector on the annually registered buses, but from the producer survey resulted the information, that about 48 %[9] of the produced buses in the categories standard line-buses, articulated buses and biplane buses are delivered to the public sector. Thus 7,430 buses (line-buses) are newly registered per year by the public sector, they represent a share of 24 % and cover an annual amount of 742,968,000 bus-km.

8.5 Theoretical European public procurement relief potential (RP^{TEPP}) for busses

The results of the calculation of the annual relief potential are presented in Table 51 and Table 52. The same as for the preceding relief potentials negative values indicate a decrease of environmental impacts in the specific impact categories and positive values indicate the opposite.

Table 51 - Theoretical European public procurement relief potential for busses (EURO IV vs. EURO II)

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	26,848	t CO_2-eq.	3,274	Global
Photochemical oxidant formation	-405	t C_2H_4-eq.	-16,201	Europe
Acidification	-2,038	t SO_2-eq.	-27,537	Europe
Nutrification	-3,882	t NO_3^--eq	-32,619	Europe
Human Toxicity	-38,738	km^3 air	-12,659	--
Cumulated Energy Requirements	124	GWh	Calc. not possible	

Source: Author's own calculation

9 This figure is based on survey among a rather small sample of European bus-producers.

Table 52 - Theoretical European public procurement relief potential for busses (EURO IV vs. EURO III)

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Global Warming	12,390	t CO_2-eq.	1,511	Global
Photochemical oxidant formation	-335	t C_2H_4-eq.	-13,411	Europe
Acidification	-1,066	t SO_2-eq.	-14,401	Europe
Nutrification	-2,006	t NO_3^--eq	-16,857	Europe
Human Toxicity	-21,698	km^3 air	-7,091	--
Cumulated Energy Requirements	62	GWh	Calc. not possible	

Source: Author's own calculation

The calculated relief potentials for busses are on an annual basis. The assumption was made that the lifetime of a bus is ten years, the presented results may therefore be multiplied by ten to obtain the relief potential over the whole lifetime of the vehicles.

For the specific product group busses the calculated theoretical relief potentials equal the corresponding achievable relief potentials, because busses complying the EURO IV-specification are at present time not yet available on the market.

9 Food

9.1 Environmental basics

The main environmental impacts for food products occur within the production stage of the products and during the transport processes. The functional unit for food products is one ton of produced food.

The following Table 53 to Table 55 show the contribution of one ton of produced foodstuff to the respective environmental impact categories. Table 56 shows the environmental impacts per ton related to transport.

Table 53 - Environmental impacts of vegetables and wheat from conventional and organic production

	Emissions per t during production	Vegetables conv.	Vegetables organic	Wheat conv.	Wheat organic
Ozone Depletion	t R11-eq.	9,0E-08	1,1E-07	1,5E-07	1,7E-07
Global Warming	t CO_2-eq.	2,0E-01	2,2E-01	7,5E-01	4,5E-01
Acidification	t SO_2-eq.	2,0E-03	2,0E-03	9,0E-03	7,0E-03
Photochemical Oxidant Formation	t C_2H_4-eq.	7,8E-04	7,8E-04	1,6E-03	1,4E-03
Nutrification	t PO_4^{3-}-equiv.	9,0E-04	9,0E-04	5,2E-03	2,8E-03
Resource Consumption (Energy)	MJ	1,5E+00	1,5E+00	4,1E+00	3,3E+00

Source: Jungbluth, 2000

Table 54 - Environmental impacts of poultry and beef meat from conventional and organic production

	Emissions per t during production	Poultry conv.	Poultry organic	Beef conv.	Beef organic
Ozone Depletion	t R11-eq.	9,8E-07	9,9E-07	1,8E-06	1,8E-06
Global Warming	t CO_2-eq.	2,9E+00	2,3E+00	1,6E+01	1,4E+01
Acidification	t SO_2-eq.	6,6E-02	6,2E-02	2,2E-01	1,9E-01
Photochemical Oxidant Formation	t C_2H_4-eq.	5,8E-03	5,3E-03	1,9E-02	1,8E-02
Nutrification	t PO_4^{3-}-equiv.	2,1E-02	1,6E-02	7,8E-02	5,3E-02
Resource Consumption (Energy)	MJ	3,6E+01	3,4E+01	3,9E+01	3,4E+01

Source: Jungbluth, 2000

Table 55 - Environmental impacts of pork meat and milk from conventional and organic production

	Emissions per t during production	Pork conv.	Pork organic	Milk conv.	Milk organic
Ozone Depletion	t R11-eq.	9,6E-07	9,8E-07	1,1E-07	1,1E-07
Global Warming	t CO_2-eq.	3,4E+00	2,6E+00	9,2E-01	7,2E-01
Acidification	t SO_2-eq.	8,8E-02	8,3E-02	1,2E-02	9,0E-03
Photochemical Oxidant Formation	t C_2H_4-eq.	7,4E-03	6,6E-03	1,2E-03	1,1E-03
Nutrification	t PO_4^{3-}-equiv.	2,9E-02	2,1E-02	4,8E-03	3,0E-03
Resource Consumption (Energy)	MJ	2,6E+01	2,3E+01	2,3E+00	1,8E+00

Source: Jungbluth, 2000

Table 56 - Environmental impacts for foodstuffs related to different types of transport

	Emissions per t during Transport	Outside Europe (by Ship)	Outside Europe (by Plane)	European Origin	Regional Origin
Ozone Depletion	t R11-eq.	4,0E-07	1,4E-05	3,0E-07	1,0E-07
Global Warming	t CO_2-eq.	3,4E-01	1,2E+01	2,3E-01	6,0E-02
Acidification	t SO_2-eq.	5,6E-03	5,7E-02	1,9E-03	3,1E-04
Photochemical Oxidant Formation	t C_2H_4-eq.	2,9E-03	5,5E-02	1,7E-03	3,1E-04
Nutrification	t PO_4^{3-}-equiv.	6,5E-04	9,3E-03	4,6E-04	1,2E-04
Resource Consumption (Energy)	MJ	5,7E+00	1,7E+02	3,8E+00	9,0E-01

Source: Jungbluth, 2000

9.2 Total amount of functional units on the European level

Opposed to the previously considered products the calculation of the relief potential is based on production data. For this reason also the estimation of the amount of functional units related to the public sector may be performed with the help of the European Input-Output-Tables (see section 3). The use of the Input-Output-Tables implies that the domestic production (which include exports) is considered for the calculation of the share of the public sector.

For food products in general only production data were available. The main sources for those data are the EUROSTAT production databases and the FAO[10] databases. The EUROSTAT data in general comprise a higher level of aggregation and for many products the data for some European countries are not completely available. Therefore the production data for the following food products: wheat, vegetables, beef, pork, poultry meat and milk (excluding butter) were taken from the food balance sheet database of the FAO for the year 2000. The overseas import shares originate from EUROSTAT statistics[11]. The basic data used in the calculations of the relief potential are presented in the following Table 57.

Table 57 - Domestic production, import and export of specific food products for 2000

	Domestic production	Imports				Exports
	(EU15)	Inside Europe	By ship	By plane	Total	
	[1000 tons]	[1000 tons]	[1000 tons]	[1000 tons]	[1000 tons]	[1000 tons]
Wheat	105,493	25,334	1,380	2.47	26,716	41,820
Vegetables	56,284	16,898	36	0.99	16,935	17,832
Beef	7,397	2,015	49	2.06	2,066	2,296
Pork	17,618	4,101	100	4.19	4,205	5,226
Poultry meat	8,758	1,667	41	1.70	1,710	2,593
Milk - excluding butter	125,942	36,574	n. a.	n. a.	36,574	47,779

Source: Data from FAO (2002), and EUROSTAT (2002), Author's own calculation, 2002

9.3 Theoretical European market relief potential (RP^{TEM}) for food products

Within the calculation of the European market relief potential, the domestic consumption resulting from domestic production plus total imports minus total exports was considered. The following Table 58 to Table 63 show the calculated relief potentials. The same as for the relief potentials of the previous investigated products, negative values indicate a decrease of environmental impacts in the specific impact categories and positive values indicate the opposite. All values represent an annual relief potential.

[10] Food and agriculture organisation of the United Nations, http://www. fao.org/, visited on Mai-July 2002

[11] Kindly provided by Simon Clement of ICLEI

Table 58 - Theoretical European market relief potential for organic grown vegetables compared to conventional grown vegetables

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	1.11	t CFC-11-eq.	13,676	Global
Global Warming	1,107,722	t CO_2-eq.	135,088	Global
Acidification	0	t SO_2-eq.	0	Europe
Photochemical Oxidant Formation	0	t C_2H_4-eq.	0	Europe
Nutrification	0	t PO_4^{3-}-eq	0	Europe
Resource consumption (Energy)	0	GWh	Calc. not possible	--

Source: Author's own calculation, 2002

Table 59 - Theoretical European market relief potential for organic grown wheat compared to conventional grown wheat

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	1.81	t CFC-11-eq.	22,318	Global
Global Warming	-27,116,670	t CO_2-eq.	-3,306,911	Global
Acidification	-180,778	t SO_2-eq.	-2,442,943	Europe
Photochemical Oxidant Formation	-11,751	t C_2H_4-eq.	-470,022	Europe
Nutrification	-216,933	t PO_4^{3-}-eq	-19,190,849	Europe
Resource consumption (Energy)	-22	GWh	Calc. not possible	--

Source: Author's own calculation, 2002

Table 60 - Theoretical European market relief potential for organic poultry meat compared to conventional poultry meat

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.08	t CFC-11-eq.	972	Global
Global Warming	-4,567,610	t CO_2-eq.	-557,026	Global
Acidification	-31,501	t SO_2-eq.	-425,686	Europe
Photochemical Oxidant Formation	-4,174	t C_2H_4-eq.	-166,954	Europe
Nutrification	-40,951	t PO_4^{3-}-eq	-3,622,699	Europe
Resource consumption (Energy)	-5	GWh	Calc. not possible	--

Source: Author's own calculation, 2002

Table 61 - Theoretical European market relief potential for organic beef compared to conventional beef

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.36	t CFC-11-eq.	4,425	Global
Global Warming	-17,920,075	t CO_2-eq.	-2,185,375	Global
Acidification	-229,377	t SO_2-eq.	-3,099,689	Europe
Photochemical Oxidant Formation	-7,885	t C_2H_4-eq.	-315,393	Europe
Nutrification	-172,750	t PO_4^{3-}-eq	-15,282,159	Europe
Resource consumption (Energy)	-11	GWh	Calc. not possible	--

Source: Author's own calculation, 2002

Table 62 - Theoretical European market relief potential for organic pork compared to conventional pork

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.33	t CFC-11-eq.	4,098	Global
Global Warming	-14,107,042	t CO_2-eq.	-1,720,371	Global
Acidification	-82,983	t SO_2-eq.	-1,121,386	Europe
Photochemical Oxidant Formation	-13,111	t C_2H_4-eq.	-524,450	Europe
Nutrification	-126,134	t PO_4^{3-}-eq	-11,158,311	Europe
Resource consumption (Energy)	-14	GWh	Calc. not possible	--

Source: Author's own calculation, 2002

Table 63 - Theoretical European market relief potential for organic milk compared to conventional milk

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.00	t CFC-11-eq.	0.00	Global
Global Warming	-22,947,468	t CO_2-eq.	-2,798,472	Global
Acidification	-344,212	t SO_2-eq.	-4,651,514	Europe
Photochemical Oxidant Formation	-9,179	t C_2H_4-eq.	-367,159	Europe
Nutrification	-206,527	t PO_4^{3-}-eq	-18,270,277	Europe
Resource consumption (Energy)	-13	GWh	Calc. not possible	--

Source: Author's own calculation, 2002

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Also transport processes are an important source for environmental impacts of food products. However, the assumption that transport processes are the same for organic grown food products than for conventional grown food products results that the transport processes have no influence on the relief potential. Nevertheless, the following Table 64 shows the environmental impacts of transport for the amount of functional units presented in Table 57. For the domestic consumption (= domestic production minus exports) it was assumed that only regional transport distances (less than 100 km) apply, thus the emission factors for "regional origin" (see Table 56) were applied.

Table 64 - Environmental impacts for the transport of the imported amount of functional units for food products in 2000

		Vegetables	Wheat	Poultry	Beef	Pork	Milk
Ozone Depletion	Person-eq.	172,253	289,866	20,882	21,981	47,228	375,437
Global Warming	Person-eq.	1,156,113	1,934,104	137,451	147,983	314,793	2,512,927
Acidification	Person-eq.	866,705	1,488,690	99,415	111,533	233,041	1,873,461
Photochemical Oxidant Formation	Person-eq.	2,402,165	3,995,078	274,642	304,746	639,779	5,205,636
Nutrification	Person-eq.	1,646,386	2,748,791	193,031	207,519	441,723	3,581783
Resource Consumption	GWh	42	70	5	5	11	91

Source: Author's own calculation based on Data from ICLEI 2000 and Table 57

9.4 Amount of functional units related to public procurement on the European level

The share for the public sector for food products was calculated according to Formula 12 and amounts to 3,15 %. The European market data presented in Table 57 consequently change to the figures indicated in the following Table 65.

Table 65 - Amount of functional units for food products related to the public sector for 2000

	Domestic production	Imports				Exports
	(EU15)	Within Europe	By ship	By plane	Total	
	[1000 tons]	[1000 tons]	[1000 tons]	[1000 tons]	[1000 tons]	[1000 tons]
Wheat	5,744	1,379	75.1	0.13	1,455	2,277
Vegetables	3,064	920	1.9	0.05	922	971
Beef	403	110	2.7	0.11	113	125
Pork	959	223	5.4	0.23	229	285
Poultry meat	477	91	2.2	0.09	93	141
Milk - excluding butter	6,857	1,991	n.a.	n.a.	1,991	6,601

Source: Data from FAO (2002), and EUROSTAT (2002), Author's own calculation based on Horbach (2002)

9.5 Theoretical European public procurement relief potential (RP^{TEPP}) for food products

Within the calculation of the European public procurement relief potential, the domestic production, inside-EU imports and overseas imports were considered. The same as earlier the calculation of the European public procurement relief potential is based on the domestic consumption of the public sector. The following Table 66 to Table 71 show the calculated relief potentials.

Again all calculated relief potentials are on an annual basis and negative values indicate a decrease of environmental impacts in the specific impact categories, positive values indicate the opposite.

Table 66 - Theoretical European public procurement Relief potential for organic grown vegetables compared to conventional grown vegetables

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.03	t CFC-11-eq.	431	Global
Global Warming	34,893	t CO_2-eq.	4,255	Global
Acidification	0	t SO_2-eq.	0	Europe
Photochemical Oxidant Formation	0	t C_2H_4-eq.	0	Europe
Nutrification	0	t PO_4^{3-}-eq	0	Europe
Resource consumption (Energy)	0	GWh	Calc. not possible	--

Source: Author's own calculation based on Table 65, ICLEI, 2002

Table 67 - Theoretical European public procurement Relief potential for organic grown wheat compared to conventional grown wheat

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.06	t CFC-11-eq.	703	Global
Global Warming	-854,166	t CO_2-eq.	-104,167	Global
Acidification	-5,694	t SO_2-eq.	-76,952	Europe
Photochemical Oxidant Formation	-370	t C_2H_4-eq.	-14,806	Europe
Nutrification	-6,833	t PO_4^{3-}-eq	-604,505	Europe
Resource consumption (Energy)	-0.69	GWh	Calc. not possible	--

Source: Author's own calculation based on Table 65, ICLEI, 2002

Table 68 - Theoretical European public procurement Relief potential for organic poultry meat compared to conventional poultry meat

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.00	t CFC-11-eq.	31	Global
Global Warming	-143,878	t CO_2-eq.	-17,546	Global
Acidification	-992	t SO_2-eq.	-13,409	Europe
Photochemical Oxidant Formation	-131	t C_2H_4-eq.	-5,259	Europe
Nutrification	-1,290	t PO_4^{3-}-eq	-114,114	Europe
Resource consumption (Energy)	-0.14	GWh	Calc. not possible	--

Source: Author's own calculation based on Table 65, ICLEI, 2002

Table 69 - Theoretical European public procurement Relief potential for organic beef compared to conventional beef

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.01	t CFC-11-eq.	139	Global
Global Warming	-564,476	t CO_2-eq.	-68,839	Global
Acidification	-7,225	t SO_2-eq.	-97,639	Europe
Photochemical Oxidant Formation	-248	t C_2H_4-eq.	-9,935	Europe
Nutrification	-5,442	t PO_4^{3-}-eq	-481,383	Europe
Resource consumption (Energy)	-0.34	GWh	Calc. not possible	--

Source: Author's own calculation based on Table 65, ICLEI, 2002

Table 70 - Theoretical European public procurement Relief potential for organic pork compared to conventional pork

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.01	t CFC-11-eq.	129	Global
Global Warming	-444,367	t CO_2-eq.	-54,191	Global
Acidification	-2,614	t SO_2-eq.	-35,323	Europe
Photochemical Oxidant Formation	-413	t C_2H_4-eq.	-16,520	Europe
Nutrification	-3,973	t PO_4^{3-}-eq	-351,483	Europe
Resource consumption (Energy)	-0.44	GWh	Calc. not possible	--

Source: Author's own calculation based on Table 65, ICLEI, 2002

Table 71 - Theoretical European public procurement Relief potential for organic milk compared to conventional milk

Environmental Impact Category	Annual impact	Unit	Person Equivalents	valid
Ozone Depletion	0.00	t CFC-11-eq.	0.00	Global
Global Warming	-722,837	t CO_2-eq.	-88,151	Global
Acidification	-10,843	t SO_2-eq.	-146,521	Europe
Photochemical Oxidant Formation	-289	t C_2H_4-eq.	-11,565	Europe
Nutrification	-6,506	t PO_4^{3-}-eq	-575,507	Europe
Resource consumption (Energy)	0.00	GWh	Calc. not possible	--

Source: Author's own calculation based on Table 65, ICLEI, 2002

10 Sanitary Products

The product group "sanitary products" comprises the installations, for instance toilets, showers, water taps, etc. as well as the usage products like toilet paper, paper towels, etc. Within the RELIEF project, the partners decided to focus on the installations and within this segment on water saving devices for toilet cisterns and water taps.

Between the primary studied products like electricity, computers, food or busses and the product water saving toilet cisterns a difference, concerning the calculation of the relief potential, exists. This difference is the fact that for the calculation of the relief potential per functional unit of a water saving toilet cistern no LCA was underlying. Therefore the relief potential in this case is not expressed with help of the environmental indicators within the habitual environmental impact categories.

The functional unit of the water saving toilet systems and water taps is defined as one use of the device. The devices show their main environmental impacts during their use stage. The product specification focuses on whether water-saving devices are installed or not.

The calculation of the relief potential was performed with the help of population statistics.

10.1 Calculating the Relief potential for toilet systems

The relief potential per functional unit can easily be expressed as the amount of water saved during one use of the device comparing one without and one with water saving capabilities.

The fact that the number of functional units in the European Union as a whole, as well as for the European public sector is not available at a statistical level necessitates a calculation based on population statistics.

The calculations focus on the Theoretical European Public Procurement Relief potential, considering only the use of the devices (functional units) which may be attributed to the public sector. The main user groups considered are: public employees, assuming that besides the civil servants and office workers also policemen, teachers and firemen are included in this group. Definitely not included are armed forces.

Table 72 - Assumptions for toilet cisterns use through different user groups

	Days per year	Use frequency per day and person	Relief Potential per FU [l] for the toilet device	Relief Potential per FU [l] for the water tap device
Schools (pupils)	190	1.0	5.25	4.67
University (students)	200	1.5	5.25	4.67
Kindergarten (children)	220	3.0	5.25	4.67
Office (civil servants, office workers, teachers, policemen, firemen, etc.)	220	2.5	5.25	4.67

Source: ICLEI, Environmental calculation for toilet cisterns, Paper prepared within the scope of WP5 of the RELIEF project

It is assumed that per functional unit 5.25 l drinking water may be saved with a water saving toilet system. Furthermore, it is assumed that every use of the toilet system is followed by hand cleaning and that for one use of a water tap equipped with a water saving facility additional 4.67 l of drinking water may be economised.

10.2 Amount of functional units related to public procurement on the European level

The following Table 73 indicates the number of persons in the EU belonging to the considered user groups. Data on the user groups are available from many sources. The main sources are UNESCO databases and EUROSTAT databases (mainly NewCronos). The available data for children, pupils and students in both sources correlate very well. The data on children, pupils and students used for the calculations were those of the EUROSTAT database. For public employees the same data as for the calculation of the relief potential for computers, derived from OECD databases, were used.

Table 73 - Numbers of users in the 15 European member states

	Children in Kindergartens	Pupils	Students	Public employees
Austria	226,700	1,178,600	247,500	572,399
Belgium	428,134	1,801,794	358,214	686,999
Denmark	243,300	789,500	183,300	770,000
Finland	119,000	850,600	250,000	542,200
France	2,403,000	9,981,200	2,027,400	5,581,750
Germany	2,283,300	12,399,800	2,097,700	4,796,000
Greece	141,000	1,530,100	374,100	466,200
Ireland	3,100	857,200	142,800	168,400
Italy	1,592,300	7,333,300	1,869,100	3,573,600
Luxembourg	10,200	59,900	1,800	23,400
Netherlands	390,000	2,674,600	461,400	704,400
Portugal	210,200	1,724,500	351,800	772,450
Spain	1,124,800	6,340,600	1,746,200	1,891,800
Sweden	347,200	1,681,300	280,700	1,278,200
UnitedKingdom	1,151,500	11,293,000	1,938,400	3,681,430
Total	**10,673,734**	**60,495,994**	**12,330,414**	**25,509,228**

Source: EUROSTAT Database NewCronos 09. April 2002

10.3 Calculation of the theoretical European public procurement relief potential (RP^{TEPP}) for water saving devices related to the public sector

Table 74 - Theoretical european public procurement relief potential for water saving facilities

	Saved water - Toilet system [m^3 per year]	Saved water - Water tap [m^3 per year]
Austria	4,003,784	1,270,734
Belgium	5,828,670	1,713,661
Denmark	4,142,633	1,248,188
Finland	3,220,161	1,251,644
France	37,593,100	11,201,539
Germany	37,432,763	10,721,022
Greece	3,950,200	1,566,710
Ireland	1,576,964	589,559
Italy	26,094,889	8,931,795
Luxembourg	165,496	26,311
Netherlands	6,779,924	2,047,141
Portugal	5,233,066	1,769,713
Spain	18,435,018	7,060,732
Sweden	7,013,050	1,999,320
United Kingdom	28,937,823	9,241,069
Total/Average	**190,407,539**	**60,639,140**

Source: Author's own calculation based on Table 72, and Table 73

From Table 74 it can be seen, that an amount of 190,407,539 m^3 of drinking water related to the use of water-saving toilet cisterns and an additional amount of 60,639,140 m^3 of drinking water related the use of water-saving devices with the water tap may be economised in Europe per year.

In Table 75 the water prices in the different European countries are indicated for the year 1999. These prices mostly also include to a certain extent the costs for waste water management.

Table 75 - 1999 Water prices in the European countries

	Water Price [€/m^3]		Water Price [€/m^3]
Austria	1.119	Italy	0.895
Belgium	2.329	Luxembourg	1.076
Denmark	3.388	Netherlands	3.366
Finland	2.940	Portugal*	1.140
France	3.313	Spain	1.140
Germany	1.800	Sweden	2.770
Greece	1.214	United Kingdom	2.424
Ireland	0.721		
* Water price for Portugal not available, assumption: price is the same as in Spain!			

Source: Household water pricing in OECD countries, ENV/EPOC/GEEI(98)12/FINAL

Considering the water prices in Table 75 a total of 402,184,579 € related to the use of water saving toilet cisterns and a total of 124,923,824 € related to the use of water saving devices for the water taps, assigned to the European public sector, may be saved annually. Thus the entire sum of achievable savings amounts to 527,108,403 €.

Table 76 - Annual water use per capita in European countries [m^3/capita and year]

	Use of surface waters			Use of groundwater			Population in 1997
	1980	1990	1999	1980	1990	1999	
Belgium	n. a.	n. a.	666	n. a.	n. a.	63	10,181,000
Denmark	9	n. a.	4	226	246	138	5,284,000
Germany	n. a.	487	438 *	n. a.	98	93 *	82,061,000
Spain	934	809	897	137	142	138 *	39,323,000
France	n. a.	556	597 *	n. a.	110	103	58,608,000
Greece	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	10,498,000
Ireland	279	n. a.	264 *	37	n. a.	63 *	3,661,000
Italy	n. a.	n. a.	707 **	n. a.	n. a.	212 **	57,563,000
Luxemburg	n. a.	n. a.	68	n. a.	n. a.	74	424,000
Netherlands	581	453	227 *	72	70	75 *	15,277,000
Austria	293	333	309	150	153	132	8,072,000
Portugal	875	426	n. a.	206	309	n. a.	9,950,000
Finland	736	420	243	40	48	53	5,140,000
Sweden	423	277	235 *	72	71	73 *	8,848,000
United Kingdom	213	201	217	45	47	41	58,105,000
* last available data from 1995				** last available data from 1985			

Source: http://wko.at/up/udb/neu/Directories/622/, March 2003

From Table 76 it may be derived, that the weighted[12] average per capita water consumption in the European Union is about 613 m^3/per capita and year. The calculated water savings,

12 $$\text{Average} = \frac{\sum_i \left((C_{Surface} + C_{Ground})_{Country\ i} \cdot Population_{Country\ i} \right)}{\sum_i Population_{Country\ i}}$$

assigned to the European public sector, correspond to 310,616 PE regarding water saving toilet devices and 98,922 PE regarding water saving water taps. Altogether an annual saving of 409,538 PE may be achieved.

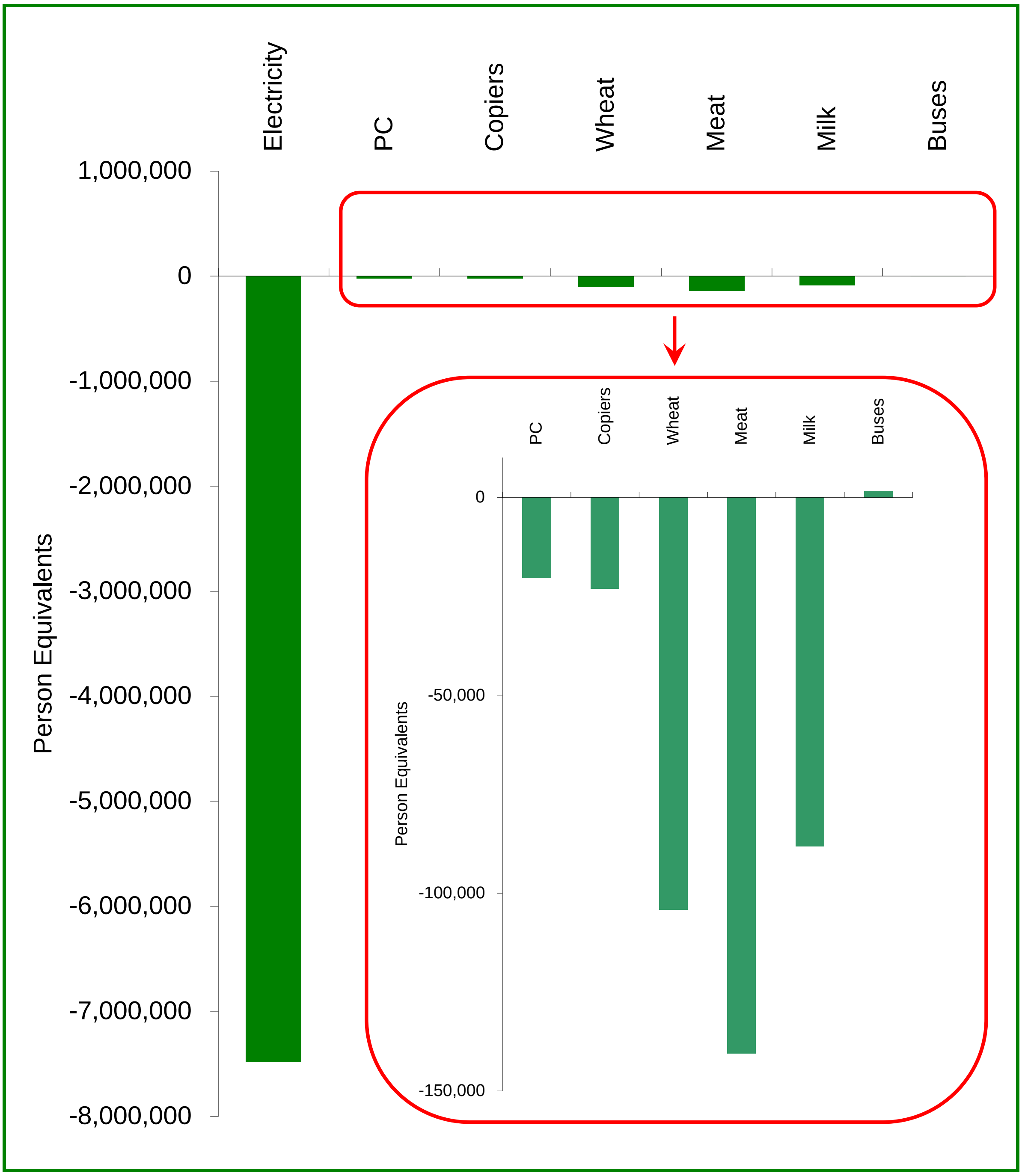
11 Comparative overview of the results

As already mentioned the comparison of the results may only take place within the single environmental impact categories. In the following sections thus the relief potentials related to public procurement are shown graphically for those environmental impact categories, for which a calculation for all considered products was possible.

11.1 Global warming

Within the environmental impact category "global warming" the annual relief potential of electricity generated from renewables is by far the highest of all considered products.

Figure 2 - Annual relief potential of different products within the environmental impact category "global warming" achievable by a change in public procurement practice



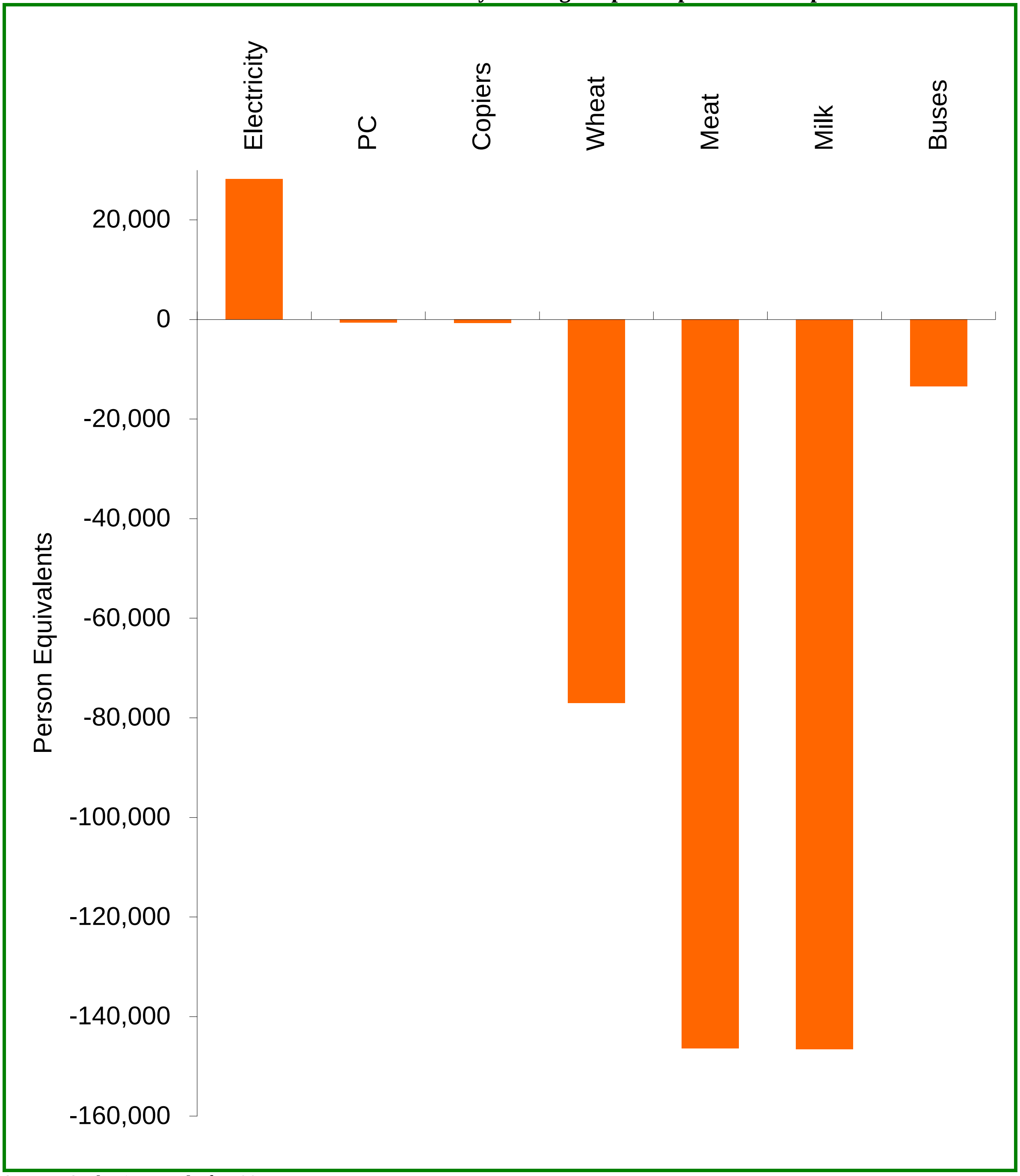
Source: Author's own draft, 2002

However also the annual relief potentials of the other products, especially the ones of organic food products may be considered as significant. The annual relief potential for organic wheat, organic meat and organic milk accounts together for more than 300.000 person equivalents.

11.2 Photochemical oxidant formation

Within the environmental impact category “photochemical oxidant formation” a completely different situation can be observed. The assumed mix of electricity from renewables will increase the emissions of photochemical oxidant formers, which is exclusively related to the use of biomass. The highest annual relief potential achievable through public procurement may be obtained by a change towards organic foodstuffs.

Figure 3 - Annual relief potential of different products within the environmental impact category “Photochemical oxidant formation” achievable by a change in public procurement practice

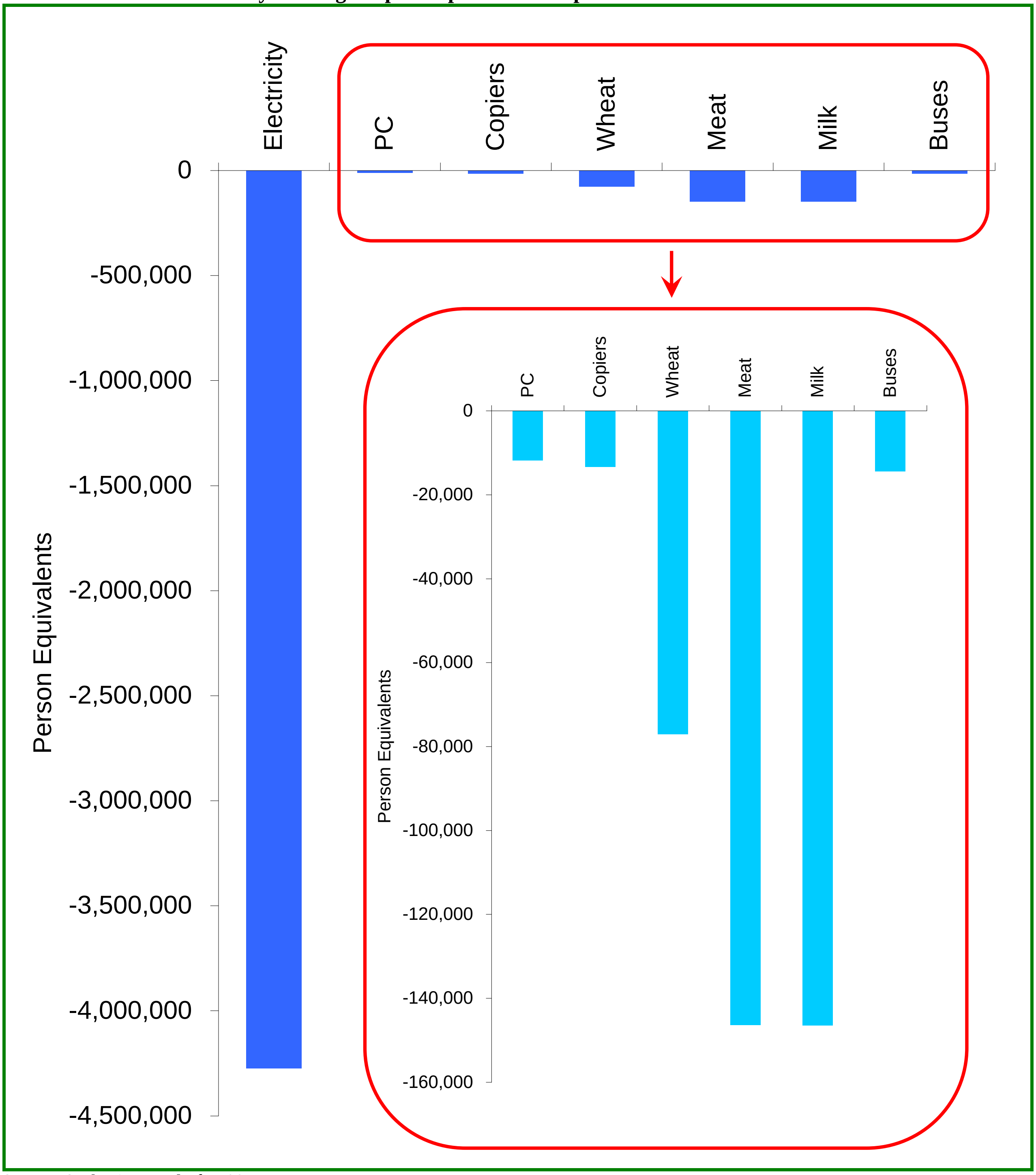


Source: Author’s own draft, 2002

11.3 Acidification

Within the environmental impact category “acidification” the picture is quite similar to the one in the category “global warming”.

Figure 4 - Annual relief potential of different products within the environmental impact category “acidification” achievable by a change in public procurement practice



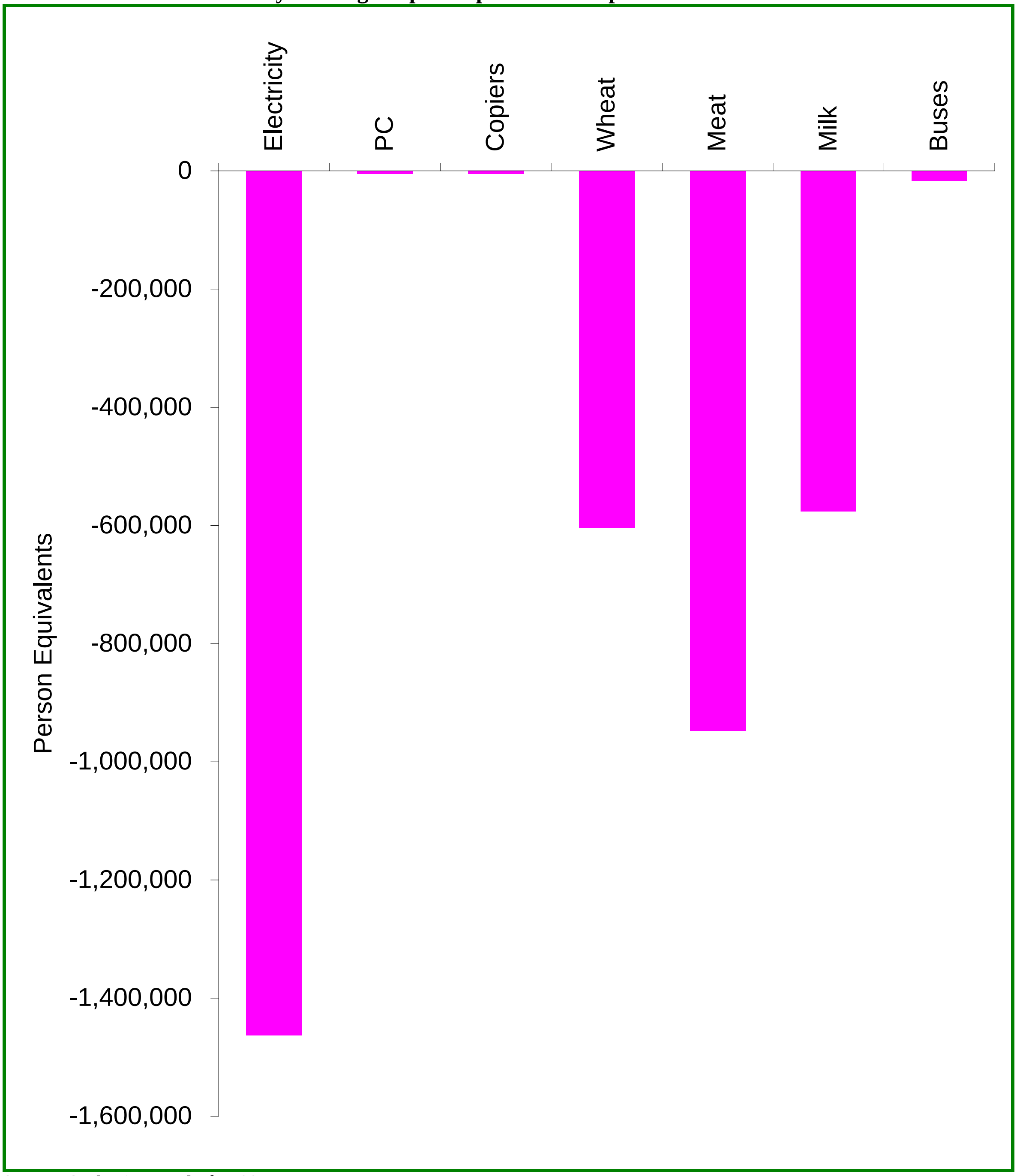
Source: Author's own draft, 2002

Electricity from renewable sources has by far the highest annual relief potential, but the relief potential of organic food also isn’t negligible.

11.4 Nutrification

For the environmental impact category “nutrification”, the same as for “photochemical oxidant formation” the biggest relief potential may be achieved through a change towards organic foodstuffs. Especially the product “organic meat” shows a significant relief potential. This seems to be an important finding, because the high level of meat consumption within the industrialised countries is known to have significant negative effects on population health. A changeover to organic produced meat may therefore on the one hand reduce the high environmental impacts of meat production (at least concerning nutrition) and on the other hand might also improve the health situation. This finally could be enforced additionally by the promotion of a lower meat consumption in general.

Figure 5 - Annual relief potential of different products within the environmental impact category “nutrification” achievable by a change in public procurement practice



Source: Author's own draft, 2002

The annual relief potential related to the category “nutrification” for all products (assuming a complete change in public procurement) accounts for more than 3.5 million person equivalents, which constitutes approx. 1 % of the annual European emissions contributing to the environmental impact category “nutrification”.

12 Conclusions

The calculation of the European relief potentials for the product groups: electricity, personal computers, copiers, buses, organic food and water saving devices results a significant potential to reduce environmental burdens. Also the corresponding part assigned to the procurement behaviour of the public sector is of high importance.

The calculation of the relief potential as outlined in this report is however, associated with a significant lack of statistical data. Especially comprehensive and up-to data statistical data about the consumption of the public sector is often unavailable, in particular at the necessary level of detail required to use the methodology developed in the RELIEF-project.

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