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## The European Relief Potential of Green Public Procurement: Methodology and Results

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# The European Relief Potential of Green Public Procurement: Methodology and Results

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**Abstract:** Green procurement often is considered as a complementary tool for environmental policy. A change in procurement practice, focusing on environmentally compliant products, is assumed to have a huge potential in reducing environmental burdens. Green public procurement in particular also could serve as a positive example for procurement in general. One of the targets within the European research project RELIEF<sup>1</sup> was to calculate this relief potential for the first time.

Based on the comparison of products with regard to their environmental impacts over their lifecycle, the relief potentials, in terms of saved environmental impacts on the European level, for the respective environmental impact categories familiar from lifecycle assessment were determined. As an appropriate basis to perform the comparisons a measurable common functional unit derived from the service function of the compared product alternatives was used.

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<sup>1</sup> Environmental Relief Potential of Urban Action on Avoidance and Detoxification of Waste Streams through Green Public Procurement

The RELIEF project was funded under the 5th Framework Programme: Thematic Programme: Energy, environment and sustainable development, Key action: 'The City of tomorrow and Cultural Heritage', by the European Commission

Partners in the RELIEF project were:

- International Council for Local Environmental Initiatives, Freiburg, Germany (Project Coordinator)
- Institute of Public Finance and Infrastructure Policy, Vienna University of Technology, Vienna, Austria
- Institute for Environmental Studies, University of Amsterdam, Netherlands
- dk Teknik, Energy and Environment, Copenhagen, Denmark
- Inter- University Research Center for Technology, Work and Culture, Graz, Austria
- Centre for Environmental Studies, Budapest, Hungary
- Chair of Business Management, especially Environmental Management, Dresden University of Technology, Dresden, Germany
- City of Hamburg, Germany
- City of Kolding, Denmark
- City of Malmö, Sweden
- City of Miskolc, Hungary
- City of Stuttgart, Germany
- City of Zürich, Switzerland

The product groups for which the relief potentials were calculated were selected in close cooperation with the city-partners in the RELIEF project in order to consider those products having a high relevance for the public authorities. The calculation of the relief potential was performed for electricity, personal computers, copiers, buses and food.

The relief potentials related to a change in public procurement practice expressed in person equivalents for the most important environmental impact categories amount to  $7.8 \times 10^6$  person equivalents for 'global warming',  $4.6 \times 10^6$  person equivalents for 'acidification' and  $3.6 \times 10^6$  person equivalents for 'nutrification'.

## 1. Introduction

The 1990's brought the insight that environmental problems could not be solved through environmental policy alone. As a consequence the concept of sustainable development evolved, which integrates social environmental and economic policy objectives. Thus, the need for an integrative policy became obvious. Environmental, social and economic considerations shall be part of all other policy fields.

*Green purchasing - or eco-procurement - encompasses all activities that aim to integrate environmental considerations into the purchasing process, from the identification of the need, through the selection of an alternative, to the provision to the user. Green purchasing tries to avoid unnecessary purchases by reviewing the actual need for the product and seeking other solutions. If this is not possible, it seeks to purchase a greener variant that supplies the same (or better) quality and functionality as the conventional choice [SEE ERDMENGER, P.11].*

The implementation of eco-procurement into public procurement is of high importance. Public purchasing for a long time has been used as a tool for achieving public policy goals. Historically, national industrialisation has been supported by public purchasing from domestic heavy industry. In the same way the supply of environmentally friendly products could be fostered, since the public authorities act as a market participant and the magnitude of their procurement has the ability to influence the market. The thorough introduction of eco-procurement into public procurement practice has the capability to serve as a general model for private procurement too.

*Most policy documents on sustainable development mention eco-procurement as a complementary tool. In fact the potential environmental impacts of green purchasing have not even been calculated [SEE ERDMENGER, P. 11].*

## 2. The RELIEF project

To close this gap, the RELIEF project, funded under the key action programme "City of Tomorrow and Cultural Heritage" within the 5<sup>th</sup> Framework Programme of the European Commission, was designed. The RELIEF project was divided into a research and an implementation phase. Within the research phase methods for assessment and calculation were developed and applied. The present paper refers to one of the principal items in this phase, namely the calculation of the European relief potential. In order to enable the calculation of relief potentials, an intense

co-operation between economists, natural scientists and public authorities was essential. The RELIEF project started in February 2001 and was finalised in November 2003.

### 3. Basics for quantification of environmental benefits within the procurement of products

The quantification of the environmental benefits of green purchasing has to be based on the comparison of the purchased products and their alternatives causing different environmental burdens. However, this is only reasonable if the considered products have the same purpose or in other words, if the product alternatives possess the same service function.

The **service function** of a product specifies the service provided by the use of a product. For instance the service function of a heavy goods vehicle consists in transporting goods. Thus, a heavy goods vehicle and a freight train provide the same service function. The dimension of the service function should be a commensurable physical value named **functional unit** e. g. for the transport of goods the physical value: transportation work (transportation work = mass × distance [ton-km]) can be used as functional unit.

The **relief potential** concerning procurement represents the magnitude of the reduction of potential environmental impacts, expressed by means of suitable indicators, which can be achieved by purchasing a specific quantity of a particular 'green' product instead of a 'non-green' product. In other words, it is the difference between potential environmental impacts of a particular combination of a 'green' product and a 'non-green' product in terms of avoided environmental impacts for a given number of functional units.

The determination of the relief potential consequently requires the knowledge of the potential environmental impacts per functional unit of a 'non-green' product as well as those of that 'green' product which substitutes the 'non-green' one. Additionally, the number of functional units relevant on the European level or the European public sector is a mandatory input.

In order to determine the environmental burdens of products in their entirety, it is necessary to consider the whole **lifecycle** of the products. In a simplified view the lifecycle of a product can be divided in four stages: raw materials extraction, manufacturing, use and disposal. In general different products have potential environmental impacts of different magnitude during the specific lifecycle phases. For a given product also each lifecycle stage may have different types of potential environmental impacts.

*The best approach to identifying and quantifying the environmental impacts from cradle to grave for one or more products is **called lifecycle assessment**. A lifecycle assessment addresses the whole lifecycle and includes a broad range of environmental impacts [SEE SCHMIDT ET AL, P. 135].*

A general framework how a lifecycle assessment has to be carried out has been described in a series of ISO<sup>2</sup> standards published in the period of

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<sup>2</sup> International Organisation for Standardisation

1997 to the present. Generally, a lifecycle assessment is divided into four stages. The first stage consists in the definition of the **goal and scope of the study**. The second stage comprises the collection of information on the interactions with the environment for all activities in the lifecycle of a product is called **inventory analysis**. The third stage called **impact analysis** is aimed at the evaluation of the significance of potential environmental impacts, by using the results of the inventory analysis. In general, this involves the association of inventory data with specific environmental impacts. In this stage of the lifecycle assessment the inventory data are assigned to impact categories like global warming ozone depletion, nutrification, etc. This allows the aggregation of different contributions to the same impact category and to express them with a single indicator value, like CO<sub>2</sub>-equivalents in the case of global warming, CFC-11-equivalents in the case of ozone depletion and NO<sub>2</sub><sup>-</sup>- or PO<sub>4</sub><sup>4-</sup>-equivalents in the case of nutrification (see Table 1). The final stage of a lifecycle assessment is called **interpretation**. Therein the findings of the inventory assessment and the impact assessment are combined.

#### 4. The scientific approach for determination of the relief potential per functional unit

The determination of a relief potential, as already mentioned, is based on the comparison of products having the same service function, but different environmental impacts. Generally a relief potential can be calculated using one of the following procedures:

1. Determination of the difference in environmental impacts resulting from the comparison of two existing products considering their respective entire lifecycles, e. g. two buses are compared by comparing every single component of the two vehicles over their respective entire lifecycle. The precondition for this procedure is the availability of lifecycle assessments of the same quality (basically using identical system boundaries as well as impact categories) for each and every component of both products, a request which in most cases proves to be impracticable.
2. Determination of the difference in environmental impacts resulting from the comparison of two existing products considering only those components of the products which primarily determine the products' service function over the entire lifecycle, e. g. not every component of two buses is considered, but only those components mainly responsible for the service function, namely the engines. For products comprising a high number of components, this procedure is easier operable since the requirements regarding the number and the scope of the underlying lifecycle assessments is not that demanding.

The structural complexity of many products and the unavailability of comprehensive lifecycle assessments for many products make simplifications unavoidable.

In the RELIEF project a procedure for setting up a lifecycle assessment-based environmental calculation was developed [SEE SCHMIDT ET AL, P. 140].

As a result of this methodology a relief potential is obtained, which describes the difference between environmental impacts of a 'green'

product and the ones of a respective 'non-green' product. It is expressed as the value of the specific category indicator per functional unit for each environmental impact category common in lifecycle assessment.

The most important environmental impact categories considered by lifecycle assessment as well as their respective category indicators are shown in Table 1.

**Table 1 - Environmental impact categories common in lifecycle assessment**

Environmental impact category	Category indicator
Global warming	t CO <sub>2</sub> -equivalent
Stratospheric ozone depletion	g CFC11-equivalent
Photochemical oxidant formation	kg C <sub>2</sub> H <sub>4</sub> -equivalent
Acidification	kg SO <sub>2</sub> -equivalent
Nutrication	kg NO <sub>3</sub> <sup>-</sup> -equivalent
Human toxicity via air	m <sup>3</sup> air
Resource Consumption	GWh
Waste Formation	tonnes
CO <sub>2</sub>	Carbon dioxide
CFC-11	Chlorofluorocarbon
C <sub>2</sub> H <sub>4</sub>	Ethylene
SO <sub>2</sub>	Sulphur dioxide
NO <sub>3</sub> <sup>-</sup>	Nitrate
m <sup>3</sup> air	Refers to the amount of air necessary to dilute an emitted amount of toxic substances up to a concentration which turns out to be no longer toxic for humans

Source: Author's version based on SCHMIDT ET AL, TABLE 8.2, P 145, 2003

The relief potential per functional unit thus is not a single figure, but a vector of the magnitude of avoided environmental impacts in the respective environmental impact categories. The calculation is performed according to the following Formula 1:

**Formula 1 - Calculation of the relief potential per functional unit**

$$\begin{pmatrix} rp_{IC_1} \\ rp_{IC_2} \\ \vdots \\ rp_{IC_m} \end{pmatrix} = \begin{pmatrix} ei_{IC_1}^g - ei_{IC_1}^n \\ ei_{IC_2}^g - ei_{IC_2}^n \\ \vdots \\ ei_{IC_m}^g - ei_{IC_m}^n \end{pmatrix}$$

with: rp Relief potential per functional unit  
 IC Environmental impact category  
 ei Environmental impacts in terms of category indicator value per functional unit  
 g 'Green' product  
 n 'Non-Green' product  
 m Number of considered environmental impact categories m=1, 2, ..., m

Source: Author's version based on SCHMIDT ET AL, 2003

According to Formula 1 a negative value within a specific environmental impact category will denote an abatement of environmental burdens, if the 'green' product is purchased instead of the 'non-green' one. On the contrary a positive value within a specific environmental impact category will denote a rise of environmental burdens, if the 'green' product is purchased instead of the 'non-green' one.

In order to get a clear impression about the relative importance of the relief potential per functional unit a supplementary approach was chosen in the RELIEF project: the results are normalised so that the results may be expressed in **person equivalents**. *A person equivalent is the potential contribution from an average person in a year to a given environmental impact.* [SEE SCHMIDT ET AL, P. 143] For impacts of global relevance, like global warming or the depletion of the stratospheric ozone layer, the person equivalents relate to an average global citizen. For impacts having regional relevance, like acidification, nutrification etc. an average European citizen is assumed.

Taking global warming as an example of an impact with global relevance. The total world wide contributions to this impact in 1994 were 43.3 billion tonnes of CO<sub>2</sub>-equivalents from all anthropogenic sources. With about 5.61 billion world citizens in 1994 this equals an annual contribution of 7.7 tonnes of CO<sub>2</sub>-equivalents per person. In other words, one person equivalent in the environmental impact category global warming equals 7.7 tonnes CO<sub>2</sub>-equivalents [SEE SCHMIDT ET AL, P. 143].

**Table 2 - Person equivalents**

Environmental impact category	Person equivalents based on statistical data from 1994		
Global warming	1 PE <sub>G</sub>	≙	7.7 t CO <sub>2</sub> -equivalents
Stratospheric ozone depletion	1 PE <sub>G</sub>	≙	81 g CFC11-equivalents
Photochemical oxidant formation	1 PE <sub>EU</sub>	≙	25 kg C <sub>2</sub> H <sub>4</sub> -equivalents
Acidification	1 PE <sub>EU</sub>	≙	74 kg SO <sub>2</sub> -equivalents
Nutrification	1 PE <sub>EU</sub>	≙	24 kg NO <sub>3</sub> <sup>-</sup> -equivalents
Human toxicity via air	1 PE <sub>EU</sub>	≙	3.6x10 <sup>9</sup> m <sup>3</sup> air
PE <sub>G</sub>	Global person equivalent		
PE <sub>EU</sub>	European person equivalent		

Source: Author's version based on SCHMIDT ET AL, TABLE 8.2, P. 145, 2003

## 5. Products under investigation

Unfortunately, there are no detailed statistics available on public sector-consumption for different product groups. Therefore, the first step to be taken was to determine the products of high importance regarding public sector purchases.

For this reason six European cities (Stuttgart, Malmö, Zürich, Kolding, Miskolc, Hamburg) joined the RELIEF project as partners and thus provided data for the analysis of the importance of products for investigation in the RELIEF project. One approach in this context was to look at the actual spending of the respective administrations.

Regrettably, only few products are in detail recorded in the cities' budgets and often, no procurement monitoring system is in place to assemble the

respective data. Therefore, much of this data had to be collected from the individual departments and their book-keeping on certain purchases.

**Table 3 – Spending on selected product groups in six European cities in 1000 €**

Product group	Stuttgart (Germany)	Malmö (Sweden)	Zürich (Switzerland)	Kolding (Denmark)	Miskolc (Hungary)	Hamburg (Germany)
Cleaning products	155	n. a.	563	242	7	614
Energy	29,875	9,000	8,777	2,382	34	72,644
Food for canteens	307	12,000	12,850	1,910	0	n. a.
Furniture	2,390	4,000	6,461	336	3	5,215
IT equipment	8,104	675	19,799	957	67	15,364
Paper	464	1,400	573	146	17	409
Office equipment	1,699	100	721	282	14	256
Person Transport	1,164	5,979	n. a.	2,294	31	2,122
Renovation of buildings	44,686	n. a.	107,734	3,934	1,064	52,425
Road construction	n. a.	n. a.	n. a.	n. a.	2,198	64,985

n. a. not available

*Source: ERDMENGER P. 118, 2003*

Table 3 indicates the spending of the six local authorities involved in the RELIEF project. It is obvious that this data is not comparable. The cities have very different sizes and the administrations have different tasks. Also, product categories can be defined differently. Still this data provides indications about relevant and less relevant product groups [SEE ERDMENGER, P. 117-120].

The key findings of this investigation may be summarised as follows:

- Construction, energy, furniture and IT equipment are financially very important product groups for all six local authorities.
- The importance of food for canteens and public transport varies with the responsibility of the city.
- Product groups such as cleaning products (not the services!), office material and paper are of only minor financial importance.

Whether or not a specific product became subject of investigation was however, also dependant from the availability of environmental data (lifecycle assessments) and statistical market data. The products finally considered in the RELIEF project were:

- Electricity
- Personal Computers
- Copiers
- Buses
- Food products (Wheat, Meat and Milk)

## 6. The relief potential of procurement - The theory

The relief potential per functional unit for a given combination of a 'green' and a 'non-green' product, is a specific value related to this particular product combination. It therefore possess only a limited significance to answer the question what the potential environmental consequences on

the European level caused by a change in procurement practice towards environmentally friendlier products might be.

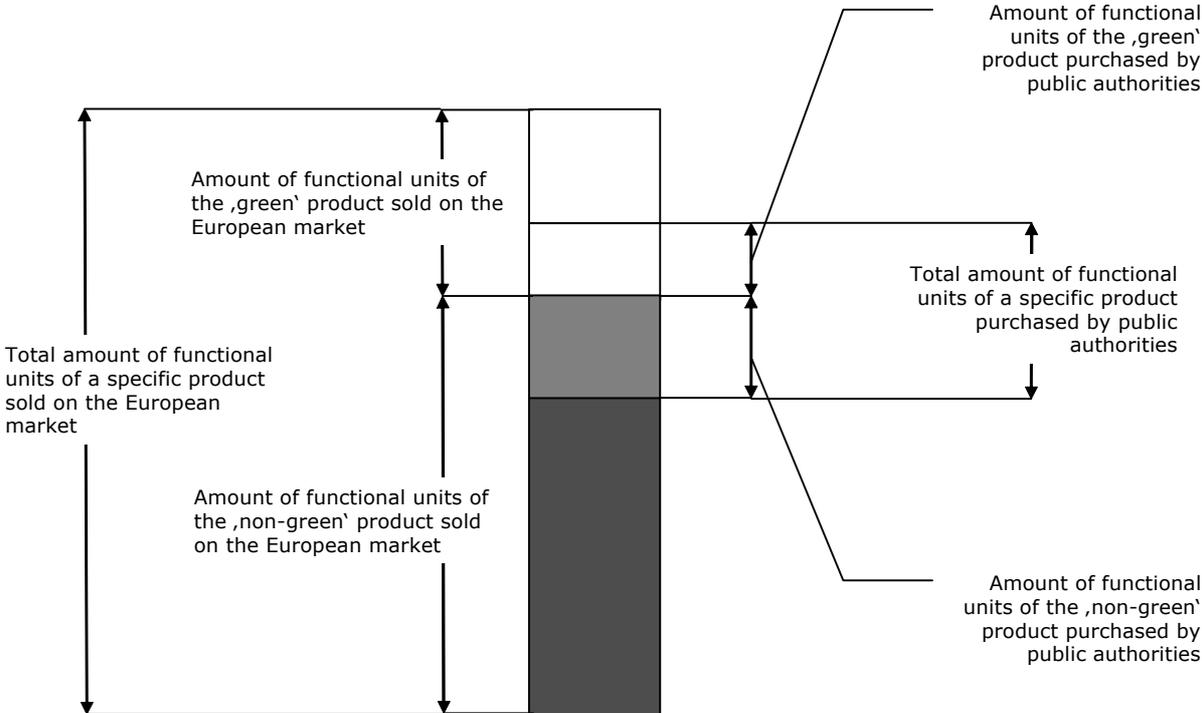
Thus, a main issue in the RELIEF project consisted in up-scaling the relief potential per functional unit to the European level and to figure out the importance of public procurement in this concern.

The order of magnitude of the relief potential within the area of procurement depends on the amount of functional units, which at a particular time:

- are requested from the market and
- are actually substitutable by an environmentally friendlier product.

Generally, the European market for a specific product may be subdivided in a share for the 'green' products and one for the 'non-green' products. 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.

**Figure 1 - Structure of the European market for a specific product**



Source: Author's version based on PIERRARD, 2003

The scientific partners in the project decided to concentrate on the calculation of the '**Theoretical European Market Relief Potential**' on the one hand, which focuses on the total functional units of a specific product on the whole European market. On the other hand the determination of the '**Theoretical European public procurement relief potential**', referring to the amount of functional units influenced by European public purchasers, was of high interest.

The theoretical approach to calculate these relief potentials is documented in the following Formula 2 and Formula 3.

Both relief potentials, the 'Theoretical European market relief potential', as well as the 'Theoretical European public procurement relief potential',

are based on the assumption that the 'non-green' amount of functional units for a specific product which is either available on the European market or purchased by public purchasers, is completely substituted by the respective 'green' product.

**Formula 2 - Calculation of the theoretical European market relief potential**

$$\begin{pmatrix} RP_{IC_1}^{EM} \\ RP_{IC_2}^{EM} \\ \vdots \\ RP_{IC_m}^{EM} \end{pmatrix} = \begin{pmatrix} rp_{IC_1} \times (nfu^{tm} - nfu^{tg}) \\ rp_{IC_2} \times (nfu^{tm} - nfu^{tg}) \\ \vdots \\ rp_{IC_m} \times (nfu^{tm} - nfu^{tg}) \end{pmatrix}$$

- with:  $RP^{EM}$  Theoretical relief potential for the European market for a specific product combination  
 $rp$  Relief potential per functional unit for a specific product combination  
 $IC$  Environmental impact category  
 $m$  Number of considered environmental impact categories  $m=1, 2, \dots, m$   
 $nfu$  Number of functional units for a specific product  
 $tg$  Total 'green'  
 $tm$  Total market

*Source: Author's version based on PIERRARD, 2003*

**Formula 3 - Calculation of the theoretical European public procurement relief potential**

$$\begin{pmatrix} RP_{IC_1}^{EP} \\ RP_{IC_2}^{EP} \\ \vdots \\ RP_{IC_m}^{EP} \end{pmatrix} = \begin{pmatrix} rp_{IC_1} \times (nfu^{tp} - nfu^{pg}) \\ rp_{IC_2} \times (nfu^{tp} - nfu^{pg}) \\ \vdots \\ rp_{IC_m} \times (nfu^{tp} - nfu^{pg}) \end{pmatrix}$$

- with:  $RP^{EP}$  Relief potential related to European public purchasing for a specific product combination  
 $rp$  Relief potential per functional unit for a specific product combination  
 $IC$  Environmental impact category  
 $m$  Number of considered environmental impact categories  $m=1, 2, \dots, m$   
 $nfu$  Number of functional units  
 $pg$  'Green' related to public purchasing  
 $tp$  Total related to public purchasing

*Source: Author's version based on PIERRARD, 2003*

**7. The relief potential of procurement - Coming down to earth**

For most of the products analysed, it was impossible to determine the European share of the 'green' product. Also investigations of the share of the 'green' product already purchased by public authorities on the European level proved to be a very time consuming task, which would have exceeded the framework of the RELIEF project by far.

Thus, the actual share of the 'green' product available on the European market on the one hand, and purchased by public purchasers on the other

hand was unknown. However, that share was not neglected, but implicitly included in the definition of an average product, which finally was used as the 'non-green' alternative in the calculations.

Taking electricity as an example, the share that 'green' electricity already has on the market contributes to slightly lower environmental impacts of average electricity, which is then considered as the 'non-green' product [see Section 8.1].

In analogy for personal computer systems the assumption was made that the average personal computer is one which complies at least with minimum Energy Star requirements. This assumption is justified by a market survey showing that almost no personal computers lacking an Energy Star label are available on the market anymore [see Section 8.2].

The same applies to the product line-buses. The average bus is considered to comply already with the actual Euro III specification [see Section 8.4].

Sometimes though, the implicit consideration of the amount of functional units of the 'green' product already available on the market was not possible e. g. for food products [see Section 8.5]. Thus, the calculated theoretical relief potentials might more or less exceed the actual figures.

The availability of market data on the number of functional units influenced by the decisions of public purchasers or traded on the European level also is a major constraint in calculating the European relief potential of products. As a result of the RELIEF project it became clear that nearly every product needed a different approach for determining the relevant amount of functional units.

Nevertheless, the general approach for the calculation of the relief potential remained to be the determination of the amount of total functional units of the specific product traded on the European market, as well as the determination of the corresponding amount of functional units influenced by the public sector.

The results of these investigations then were 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 average product being the object of investigation. Among the variety of products the 'green' product was by definition the one which showed the least environmental impacts for most of the considered environmental impact categories.

Finally, the calculated relief potentials were expressed in person equivalents to enable the comparison of the relief potentials within the same environmental impact category for the different products. Nevertheless, 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.

Furthermore, the calculated relief potentials for the respective products were calculated on an annual basis. The relief potential over the whole lifetime of the product then may be easily calculated by linear extrapolation.

For reasons of feasibility and transparency for the purchaser, it was necessary to reduce the number of impact categories, as they are

predefined in the lifecycle assessment procedure, to the 4 or 5 most important ones. Thus, the calculated relief potentials do not represent the whole range of environmental impacts but concentrate on the politically most important, or the most momentous ones.

## 8. Selected results [SEE PIERRARD, 2003]

Because of its dependence on local circumstances, the local information [see Section 5] could not easily be extrapolated to the European level, therefore other information sources had to be tapped into. These had to be individually identified for every product being under investigation.

### 8.1. Electricity

The functional unit for electricity is one GWh of consumed electricity. The main environmental impacts occur during the production stage.

'Green' electricity was assumed to be electricity generated from renewable energy sources in accordance with the European directive 2001/77/EG. The European average electricity mix was considered as the 'non-green' product.

The main data source for the determination of the total amount of functional units on the European market are the International Energy Agency databases [see IEA, 2002]. The observed consumption of electricity in Europe (EU-15) for the year 1999 amounted to 2,232,669 GWh.

The amount of functional units related to the consumption of public authorities in 1999 was determined, using various national electricity reports, to be about 6.2% or 148,460 GWh.

### 8.2. Personal Computers

For personal computers the functional unit is one PC consisting of a central processing unit and a computer screen. The main environmental impacts occur during the use stage as a result of the use of electrical power. A likely use pattern for an average office PC was assumed.

The 'green' PC was identified as being one with low energy consumption according to a good Energy Star standard, equipped with a thin film transistor (TFT) display. As the average product a PC complying with minimum Energy Star requirements, equipped with a cathode ray tube display was assumed.

The amount of functional units sold on the European market for the year 2000 was 27,431,912 units [SEE EITO, 2001]. Statistical data on the number of purchased units by public authorities were not available. Therefore, the calculation of the amount of functional units related to the public sector was based on population statistics. The number of public employees in EU-15 was retrieved from OECD-statistics [SEE OECD, 2001], it was multiplied with the share of white collar workers obtained from an EUROBAROMETER survey [SEE EUROBAROMETER, 1994] and with the number of business PC's per white collar worker [SEE EITO, 2001] and finally divided by the annual replacement rate of PC's in the public sector. The replacement rate was assumed to be 5, i. e. every PC is replaced after 5 years. Thus, a number of annual purchased PC's by public authorities of 2,836,512 units or a share of 10.3 % results.

### 8.3. Copiers

For copiers the functional unit is one copier. From lifecycle assessments the use stage was identified as the one causing the most environmental impacts as a result of the use of electricity. A likely use pattern assuming 1,500 copies a day or 2,250,000 copies a year was assumed.

As the 'green' copier an appliance with enhanced energy saving capabilities complying with good Energy Star requirements was identified. The average copier is one possessing no energy saving capabilities.

The copiers sold on the European market during the year 2000 amount to 1,418,637 units [SEE EITO, 2001]. The share of 14.75% or 209,184 units purchased by the public sector was derived from European Input-Output statistics [SEE HORBACH, 2002].

### 8.4. Line-Buses

The functional unit for line-buses is one bus-km. The main environmental impacts occur during the use stage as a result of fuel consumption.

The 'green' bus is defined to be one complying to EURO IV specification despite the fact that such buses are at present time not yet available on the market. Buses complying to the EURO III specification are considered as the average and therefore 'non-green' product.

The number of newly registered buses and coaches in Europe in the year 1999 was 30,957 [SEE ACEA, 2002]. A survey among producers showed that approx. 50% of these vehicles are line buses, the remaining are coaches. Assuming that a bus drives 100,000 km a year an annual number of functional units of 1,547,850,000 bus-km results. The producer survey also showed that approx. 48% of the line-buses are purchased by public authorities. Thus, a share of the public sector of 24% or an amount of functional units of 742,968,000 bus-km may be calculated.

### 8.5. Food products

The functional unit for food products is 1000 tonnes of consumed food. The main environmental impacts occur during the production stage, mainly within the agricultural sector.

The 'green' product is one, which is grown under consideration of the rules of organic farming, as they are stipulated in the 'Council Regulation (EEC) No 2092/91 of 24. June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs'. Food products produced by conventional farming are considered to be the average or 'non-green' products. Within the RELIEF project the relief potential for wheat representing the product group cereals, for meat including beef, poultry and pork as well as for milk was determined.

The number of functional units consumed on the European level for the year 2000 was retrieved from FAO databases [SEE FAO, 2002]. Wheat amounts to 90,389 units, meat to 31,649 units and milk to 114,757 units. The share of 3.15% or 2,887 units for wheat, 997 units for meat, and 3,615 units for milk, purchased by the public sector was derived from European Input-Output statistics [SEE HORBACH, 2002].

Considering all this information as well as the scientific approach for the determination of the relief potential per functional unit presented in Section 4 and 7 the relief potentials per functional unit for the considered products were calculated and are shown in Table 4. Negative numbers indicate a decrease of environmental impacts, and positive numbers an increase of environmental impacts in the respective environmental impact category.

**Table 4 - Relief potential per functional unit for different products in person equivalents per functional unit**

Product group	Electricity [1Gwh]	Personal Computers [1 Unit]	Copiers [1 Unit]	Buses [1 bus-km]	Wheat [1000 tonnes]	Meat [1000 tonnes]	Milk [1000 tonnes]
Global warming	-50.4	-7.2x10 <sup>-3</sup>	-110x10 <sup>-3</sup>	2.0x10 <sup>-6</sup>	-36.6	-479.3	-24.4
Stratospheric ozone depletion	n. a.	n. a.	n. a.	n. a.	0.2	1.0	0.0
Photochemical oxidant formation	0.2	-0.2x10 <sup>-3</sup>	-3x10 <sup>-3</sup>	-1.8x10 <sup>-5</sup>	-5.2	-96.8	-3,2
Acidification	-28.8	-4.2x10 <sup>-3</sup>	-64x10 <sup>-3</sup>	-2.0x10 <sup>-5</sup>	-27.0	-554.1	-40.5
Nutrition	-9.9	-1.5x10 <sup>-3</sup>	-2x10 <sup>-3</sup>	-2.3x10 <sup>-5</sup>	-212.3	-3,264.3	-159.2
Human toxicity via air	n. a.	n. a.	n. a.	-9.5x10 <sup>-6</sup>	n. a.	n. a.	n. a.

n. a. not available

Source: Author's version based on PIERRARD, 2003

**Table 5 – Market volumes in the European Union and of European public authorities for selected products**

Product	Functional unit	Annual functional units European market	Annual functional units public sector	
Electricity	Consumption of 1 GWh	2,232,669	148,460	6.2%
Personal Computers	1 Unit	27,431,912	2,836,512	10.3%
Copiers	1 Unit	1,418,637	209,184	14.8%
Buses	1 bus-km	1,547,850,000	742,968,000	24.0%
Wheat		90,389	2,847	
Meat	Consumption of 1000 tonnes	31,640	997	3.15%
Milk		114,737	3,614	

Source: Author's version based on PIERRARD, 2003

Based on the data shown in Table 4 and Table 5 the 'Theoretical European Market Relief Potential' and the 'Theoretical European public procurement relief potential' were determined. The results of these calculations are presented in Table 6 and Table 7.

**Table 6 – Relief potentials of selected products for the whole European market**

Environmental impact category	Electricity	Personal Computers	Copiers	Wheat	Meat	Milk	Buses
Global warming [PE]	-112,517,000	-196,300	-156,400	-3,306,900	-4,462,800	-2,798,500	3,100
Stratospheric ozone depletion [PE]	n. a.	n. a.	n. a.	22,300	9,500	0.0	n. a.
Photochemical oxidant formation [PE]	424,400	-6,100	-4,900	-470,000	-1,006,800	-367,200	-27,900
Acidification [PE]	-64,273,300	-114,200	-91,000	-2,442,900	-4,646,800	-4,651,500	-30,000
Nutrification [PE]	-21,995,000	-41,800	-33,300	-19,190,800	-30,063,200	-18,270,300	-35,100
Human toxicity via air [PE]	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	-14,800
Resource Consumption [GWh]	-2,750,600	-9,900	-2,200	-20	-30	-10	130
Waste Formation [t]	-100,928,000	-163,800	-130,500	n. a.	n. a.	n. a.	n. a.
n. a. not available PE Person Equivalent							

Source: Author's version based on PIERRARD, 2003

**Table 7 – Relief potentials of selected products for the whole European market under influence of the public sector**

Environmental impact category	Electricity	Personal Computers	Copiers	Wheat	Meat	Milk	Buses
Global warming [PE]	-7,481,800	-20,300	-23,100	-104,200	-140,600	-88,200	1,500
Stratospheric ozone depletion [PE]	n. a.	n. a.	n. a.	700	300	0.0	n. a.
Photochemical oxidant formation [PE]	28,200	-600	-700	-77,000	-31,700	-11,600	-13,400
Acidification [PE]	-4,273,800	-11,800	-13,400	-77,000	-146,400	-146,500	-14,400
Nutrification [PE]	-1,462,500	-4,300	-4,900	-604,500	-947,000	-575,500	-16,900
Human toxicity via air [PE]	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	-7,100
Resource Consumption [GWh]	-182,900	-1,000	-300	-1.0	-1.0	-0.4	60
Waste Formation [t]	-6,711,100	-16,900	-19,200	n. a.	n. a.	n. a.	n. a.
n. a. not available PE Person Equivalent							

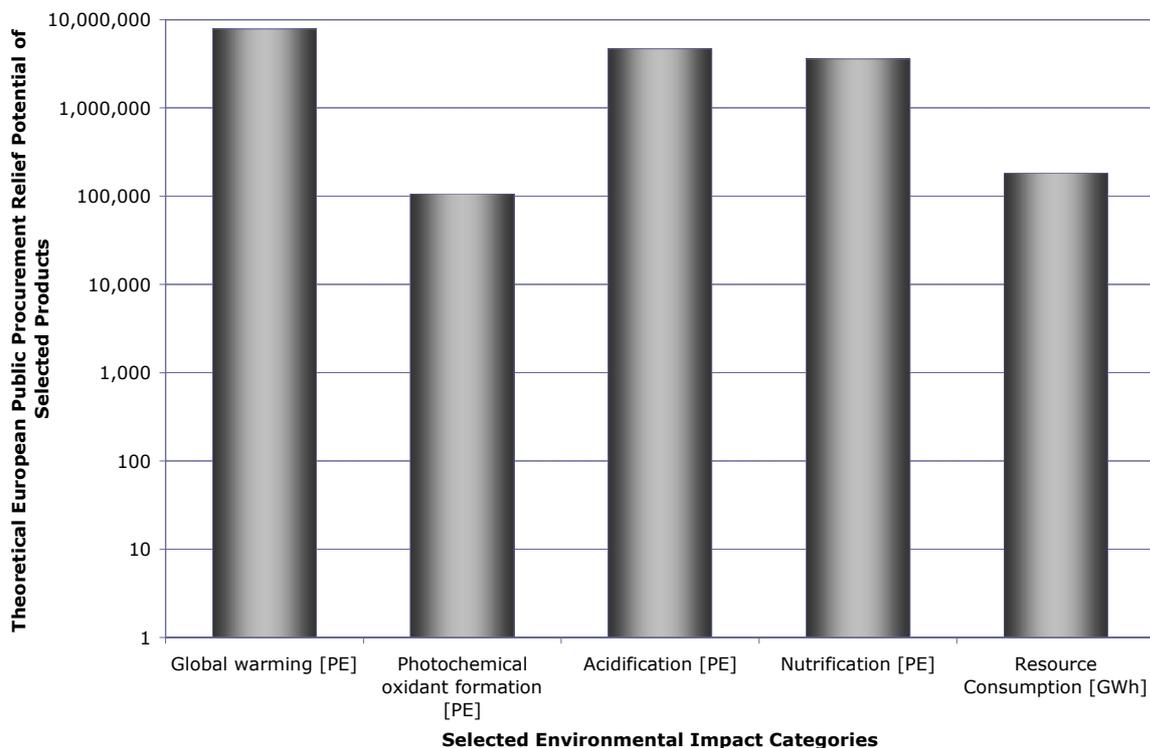
Source: Author's version based on PIERRARD, 2003

**Table 8 - Total relief potentials for all products in selected environmental impact categories**

Environmental impact category	Theoretical European market relief potential	Theoretical European public procurement relief potential
Global warming [PE]	123.4x10 <sup>6</sup>	7.86x10 <sup>6</sup>
Photochemical oxidant formation [PE]	1.5x10 <sup>6</sup>	0.11x10 <sup>6</sup>
Acidification [PE]	76.2x10 <sup>6</sup>	4.68x10 <sup>6</sup>
Nutrification [PE]	89.6x10 <sup>6</sup>	3.62x10 <sup>6</sup>
Resource Consumption [GWh]	2.8x10 <sup>6</sup>	0.18x10 <sup>6</sup>

Source: Author's version based on Table 6 and Table 7

**Figure 2 - Total relief potential of the selected products in selected environmental impact categories achievable by European public procurement**



Source: Author's version based on Table 7

## 9. Conclusions

Considering the results presented in Table 8 and Figure 2 for the 'Theoretical European public procurement relief potential' for those environmental impact categories for which the contribution of all products could be determined, it becomes obvious that public purchasing is a key tool for 'greening' the market place. Green public procurement therefore, is far from being only a complementary policy tool to accompany the 'real' mechanisms presumed of being able to change the environmental situation significantly.

The chosen approach to calculate the relief potential of products seems to be rather academic at the first glance. However, appearances are deceptive. The simplifications made in the RELIEF project, like the focus on the most relevant service functions, the most polluting lifecycle stages as well as the concentration on those environmental impact categories

depicting the most urgent environmental problems, on the one hand and an adequate flexibility for the determination of the market volumes of the different products under consideration on the other hand, provide results with a reasonable range of accuracy to serve as an input for the decision making process of purchasers.

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