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

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1. Introduction

The total expenditures for public procurement within the EU-15 countries for the year 2002 was estimated to amount to 1.5 trillion €, which is about 16 % of the Union's GDP. The Importance of total public procurement by Member State varies significantly: from 11.9 % of GDP in Italy to 21.5 % of GDP in the Netherlands.

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.

Public procurement in the European Union is subject to many legislative rules (92/50/EEC 93/37/EEC, 93/36/EEC, 93/38/EEC, 97/52/EC, 98/4/EC), mainly aiming at increasing transparency of public procurement activities as well as increasing cross border procurement in order to reduce the expenditures for public procurement. Finally also environmental, social and consumer protection aspects are taken into account (2004/17/EC, 2004/18/EC).

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 (Erdmenger 2003, 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, because 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.

Green public procurement can promote "green markets" and thus act as a stimulus for environment oriented innovation in companies.

Technological change is always connected with social change and rooted in social systems and organisational networks (Mulder et al. 1999). It is guided by engineering ideas and very much driven by economics and policies, procurement policy; especially public procurement policy can play a mayor role in this concern.

Most policy documents on sustainable development mention eco-procurement as a complementary tool to environmental policy. In fact the potential environmental impacts of green purchasing have not even been calculated (Erdmenger 2003, p. 11).

2. The RELIEF project

To close this gap, the project named: 'Environmental Relief Potential of Urban Action on Avoidance and Detoxification of Waste Streams through Green Public Procurement' (RELIEF), funded under the key action programme "City of Tomorrow and Cultural Heritage" within the 5th 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 will be 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 (Schmidt 2003, p. 135).

A general framework how a lifecycle assessment has to be carried out has been described in a series of ISO (International Organisation for Standardisation) standards published in the period of 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** aimes at the evaluation of the significance of potential environmental impacts, by using the results of the inventory analysis. In general, this involves the combination 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_2-equivalents in the case of global warming, CFC-11-equivalents in the case of ozone depletion and NO_2^-- or PO_4^{4-}-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 (Schmidt 2003, 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_2-equivalent
Stratospheric ozone depletion	g CFC11-equivalent
Photochemical oxidant formation	kg C_2H_4-equivalent
Acidification	kg SO_2-equivalent
Nutrification	kg NO_3^--equivalent
Human toxicity via air	m^3 air
Resource Consumption	GWh
Waste Formation	tonnes

CO_2 Carbon dioxide CFC-11 Chlorofluorocarbon C_2H_4 Ethylene SO_2 Sulphur dioxide NO_3^- Nitrate m^3 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 2003, table 8.2, p 145

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

$$\begin{pmatrix} rp_{IC_1} \\ rp_{IC_2} \\ \vdots \\ rp_{IC_m} \end{pmatrix} = \begin{pmatrix} ei^g_{IC_1} - ei^n_{IC_1} \\ ei^g_{IC_2} - ei^n_{IC_2} \\ \vdots \\ ei^g_{IC_m} - ei^n_{IC_m} \end{pmatrix}$$

Source: Author's version based on Schmidt 2003

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

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.*(Schmidt 2003, 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, this is an environmental impact of global relevance. The total world wide contributions to this impact in 1994 were 43.3 billon tonnes of CO_2-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_2-equivalents per person. In other words, one person equivalent for the environmental impact category global warming, equals 7.7 tonnes of CO_2-equivalents (Schmidt 2003, p. 143).

Table 2 - Person equivalents

Environmental impact category	Person equivalents based on statistical data from 1994		
Global warming	1 PE_G	Ù	7.7 t CO_2-equivalents
Stratospheric ozone depletion	1 PE_G	Ù	81 g CFC11-equivalents
Photochemical oxidant formation	1 PE_{EU}	Ù	25 kg C_2H_4-equivalents
Acidification	1 PE_{EU}	Ù	74 kg SO_2-equivalents
Nutrification	1 PE_{EU}	Ù	24 kg NO_3^--equivalents
Human toxicity via air	1 PE_{EU}	Ù	3.6×10^9 m^3 air
PE_G Global person equivalent PE_{EU} European person equivalent			

Source: Author's version based on Schmidt 2003, table 8.2, p. 145

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 and provided data for the analysis of the importance of products for investigation in the 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 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 (Erdmenger 2003, pp. 117-120).

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 2003, pp. 118

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)

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.

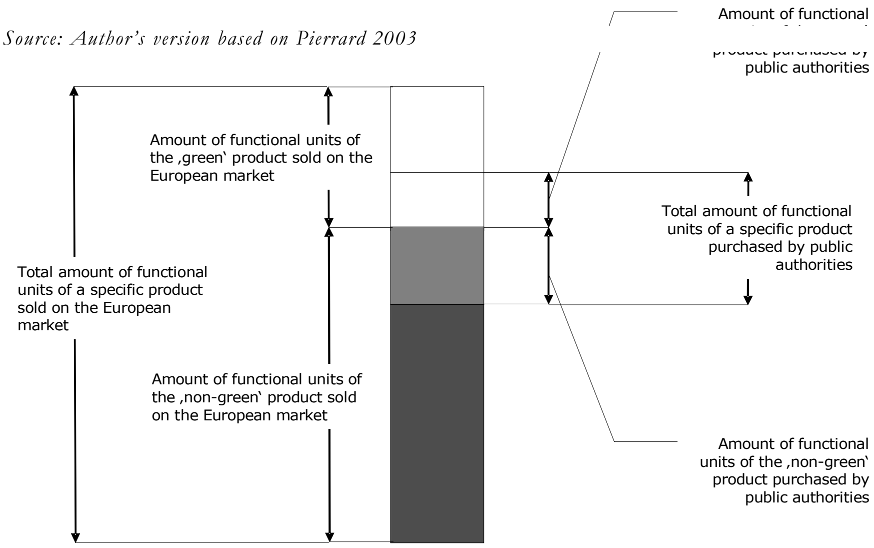
Thus, a main issue in the RELIEF project consisted in up-scaling the relief potential per functional unit to the European level and to figure out the importance of public procurement in this concern.

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
- 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 again 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 calculational approach to determine the **Theoretical European Market Relief Potential**' which focuses on the total functional units of a given product on the European market, as well as the '**Theoretical European public procurement relief potential**', referring to the respective amount of functional units influenced by European public purchasers is shown in the following Formula 2 and Formula 3.Both relief potentials 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

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

Source: Author's version based on Pierrard 2003

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, …, m
- nfu Number of functional units for a specific product
- tg Total 'green'
- tm Total market

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

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

Source: Author's version based on Pierrard 2003

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, …, m
- nfu Number of functional units
- pg 'Green' related to public purchasing
- tp Total related to public purchasing

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 to determine 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 (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 is the International Energy Agency databases (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 (CRT) was assumed.

The amount of functional units sold on the European market for the year 2000 was 27,431,912 units (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 (OECD 2001), it was multiplied with the share of white collar workers obtained from an EUROBAROMETER survey (EUROBAROMETER 1994) and with the number of business PC's per white collar worker (EITO 2001). Finally it was 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 (EITO 2001). The share of 14.75% or 209,184 units purchased by the public sector was derived from European Input-Output statistics (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 with EURO IV specification despite the fact that such buses are at present time not yet available on the market. Buses complying with 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 (ACEA 2002). A survey among producers showed that approx. 50% of these vehicles are line buses, the remaining are coaches. The assumption that one bus drives 100,000 km during one year was made. This equals an annual number of functional units of 1,547,850,000 bus-km. 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 produced considering 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 (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 (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	-7.2×10^{-3}	-110×10^{-3}	2.0×10^{-6}	-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	-0.2×10^{-3}	-3×10^{-3}	-1.8×10^{-5}	-5.2	-96.8	-3,2
Acidification	-28.8	-4.2×10^{-3}	-64×10^{-3}	-2.0×10^{-5}	-27.0	-554.1	-40.5
Nutrification	-9.9	-1.5×10^{-3}	-2×10^{-3}	-2.3×10^{-5}	-212.3	-3,264.3	-159.2
Human toxicity via air	n. a.	n. a.	n. a.	-9.5×10^{-6}	n. a.	n. a.	n. a.
n. a. not available							

Source: Author's version based on Pierrard 2003

Based on the data shown in Table 4 and Table 5 the 'Theoretical European public procurement relief potential' was calculated. The respective results are presented in Table 6.

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 pubic 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	Consumption of 1000 tonnes	90,389	2,847	3.15%
Meat		31,640	997	
Milk		114,737	3,614	

Source: Author's version based on Pierrard 2003

Summarising these results, the 'Theoretical European public procurement relief potential' for the selected 7 products were calculated and are presented in Table 7.

Table 6 - 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.

Source: Author's version based on Pierrard 2003

9. Conclusions

Considering the results presented in Table 7 it becomes obvious that public purchasing is a key tool for 'greening' the market place. Green public procurement is capable of achieving significant savings in terms of environmental impacts, and 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.

Table 7 - Total relief potential of the selected products in selected environmental impact categories achievable by European public procurement

Environmental impact category	Theoretical European public procurement relief potential	As % of the Theoretical European market relief potential
Global warming [PE]	7.86×10^6	6.4%
Photochemical oxidant formation [PE]	0.11×10^6	7.3%
Acidification [PE]	4.68×10^6	6.1%
Nutrification [PE]	3.62×10^6	4.0%
Resource Consumption [GWh]	0.18×10^6	6.4%

Source: Author's version based on Table 6

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