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Study on the Implementation of Directive 94/62/EC on Packaging and Packaging Waste and Options to Strengthen Prevention and Re-use of Packaging

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LIST OF ABBREVIATIONS

CNE	Conseil National de l'Emballage (France)
CONAI	Consorzio Nazionale Imballagi, the National Packaging Waste Decree
DPPWD	The Dutch Packaging Waste Decree
EPD	Environmental Product Declaration
EPR	Extended Producer Responsability
ER	Essential Requirements
GDP	Gross Domestic Product
GWP	Global Warming Potential
IMS	Integrated Management System
IRPC	Interregional Packaging Commission (Belgium)
LCA	Life Cycle Assessment
PEI	Packaging Environment Indicator
PPrP	Packaging Prevention Plan
PPWD	Packaging and Packaging Waste Directive
PRO	Producer Responsibility Organisation
SVM-PACT	Stichting verpakking en milieu (The Netherlands)
VROM	Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, The Dutch Ministry of Spatial Planning, Housing and the Environment

LIST OF DEFINITIONS

Packaging waste disposal	“Disposal” of packaging waste is defined in Annex II.A to the Waste Framework Directive 75/442/EEC. It includes landfilling and incineration at waste incineration plants with energy recovery, if the main purpose of the operation is to dispose of the waste.
Packaging waste recovery	“Recovery” of packaging waste includes any of the applicable operations provided for in Annex II.B to the Waste Framework Directive 75/442/EEC. It includes packaging recycling and incineration with energy recovery, if the main purpose of the operation is to replace alternative fuels. The Packaging Directive includes targets for packaging waste recovery and incineration at waste incineration plants with energy recovery. For reasons of readability, generally the term recovery is meant in this study to include both recovery and incineration at waste incineration plants, even if this is not explicitly indicated.
Packaging waste treatment	The more general term for packaging waste disposal and packaging waste treatment.
Gross Costs of Packaging Recovery	All costs from the moment a packaging becomes waste to the moment when, after recovery, it becomes a recycled product or turns into energy
Financing Need	The gross costs minus the revenue from the sale of secondary raw materials or energy. The financing need equals the funds that need to be injected into the market in order to render recovery economical or, in other words, to make recovery happen. This is the relevant cost from the point of view of the recovery chain.
Net Internal Costs for Society	The financing need minus the saved disposal costs. Depending on the material and the circumstances, recovery may be cheaper or more expensive than disposal.
Scenario 1: Zero Recovery	Involves a situation with no packaging recovery, no recycling and no other national measures on packaging and packaging waste management. Although many countries already had recovery and recycling systems in place prior to the introduction of the Directive, this provides background information relating to the worst case scenario
Scenario 2: Baseline Policy	Involves a situation with such recycling and recovery rates and other national measures as would have been likely in the absence of the Directive (based on estimates and extrapolations). For some member states, including Germany, Sweden and Finland, collection and recovery systems (especially for materials such as glass, corrugated board and paper) were developed before the implementation of the Packaging Directive. For many of these member states this scenario is unlikely to be different from the actual situation.
Scenario 3: Packaging Directive	Involves the actual situation with the Packaging and Packaging Waste Directive in place. Data are based on the returns made to the European Commission.

Waste Prevention	Includes both quantitative and qualitative prevention: quantitative prevention refers to a reduction of the amount of waste generated; qualitative prevention refers to a reduction of the hazardousness of waste generated.
Extended Producer Responsibility	Is defined by the OECD as a policy in which the producer's financial and/or physical responsibility for a product is extended to the post-consumer stage of the product's life cycle. It specifically focuses on reducing the environmental impacts of a product at the post-consumer phase. The responsibility for a product at its post consumption phase is shifted upstream in the production-consumption chain, to the producer; and it provides incentives to producers to incorporate environmental considerations into the design of their products.

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EXECUTIVE SUMMARY

1. TASK 1: EVALUATION OF THE IMPLEMENTATION OF THE PACKAGING DIRECTIVE 94/62/EC

1.1 OBJECTIVE

An overall evaluation was undertaken of the impacts of the Directive from an environmental, economic and social perspective. The geographical coverage of the evaluation under this task is the EU15. The European Union has been looked at as a community rather than as 15 individual countries. The aim was not to make exact calculations of costs, but rather to estimate the magnitude of costs, as it was not the objective to carry out a fully-fledged cost-benefit analysis.

1.2 IMPACTS OF THE DIRECTIVE EVALUATED FROM AN ENVIRONMENTAL PERSPECTIVE

The impacts of the Directive have been assessed using an LCA-based approach. The environmental impact of the management of packaging waste in the EU15 was assessed through the use of three scenarios:

Scenario 1: Zero Recovery: no packaging recovery, no recycling and no other national measures on packaging waste management. Although many countries already had recovery and recycling systems in place prior to the introduction of the Directive, this provides background information on the impact of all packaging recovery and recycling in EU15.

Scenario 2: Baseline Policy: the recycling and recovery rates and other national measures as would have been likely in the absence of the Directive. This scenario is based on work conducted with the consultants Perchards investigating the likely legislation that would have been in place and the impact that this legislation would have had on the recovery/recycling rates. It is based on the assumption that for some Member States, including Germany, Sweden and Finland, there is no difference from the actual situation because their recovery/recycling systems were in place already before the Directive.

Scenario 3: Packaging Directive: the actual situation with the Packaging and Packaging Waste Directive in place. Data are based on the official data submitted to the European Commission.

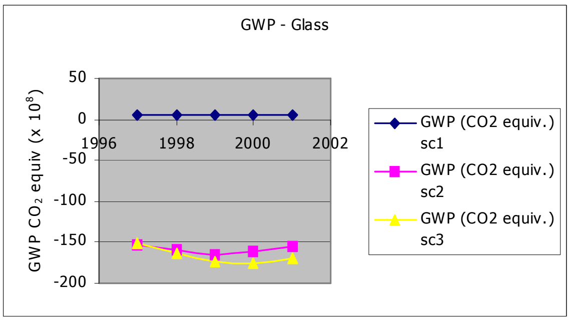
For the majority of the systems studied, packaging recovery and recycling has reduced the environmental impacts of packaging waste management. The results for the four materials indicate that among 56.3 million tonnes of packaging waste, 34.6 million tonnes (61.4%) have been diverted from landfills and 30.7 million tonnes (54.5%) have been recycled. However, only a small part of packaging recovery and recycling is directly related to the effects of the Packaging and Packaging Waste Directive. Most of the packaging recycling would also have taken place in the absence of the Directive, either because it is economically profitable or because of pre-existing national legislation or other initatives (e.g. voluntary industry commitments). A major factor in this calculation is that for half of the Member States, the Packaging Directive is assumed to have had no effect. This is because they had national policy measures in place before the Directive which guaranteed at least the same recovery and recycling rates as the Directive. Even for the remaining Member States, significant amounts of packaging waste were recovered or recycled before the transposition of the Directive in national law. Therefore, the direct effect of the Packaging and Packaging Waste Directive in reducing packaging waste to landfill is estimated at only around 2.8 million tonnes or around 8% of total packaging recovery in EU15. The direct effect of the

Packaging and Packaging Waste Directive in increasing packaging recycling is also estimated at around 2.8 million tonnes or around 9% of total packaging recycling in EU15.

The environmental impact of packaging waste management was significantly reduced through packaging recovery and recycling. The results showed a significant variation between the various packaging materials. As shown in other studies, this variation also exists within the various packaging material categories, depending on the concrete application. Therefore, the results are approximations only based on certain assumptions. In particular, it should be taken into account that, the higher recycling targets and rates are, the more it will be necessary to collect packaging fractions which are less suitable for recycling and which will not correspond to the patterns assumed for the purpose of the following estimations.

On the basis of the assumptions underlying this study, all packaging recovery and recycling together has saved roughly 10 million tonnes of oil equivalent and 25 million tonnes of CO_2 equivalent compared to a scenario where all packaging waste was sent to landfill or incineration without energy recovery. However, only around 1 million tonnes of oil equivalent and 3 million tonnes of CO_2 equivalent, i.e. roughly 8-9% of these savings are the direct result of the implementation of the Packaging Directive[1]. Additionally, significant reductions have been identified for several other impact categories (nutrification, acidification, ozone depletion, human toxicity, ecotoxicity, smog) as a result of increased recycling and recovery.

Full results are contained in this study. To provide an example of the results obtained, a graph showing the global warming potential (GWP) result for glass is shown below. The glass results are typical of those of other materials.



1.3 IMPACTS OF THE DIRECTIVE EVALUATED FROM AN ECONOMIC PERSPECTIVE

In the economic evaluation, an effort is made to quantify the economic impacts as much as possible. The main types or categories of economic impacts studied are the following:

1. changes in compliance costs
   1.1. investment costs
   1.2. operating costs
   1.3. administrative burden to companies/SME's
   1.4. implementation costs for public authorities

[1] In these calculations, the effect of paper recycling was assumed to be neutral because CO_2 emissions from paper come from biogenic sources. Equally, the figures for abiotic depletion do not include the data for steel and paper due to methodological problems.

2. changes in output
3. impacts on innovation and technological development

1.3.1 Changes in compliance costs

Table 1 gives the total financing need for packaging waste management for three scenarios. The financing need includes waste management costs minus the revenues from the sale of secondary materials and covers both the operating cost and the investment cost.

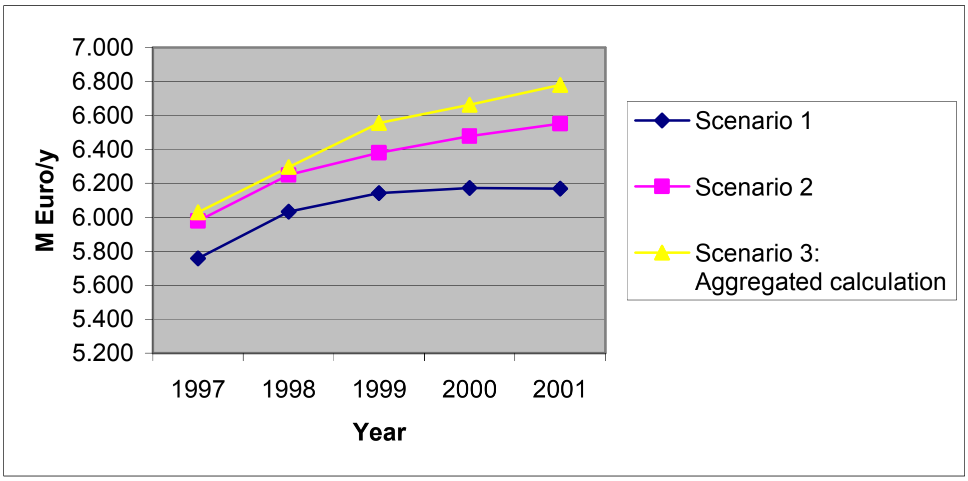
Table 1 : Total financing need for packaging waste management for the EU 15

		Year	1997	1998	1999	2000	2001
Scenario 1	Zero Recovery	bn. Euros/y (1)	5,8	6,0	6,14	6,17	6,17
		% of Scenario 3	96%	96%	94%	93%	91%
Scenario 2	Baseline Policy	bn. Euros/y	6,0	6,3	6,4	6,5	6,6
		% of Scenario 3	99%	99%	97%	97%	97%
Scenario 3	Packaging Directive						
	Aggregated calculation	bn. Euros/y	6,0	6,3	6,6	6,7	6,8
		% of Scenario 3	100%	100%	100%	100%	100%
	Detailed calculation	bn. Euros/y	6,1	6,3	6,5	6,5	6,6
Incremental cost : Scenario 3 minus Scenario 2		Mio Euros/y	50	46	176	185	227
		% of Scenario 3	0,8%	0,7%	2,7%	2,8%	3,3%

(1) In real prices of 1998

The costs for Scenario 3 (2001 levels of packaging recovery and recycling) are of the same order of magnitude as Scenarios 1 (no packaging recovery and recycling) and 2 (likely recovery and recycling levels in the absence of the Packaging Directive). According to our estimates, packaging recovery only causes around 4-9% of additional costs compared to no recovery and around 3% compared to a likely scenario in the absence of the Packaging Directive.

The three scenarios are represented graphically in the figure below:



Total financing need for packaging waste management for the EU 15

The total financing need for packaging recycling (excluding the waste management costs for the remaining waste sent for disposal or recovery) is estimated at 3.7 billion Euro for 2001. This corresponds to around 20% of the turnover of the recycling industry and around 4% of the turnover of the packaging industry.

1.3.2 Changes in output and impacts on innovation

Between 1998 and 2001, the turnover of the recycling industry increased from 10 billion euros to 18 billion euros. Packaging recycling certainly has contributed to this increase but the exact dimension of the impact of the Packaging Directive and whether this is compensated by reduced output in other sectors (crowding-out effect) is however difficult to determine. There also seems to be some technological innovation in sorting and recycling of packaging waste. The exact degree to which this was influenced by recycling obligations is however difficult to determine.

1.4 IMPACTS OF THE DIRECTIVE SCREENED FROM SOCIAL PERSPECTIVE

The information found on social aspects was limited to changes in employment levels or job quality, which is however the most obvious impact and considered by many to be very important.

We estimate the direct employment in packaging recovery operation (recycling plus incineration with energy recovery) at 30.000 FTE/yr and the first round indirect employment at 12.000 FTE/yr. We note that this estimate is based on a so-called "demand side approach" and no conclusions can be drawn from this with regard to the macroeconomic net employment effect. Also, if increased expenditure on packaging recovery means that there is less expenditure in other sectors, then jobs in those sectors may be lost. This is known as a 'crowding-out' effect.

It has been argued that recycling and other waste management may provide initial routes into employment for the socially excluded or the low skilled. Information on the nature of waste management employment is limited however and appears somewhat contradictory. Some studies indicate that jobs are of a higher quality in waste management than in some other environment-sector activities. Other data indicate that waste management jobs are mainly low-skilled and low-paid. The poorest quality jobs appear to be in collection and transport, manual sorting and composting. Higher-quality jobs are associated with the more technology-intensive, specialised activities.

The distributional consequences of increased recovery schemes greatly depend on the associated financing mechanism. In principle, the recovery schemes can be financed by industry or from public budgets. In the case of industry-financed recovery schemes, it is likely that poorer people are more affected by additional costs for recycling than rich people, who spend a lower share of their income on packed goods.

1.5 EFFECTIVENESS AND EFFICIENCY OF THE IMPLEMENTATION OF THE PACKAGING DIRECTIVE

EFFECTIVENESS

It has been demonstrated that the packaging recycling and recovery targets of the PPWD have largely been met and that the PPWD has also met its objective to reduce the environmental impact of packaging and packaging waste.

As regards the prevention of packaging waste, the picture is more nuanced. Packaging waste generation is almost following the growth in GDP, even though there seems to be some relative de-coupling. From

1997 to 2001 the packaging waste generation and the GDP have increased by 8,3% and 11% respectively.

EFFICIENCY

In the study the specific cost to obtain one unit of environmental benefit through packaging recovery has been calculated, both for packaging recovery in general and the proportion that can be attributed to the Packaging Directive.

The cost of reducing the Global Warming Potential by 1 kg of CO_2-equivalents through packaging recovery was calculated as 1,2 Eurocents in 1997 and rose to 2,3 Eurocents in 2001. This shows that the marginal cost rises as the recovery rate increases. These figures should, however, be taken with care because they are highly dependent on assumptions regarding recycling and alternative waste management costs, which are both a dimension bigger than the difference between both, which is taken as a basis for this calculation. The costs and benefits also strongly vary between the various packaging materials and applications. It should also be taken into account that the reduction of greenhouse gas emissions is not the only environmental benefit of recycling. Therefore the cost of recycling should be compared to all environmental benefits which occur simultaneously as a result of recycling. The specific costs for the other environmental benefits can be found in the report.

For most environmental impacts, the specific cost of environmental benefits that can be attributed to the Packaging Directive is significantly higher than the specific cost of environmental benefits of packaging recovery in general.

2. TASK 2 : PACKAGING PREVENTION

2.1 INDICATORS FOR THE ENVIRONMENTAL PERFORMANCE OF PACKAGING

A Packaging Environmental Indicator – PEI – is a conceptual tool that measures the environmental impact of packaging and produces a simple result that aids packaging improvement and facilitates selection between different packaging systems. A PEI uses streamlined LCA methodology to measure environmental impact. There are many challenges involved in simplifying LCA to the degree required for use in a PEI, and these are discussed in this report.

Information from stakeholders was obtained via a one-day workshop plus a questionnaire-based consultation. Stakeholders were invited to test a conceptual software-based PEI tool and provide feedback. Stakeholders tested the tool on a variety of packaging types for fast moving consumer goods such as beverages and snack products. Most stakeholder found the tool easy to use but most did not find that the tool aided their understanding of environmental impact. Stakeholders found it difficult to estimate the costs involved in applying a PEI tool. Estimates ranged from 4 Euros to 600 Euros per item of packaging and up to 10 million Euros annually per company, as detailed in the report.

Conclusions drawn from the stakeholder feedback on the PEI concept were that:

- A PEI considers packaging in isolation from its product and takes no account of the broader function of packaging
- A PEI reduces environmental impact to one number despite the lack of scientific basis for this
- The costs of applying a PEI to all packaging may outweigh the benefits
- Sufficiently accurate data do not exist at this stage to enable a functional PEI to be created

- It seems illogical to investigate a PEI without first applying and enforcing the current regulatory measures in this area: the Essential Requirements and CEN Standards

While stakeholders were not in favour of the PEI concept, they supported the use of life cycle thinking and supported EC encouragement of its use.

2.2 PACKAGING PREVENTION PLANS

We have evaluated the existing experiences with packaging plans in the countries where they are already applied. These PPrP's are already required for certain businesses in Belgium, Italy, Slovakia, Spain and in the Netherlands in application of Article 4 of the PPWD.

Experience in these Member States shows that not only the quality of the PPrP's improves over the years but also the percentage of plans which are implemented as planned increases. The PPrP's have proven to be an important source of information for the authorities.

In conjunction with packaging prevention plans, several Member States introduced a stand-still principle or reduction targets, meaning that the ratio between the weight of the packaging and the weight of the product placed on the market shall not increase, respectively shall decrease. Over 70% of the parties responsible for packaging in Belgium state that they respect this principle. Spain has a quantified reduction target of 10% to be reached in 2001, compared with 1997. The compliance scheme Ecoembes has obtained a reduction of 14% during the period 1990-2002, of which 12% corresponds to the period 1990-1998, during which it was not obligatory to draw up PPrP's, and the remaining 2% relates to 1998-2002. The Netherlands have a similar reduction target from 1997-2001, calculated in the same way.

In their Packaging Prevention Plan companies propose a wide variety of prevention measures: increasing the percentage of recyclable packaging, increasing the percentage of reusable packaging, improving the reuse or recycling possibilities, decreasing the hazardous character of packaging materials, decreasing the use of single-trip packaging, and so on.

PPrP's can vary in size from a short description in one page to a substantial report. The costs of this will differ per individual company and can mount up to some thousands of euro (in the Netherlands). Monitoring and the formulation of prevention plans in the Netherlands under the covenant of 1991 cost about 5,5 million euro yearly. It was expected that the total costs (administrative costs for prevention, notification, monitoring and reporting) under the covenant II would amount up to about 9 to 10 million euro yearly. Because it is assumed that the obligation to prepare a packaging prevention plan places a burden on companies that is only justified above a certain threshold level, many countries implementing the system of PPrP's (Belgium, Slovakia, Spain,…) have set a threshold (either a total amount of packaging per year placed on the market or a threshold per material) on the obligation to present a packaging prevention plan.

In the case of Belgium the administrative burden to public authorities amounts to the equivalent of 1,5 person full time or about 100.000 € yearly.

In countries where PPrP's are made, they are seen as a useful instrument by the responsible authorities that at least partly meet their intended prevention objective. There is a certain similarity in conception between PPrP and the declarations on conformity with the essential requirements as e.g. required in France.

2.3 ESSENTIAL REQUIREMENTS

The essential requirements have been implemented in all the Member States of the EU-25 through the transposition of the packaging and packaging waste directive into national legislation. The enforcement is however very limited in most countries.

The pertinence of the existing essential requirements to protect environmental interest is under discussion. Based on the quantitative data available it is not possible to assess the total environmental benefit of the ER in relation to the total environmental impact of the packaging. Therefore it is not possible to assess whether the present ER are sufficient.

The experience with the ER is limited since in most countries there is very limited enforcement and no market surveillance systems are in place (except for France and the UK). Therefore the present data concerning the environmental impact of packaging on the environment can not be used to make a full assessment of the application of the New Approach in the PPW Directive. It is recommended to enhance the market surveillance throughout the EU-25 and to collect data to evaluate the environmental impact.

Compliance with harmonised standards developed by CEN automatically gives presumption of conformity but there is no legal obligation to use these standards. The approach chosen by CEN consists of the establishment of management standards and not of product standards.

In the present directive, no conformity assessment and marking procedure are foreseen. Different conformity assessment options to be applied were evaluated.

Of the procedures proposed by the European Commission in the New Approach, only the "internal control procedures" or "use of quality management systems" is perceived as feasible by the industry. From the side of the environmental NGO's, a more stringent conformity assessment with more enforcement possibilities is demanded.

2.4 HEAVY METALS AND OTHER DANGEROUS SUBSTANCES

The four heavy metals mentioned in Article 11.1 of Directive 94/62/EC on packaging and packaging waste [Lead (Pb), Cadmium (Cd), Mercury (Hg) and Hexavalent chromium (CrVI)] and Antimony and Chlorine were assessed.

2.4.1 Four heavy metals

The evaluation of the reduction of the permissible concentration level for the four heavy metals to a level lower than 100 ppm must take into account the technical possibilities, the environmental impact of lower limit values, the possible positive impact on human health and the financial implications involved for the industry.

Most packaging items respect the limit value of 100 ppm. Exceptions are in particular recycled glass, pallets and crates which are covered by exemption decisions from the limits. However, there are also reports on higher levels in other items such as plastics packaging nets with heavy metal containing colouring agents.

The technological feasibility of a further reduction of the heavy metal contents in packaging depends on the use of secondary raw materials and their possible contamination and of the background values (level of impurities) in the primary raw materials used. For most materials and applications, it should be possible to respect a lower limit value. However, there is no full picture on those materials and applications for which this might pose a problem and whether reductions for those materials and application are technologically feasible. For materials and applications with a high content of secondary materials, the only possibility is very often to reduce the use of recycled material.

No scientific information is available concerning the environmental impact or the impact on human health of limit values for heavy metals lower than 100 ppm in packagings.

Based on the available information it is not possible to assess the financial feasibility of potential lower limit values for the different materials and types of packagings.

2.4.2 Antimony

Current methodologies based on the PBT (Persistence, Bioaccumulation and Toxicity) do not apply for the ranking of the environmental hazards of antimony and metals and inorganic metal compounds in general. Currently, a risk assessment for antimony trioxide (DAT) is ongoing. The conclusions of this Risk Assessment which includes an exposure assessment will most possibly provide additional information to come to scientific based conclusions concerning the risk of antimony trioxide in general.

2.4.3 Chlorines

Chlorines are used for the production of PVC (polyvinyl chloride) packaging. Overall, the use of PVC packaging is declining. The debate concerning the necessity of substituting PVC has been ongoing for several years at the EU level, e.g. between environmental NGOs and industry, but there is so far no consensus on the risk to human health and the desirability of such a substitution.

2.5 PACKAGING PREVENTION – PRODUCER RESPONSIBILITY

Extended producer responsibility (EPR) seeks to place the responsibility for the life cycle of a product onto its producer. EPR has the potential to internalise the external costs of waste management through a combination of economic and physical responsibility and in this way to encourage the optimisation of the use of resources such as materials and energy. There is a large variety of different types of producer responsibility legislation and schemes in the EU. For industrial packaging waste, industry itself or producer responsibility schemes normally both operate and cover the costs of collection of packaging waste. This is also the case for household packaging waste in some Member States such as Germany or Austria. In many other Member States, the operation of the collection schemes is mainly the responsibility of municipalities, which are financially supported by producer responsibility schemes to a varying degree. In other Member States such as Denmark or the Netherlands, producers only play a subsidiary role.

The costs to industry per ton of recycled material in different member states vary significantly. The cost of compliance in Germany in 2001 was €12,5 million per percentage point of recycling, in France it was €6,8 million and in the UK €2,4 million. Costs are expected to rise in the low cost countries. In such countries, the cost of household packaging waste management is mostly born by municipalities. However, little is known about these costs.

If success is measured by the achieved recycling levels, then member states with strong producer responsibility systems have successfully increased the overall rates. Producer responsibility has also to a certain degree enhanced incentives for packaging minimisation but not enough to counteract rising consumption.

2.6 PREVENTION TARGETS AND LANDFILL BANS

2.6.1 Waste prevention targets

The existing waste prevention targets have focused on the weight or volume of waste generated (sometimes in relation with the amount of packed product). In the Member States with specific packaging waste prevention targets set in national legislation or in national waste management plans, packaging waste prevention has been a limited success. Although there seems to be a certain de-coupling between GDP and packaging consumption, absolute amounts of packaging consumption are still rising and the trend in countries with prevention targets is not substantially different from countries without such a target. A number of countries have general waste prevention targets. In general, such targets failed to have a significant effect and trends indicate that they will be missed by a large margin. They are also of limited importance for packaging waste generation.

2.6.2 Implementation of landfill bans

Landfill bans mainly redirect the generated waste to other waste management methods such as recovery (material or energy) and incineration without energy recovery. They have limited impact on prevention at source.

3. TASK 3 : PACKAGING REUSE

There are many examples of existing reusable packaging systems in Europe and this study outlines a variety of successful systems in Germany, Austria, Denmark, Norway, the UK and other countries. Overall the market share of reusable primary packaging is falling while the market share of reusable transit packaging is growing.

Many LCA studies have been undertaken in this field, although they mainly focus on reusable consumer packaging for beverages. When their assumptions are taken into account their findings are found to agree to a reasonably high degree. The environmental, social and economic performance of reusable packaging systems is highly context specific. Reusable packaging systems perform best in certain societal and logistical situations and single-trip packaging systems perform best in other situations. In general, reuse systems are most likely to be environmentally beneficial when distribution distances are short and return rates are high (for example, the highly localised and efficient German mineral water pool system), although there are many other factors that must be taken into account when assessing the environmental performance of any packaging system. In general terms the maximum environmentally feasible distance for reuse systems is in the order of magnitude 100km to 1000km.

The social benefits of reuse systems are discussed, including landfill avoidance (which for some stakeholders has perceived importance greater than the way in which waste processing is dealt with in LCAs) and the social benefits of encouraging environmentally responsible behaviour in consumers. The issues of littering and employment are particularly significant social issues according to some stakeholders.

In terms of total social cost (the internal, external and environmental costs combined) reusable packaging has been found to be best for short distribution distances (based on a limited number of available case studies), reusable packaging and single-trip packaging have been found to be approximately equal for medium distribution distances, and single-trip packaging has been found to be best for long transport distances. However, in terms of internal cost alone – the financial cost companies pay – single-trip packaging has been found to be cheapest in the cases studied. In other words, in some situations businesses have more financial motivation to use single-trip packaging than does society as a whole. Therefore, in such cases, support measures for reuse may be appropriate. Any such measures should aim to accurately and fairly internalise society's costs into business's costs so that businesses are motivated to make the same packaging decisions that society as a whole would make.

In practice the decision about whether support measures are appropriate must be a political decision because different viewpoints are valid. The following statements are simplifying but they may help illustrating the various aspects of this complex question:

- In scientific terms there is a case for support measures in specific cases.
- In social terms reuse systems are highly valued in certain member states and their survival is important to many stakeholders in those member states.
- In sustainable development terms some stakeholders believe that moving towards a more localised society will be necessary for sustainability, and reuse systems may have a greater role in such a society.
- In economic theory terms it can be challenging to measure external costs accurately and internalise them fairly.
- In investment terms it may be more appropriate to invest in other environmental measures that may produce a better environmental return on investment.
- In logistical terms the cost would be high of changing existing long-distance product supply systems to be more localised in order to suit reusable packaging.
- In market theory terms it may be difficult to maintain certain reuse systems if these are naturally being out-competed due to economic reality and consumer choice.

In this report various potential support measures are discussed: quotas, compulsory reuse, bans on single-trip packaging, deposit return systems, recycling targets, packaging taxes, depreciation allowances, state aid and tradable permits.

1. TASK 1: EVALUATION OF THE IMPLEMENTATION OF THE PACKAGING DIRECTIVE 94/62/EC

1.1 OBJECTIVE

Under task 1, an overall evaluation is given of the impacts of the Packaging and Packaging Waste Directive 94/62/EC from an environmental, economic and social perspective. This is done on the basis of available information and appropriately reasoned extrapolations. Critical questions have been verified on the basis of additional work.

The geographical coverage of the evaluation under this task is the EU15 i.e. the 15 Member States prior to the enlargement in May 2004. It is important to note that the European Union is looked at as a community rather than 15 individual countries.

It should be noted that the ambition is not to make exact calculations of the costs, the environmental benefits or the social impacts but rather to estimate the magnitude of impact that the Directive has had.

1.2 BACKGROUND

EU wide packaging waste management was first introduced in the early 1980s through Directive 85/339/EEC which covered the packaging of liquid beverage containers intended for human consumption. Resulting policies and the development in some Member States of legislation covering packaging waste management as a whole led to potential problems with the Internal Market. As a result of these problems and the diverging national measures, Community wide packaging legislation was proposed. After intense negotiations, the Packaging and Packaging Waste Directive (94/62/EC) (PPWD), encompassing all packaging placed on the market and all packaging becoming waste within the European Community, came into force on 31 December 1994. The date for implementation by Member States into national legislation was 30 June 1996.

Although some Member States were late implementing legislation, all Member States have now introduced procedures to comply with the PPWD and most have incorporated it into national law. In some Member States, such as Denmark and the Netherlands, the legislation is accompanied by voluntary agreements. The mechanisms in place vary from Member State to Member State however most have implemented producer responsibility legislation based on individual compliance which can be discharged through membership of a Producer Responsibility Organisation (PRO) (see chapter 2.5). Some Member States also have additional mechanisms in place including prevention plans, reuse targets and quotas, deposit/tax schemes and landfill bans.

The main aims of the Packaging and Packaging Waste Directive (PPWD) are

- to harmonise national measures in order to reduce environmental impact; and
- to ensure the functioning of the internal market.

To achieve these aims, the Directive promotes prevention of the production of packaging waste as a first priority along with the additional fundamental principles of reuse, recycling and other forms of recovery of packaging waste (such as energy recovery). One of the common – and critical – remarks made with respect to the PPWD, according to the Technology and Environmental Policy study[2] , "consists of its lack

[2] Bongaerts J and Kemp R. The implementation and technological impact of the Packaging and Packaging Waste Directive (94/62/EC) in France, Germany and Finland. Synthesis report for TEP, MERIT, November 2000.

of incentives to promote prevention or avoidance and – instead – focus on separate collection and recycling as the main routes for environmental improvement". This is despite the presence of Article 4 – Prevention, which states that "Member States shall ensure that, in addition to the measures to prevent the formation of packaging waste taken in accordance with Article 9, other preventive measures are implemented". The European Parliament report on the implementation of the Directive[3] published in 2001 indicated that only The Netherlands, Finland and Spain had introduced targets for the prevention of packaging aiming at quantitative prevention through either the reduction of packaging consumption growth or packaging waste arising.

1.2.1 Targets

Article 6 of the PPWD established targets to be achieved by 30 June 2001 for the recovery and recycling of packaging. The targets were:

- 50%-65% recovery and incineration at waste incineration plants with energy recovery[4]; and
- 25%-45% recycling with a minimum of 15% by weight for each material.

Greece, Ireland and Portugal, due to their specific situations, were required to achieve at least 25% recovery and incineration at waste incineration plants with energy recovery by 30 June 2001.

The actual techniques whereby Member States were to achieve these targets were not specified and the mechanisms implemented have been based largely on national policies. The achievements of the Member States against these targets are outlined in section 1.3.

1.2.2 Essential Requirements and Heavy Metals

Together with targets for recovery and recycling, the PPWD included requirements relating to the design of packaging (The Essential Requirements and limits relating to heavy metals). The Essential Requirements and heavy metals limits are set out in Articles 9 and 11, respectively. The Essential Requirements specify that:

- Packaging weight and volume must be reduced to the minimum necessary for safety, hygiene and consumer acceptance of the packaged product;
- Hazardous substances and materials must be minimised as constituents of packaging with regard to emissions from incineration or landfill;
- Packaging must be suitable for material recovery, energy recovery or organic recovery; and
- If reuse is claimed, packaging must be suitable for the purpose as well as for at least one of the three recovery methods specified ie material recycling, energy recovery or composting/biodegradation.

Article 11 specifies concentration limits for the sum of specified heavy metals (lead, cadmium, mercury and hexavalent chromium) in packaging. The content of the specified heavy metals in packaging must not exceed the following:

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[3] European Parliament – Committee on the Environment, Public Health and Consumer Policy. Report on implementation of Directive 94/62/EC on packaging and packaging waste (2000/2319(INI)). A5-0323/2001 Final. 10 October 2001.

[4] As modified by Directive 2004/12/EC; as a result of Court Judgements C-228/00 and C-458/00, the recovery target was changed into a target for recovery and incineration at waste incineration plants with energy recovery. In the following, the term recovery is in general used as meaning both recovery and incineration at waste incineration plants, even if this is not explicitly indicated.

- 600ppm by weight by 30 June 1998
- 250ppmby weight by 30 June 1999
- 100ppm by weight by 30 June 2001

The implementation and environmental, economic and social impact of the Essential Requirements and Heavy Metals are discussed in Section 2.3 Prevention Requirements – Essential Requirements and Section 2.4 Packaging Prevention – Heavy Metals and Other Hazardous Substances.

1.2.3 Re-use

As already mentioned, packaging reuse, in order to prevent the generation of packaging waste, is one of the fundamental principles outlined in the PPWD. Article 5 of the Directive allows Member States to set up re-use schemes where these are environmentally sound and in conformity with the Treaty, and several Member States have systems in operation. The economic, environmental and social impacts associated with reuse are considered in detail within this report under Section 3.

1.3 SUSTAINABLE CONSUMPTION/DEVELOPMENT AND THE FUNCTIONS OF PACKAGING

The PPWD deals with packaging as a stand alone product. However packaging performs a number of functions which are vital in the supply of products from manufacturer to consumer. Indeed packaging would not exist without products and many products would not exist were it not for packaging as packaging provides a mechanism for delivery. Certainly the range of products available in many Western countries is a function of the protection, preservation and containment functions provided by different packaging systems. The range of functions offered by packaging includes:

- Protection and preservation i.e. the prevention of physical damage and the stopping or inhibiting of chemical and biological changes during transportation, handling and storage;
- Collation and containment i.e. facilitating distribution and storage of a given quantity of product through unitisation and containerisation;
- Marketing/Sales Enhancement e.g. to add value, to attract sales, branding and image;
- Identification and information e.g. providing product information, company information, usage instructions , storage and handling instructions, machine readable codes, human readable codes;
- Security e.g. tamper evidence, child resistance, anti-counterfeiting; and
- Convenience e.g. openability, reclosability, dispensing.

Along with these basic functions, packaging must also respond to ever-changing drivers (such as smaller households, time-poor consumers) and social needs which affect consumption patterns.

Initiatives such as lightweighting can produce (and have produced) remarkable results without affecting the delivery of the product but limits do exist past which no further advances can be made without technological advancements in terms of new materials, techniques etc. It is therefore important that packaging design should be integrated at an early stage within the product development process and any subsequent changes in product or packaging take account of the integrated system (which includes the product and multiple levels of packaging). Not considering the system as a whole can lead to unintended and unwanted results. This is discussed further under the prevention section of this report.

1.4 ACHIEVEMENTS OF MEMBER STATES (EU15) AGAINST TARGETS

The data reported in this section are those provided by the European Commission and represent the official figures reported by the authorities for each Member State.

1.4.1 Conformity of Member State data submission

All Member States are required to submit data to the European Commission relating to achievements against the recovery and reuse targets. The data must be submitted in a specified format in order to render data comparable. However it is important to note that differences between national data sets still exist due to the absence of common methodologies. Some variations, such as those reported by PriceWaterhouseCoopers[5], ARGUS[6] and van Beek[7] exist due to:

- different definitions of concepts such as recycling and recovery;
- different definitions of packaging;
- different waste classifications;
- different measurement systems e.g. in the Netherlands, figures from government and industry are combined, whereas in the UK, figures are based on returns by industry alone; and
- the effect of free riders e.g. by 'underestimating' the amount of packaging put onto the market.

The Commission has analysed differences in data collection methods in a working paper of the Committee for the technical and scientific adaptation of the Packaging Directive (see Annex 20. As a result of this work, a revision of Commission Decision 97/138/EC is currently being prepared to ensure a better comparability of data between the Member States. A study has also been carried out in Scandinavia to investigate the differences in methodologies for calculating packaging waste quantities in Denmark, Finland, Norway and Sweden[8].

1.4.2 Member State achievements against the recycling and recovery targets

Figure 1 illustrates graphically Member State achievements against the targets. The actual percentage recovery and recycling rates are shown in tables 2 and 3.

[5] PricewaterhouseCoopers. The Facts: A European Cost/Benefit Perspective. Management Systes for Packaging Waste. Utrecht. October 1998.

[6] ARGUS in association with ACR and Carl Bro a|s. European Packaging Waste Management Systems. European Commission DGXI.E.3. February 2001.

[7] R van Beek. The implementation of the EU Directive on Packaging and Packaging Waste 94/62/EC: A comparison between five member states.

[8] This study can be found on: http://www.norden.org/pub/miljo/miljo/sk/TN2003562.pdf.

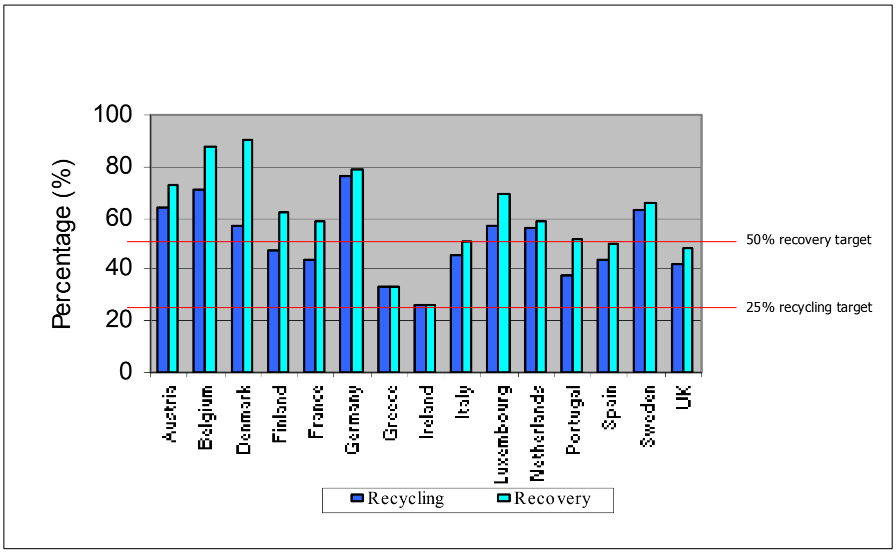


Figure 1: Member State achievements against targets (2001)[9]

Figure 1 indicates that all Member States that were obliged to achieve 50% recovery by 2001, with the exception of the UK, achieved this. The recovery target for Greece, Ireland and Portugal for 2001 was 25% and all three Member States achieved this. All Member States achieved the 2001 recycling target.

Some Member States had systems and/or legislation in force prior to the implementation of the PPWD, and the targets were therefore easier to achieve in these countries. For example, in Germany in the late 1980s and early 1990s, landfill pressures and increasing amounts of waste led to the drafting of the Packaging Ordinance, based on ideas presented by the AGVU (Arbeitsgemeinschaft Verpackung und Umwelt) for a separate collection and processing system. The Ordinance came into force on 12 June 1991 and imposed take-back requirements on producers and retailers unless they participated in a private disposal system – the "dual system" which led to the formation of DSD. The transposition of the PPWD therefore did not cause any substantial changes to the German packaging waste sector[10]. Another example is Sweden, where collection and recovery systems for glass and corrugated board were in place well before the PPWD or the first ordinance on producer responsibility in 1994. Results achieved from these systems are shown in Table 1 and Figure 2.

Table 1: Recycling rate for glass in Sweden[11]

Year	Recycling rate	Tonnage
1987	17	22,000
1990	38	49,800
1992	58	75,700

[9] data provided by European Commission

[10] Eichstädt T and Kahlenborn W. Packaging Waste: German Case Study. Final report for TEP project. European Commission Framework Programme IV72 (1994-1998). June 2000. Ecologic.

[11] Data from Packforsk

1994	56	94,200
1996	72	119,600
1998	84	143,100
2000	86	143,800
2002	84	149,000
2003	92	151,200

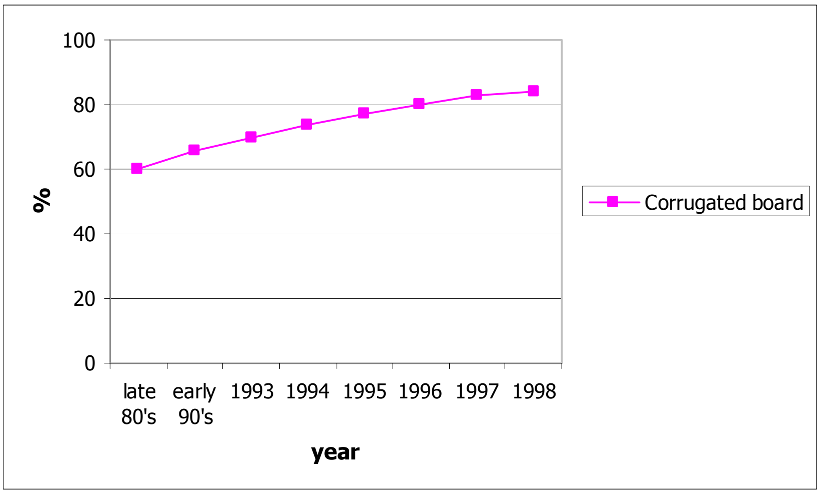


Figure 2: Recycling rate for corrugated board in Sweden[12]

Other Member States such as Austria, Denmark, Finland, France and the Netherlands also had measures in place prior to the introduction of the PPWD. However in some Member States, such as Greece, Ireland and Italy, the recovery and recycling of packaging waste was very limited.

Tables 2 and 3 show that, for the EU15 as a whole, the overall levels of recovery and recycling have increased annually (from 53% in 1997 to 60% in 2001 for recovery, and from 46% in 1997 to 53% in 2001 for recycling) although levels in some Member States, such as Austria, Germany and the Netherlands, showed a slight decrease in 2001 compared to 2000.

Table 2: Percentage recovery and incineration at waste incineration plants with energy recovery by Member State for the period 1997 to 2001[13]

Member State	*1997 (%)*	*1998 (%)*	*1999 (%)*	*2000 (%)*	*2001 (%)*
Austria	69	70	72	76	73

[12] RWA Returwell AB

[13] data provided by European Commission

Belgium	62	73	71	71	88
Denmark	84	89	92	91	90
Finland	54	55	60	60	62
France	55	56	57	57	59
Germany	83	81	80	81	79
Greece	37	35	34	33	33
Ireland	15	15	17	19	27
Italy	32	34	37	43	51
Luxembourg	44	51	43	59	69
Netherlands	78	84	85	77	59
Portugal		35	35	45	52
Spain	37	37	42	44	50
Sweden	65	82	73	66	66
UK	27	33	41	45	48
EU15	**53**	**54**	**56**	**58**	**60**

Levels of recovery vary considerably between the different Member States, for example in 2001 the percentage of packaging waste recovered ranged from 27% in Ireland to 90% in Denmark. The top six Member States had recovery levels ranging from 66% to 90% for 2001 and recycling levels of 57% to 76%.

Table 3: Percentage recycling by Member State for the period 1997 to 2001[14]

Member State	*1997 (%)*	*1998 (%)*	*1999 (%)*	*2000 (%)*	*2001 (%)*
Austria	64	65	66	69	64
Belgium	62	64	59	63	71
Denmark	40	50	53	56	57
Finland	42	45	50	50	47
France	40	42	42	42	44
Germany	81	80	79	78	76
Greece	37	35	34	33	33
Ireland	15	15	17	19	27
Italy	30	32	34	38	46
Luxembourg	38	42	40	45	57
Netherlands	55	62	64	59	56
Portugal		35	35	31	38

[14] data provided by the European Commission

Spain	34	34	38	40	44
Sweden	58	75	65	58	63
UK	24	28	35	40	42
EU15	**46**	**47**	**50**	**51**	**53**

According to Table 4, the total amount of packaging waste arising within the European Union in 1997 was around 60 million tonnes. This increased to just over 65 million tonnes in 2000 and showed a very slight decrease in 2001, falling to 64,875,949 tonnes.

Table 4: Tonnes of packaging placed on the market

Member State	*1997 (tonnes)*	*1998 (tonnes)*	*1999 (tonnes)*	*2000 (tonnes)*	*2001 (tonnes)*
Austria	1,103,000	1,115,000	1,130,000	1,170,000	1,096,650
Belgium	1,356,100	1,426,360	1,477,830	1,496,290	1,423,542
Denmark	906,792	837,927	846,061	852,258	864,616
Finland	418,300	424,100	442,600	442,500	457,100
France	11,070,000	11,641,000	11,999,000	12,499,000	12,336,000
Germany	13,712,900	14,090,200	14,626,800	15,121,100	15,017,800
Greece	710,800	794,800	855,500	934,500	974,500
Ireland	602,197	682,688	704,038	795,197	820,320
Italy	9,529,000	10,846,000	11,122,000	11,168,200	11,262,000
Luxembourg	76,508	77,496	78,511	79,701	79,440
Netherlands	2,745,000	2,525,000	2,593,000	2,903,000	2,984,000
Portugal	838,878	1,025,025	1,211,172	1,248,259	1,285,418
Spain	5,834,671	6,318,358	6,239,979	6,628,035	5,950,509
Sweden	923,400	955,200	972,000	976,800	1,010,154
UK	10,003,325	10,244,000	9,200,244	9,179,981	9,313,900
EU15	**59,830,871**	**63,003,154**	**63,498,735**	**65,494,821**	**64,875,949**

Figure 3 illustrates graphically packaging placed on the market in the EU over the period 1997-2001 together with total recovery and recycling over the same period.

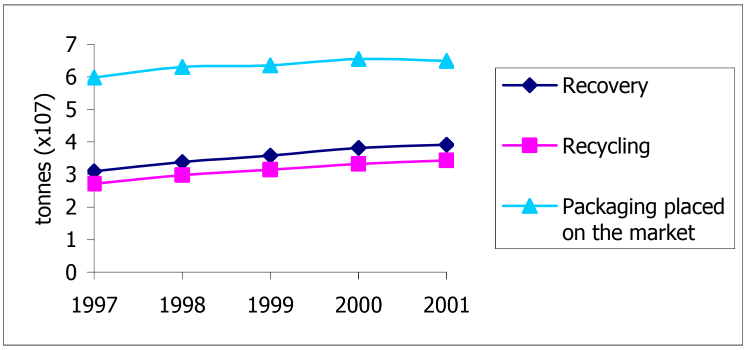


Figure 3: Tonnes of packaging placed on the market, recovered and recycled in the period 1997 to 2001

Figure 4 illustrates packaging waste arising by Member State. Note that it has been assumed that "packaging placed on the market" is synonymous with "packaging waste" i.e. it is assumed that all packaging which has been placed on the market will become waste within that same year. The Member States with the largest waste arisings in 2001 were Germany (15 million tonnes), France (12.3 million tonnes), Italy (11.2 million tonnes) and the UK (9.3 million tonnes).

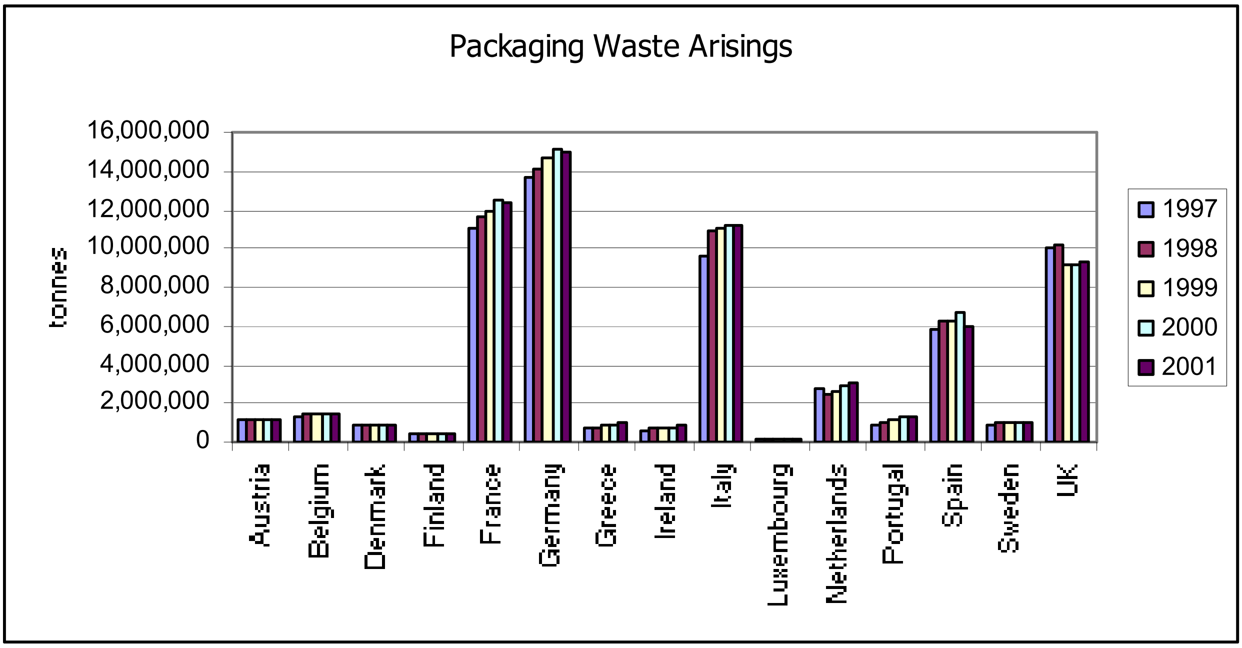


Figure 4: Packaging waste arisings

In terms of packaging waste arising per capita, from 1997 to 2001, as shown in Figure 5 (which takes account of the different demographics of each Member State), many countries show year on year growth. The countries with the highest levels in 2001 were Ireland (214kg per capita), France (208kg per capita), Italy (194kg per capita), The Netherlands (186kg per capita), Germany (182kg per capita) and Luxembourg (180kg per capita). Finland and Greece had the lowest waste arisings per capita.

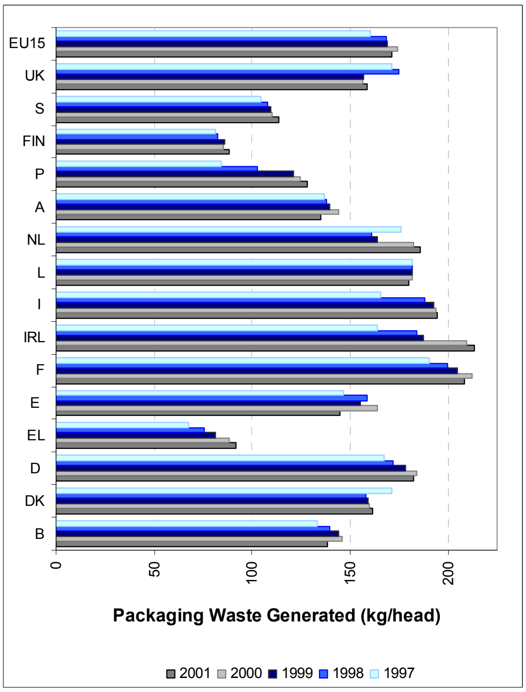


Figure 5: Tonnes waste arising per capita in the period 1997 to 2001

Table 5: Packaging waste arisings per capita (kg per capita)

Member State	*1997 (kg per capita)*	*1998 (kg per capita)*	*1999 (kg per capita)*	*2000 (kg per capita)*	*2001 (kg per capita)*
Austria	137	138	140	144	135
Belgium	133	140	145	146	138
Denmark	172	158	159	160	161
Finland	81	82	86	86	88
France	190	199	205	212	208
Germany	167	172	178	184	182
Greece	68	76	81	88	92
Ireland	164	184	188	210	214
Italy	166	188	193	194	194
Luxembourg	182	182	182	182	180
Netherlands	176	161	164	182	186
Portugal	84	103	121	125	128
Spain	147	159	155	164	145
Sweden	104	108	110	110	114
UK	171	175	157	156	158
EU15	160	168	169	174	172

Data sets relating to reuse in the period 1997 to 2001 were not available for all Member States as these are not a requirement of the data submission and are therefore only provided on a voluntarily basis.

1.5 REVISION OF THE DIRECTIVE

The original Packaging and Packaging Waste Directive has recently been revised after a long consultation phase. Directive 2004/12/EC amending Directive 94/62/EC came into force on 18 February 2004 from which time Member States have 18 months to transpose the Directive into national legislation. Directive 2004/12/EC changed the original recovery targets into targets for recovery and incineration at waste incineration plants with energy recovery and added revised targets together with material specific targets as outlined in table 6 below. These are to be achieved by 31 December 2008 for the EU12 and by 31 December 2011 for Greece, Ireland and Portugal.

Table 6: Targets for recycling and recovery and incineration at waste incineration plants with energy recovery of Directive 2004/12/EC

	Targets
Overall recovery and incineration at waste incineration plants with energy recovery	Minimum 60%
Overall recycling	55-80%
Glass recycling	60% minimum by weight
Paper recycling	60% minimum by weight
Metals recycling	50% minimum by weight
Plastics recycling	22.5% minimum by weight
Wood recycling	15% minimum by weight

For some Member States these targets will be very challenging whilst for others, the overall targets have already been achieved as shown in **Figure** 6.

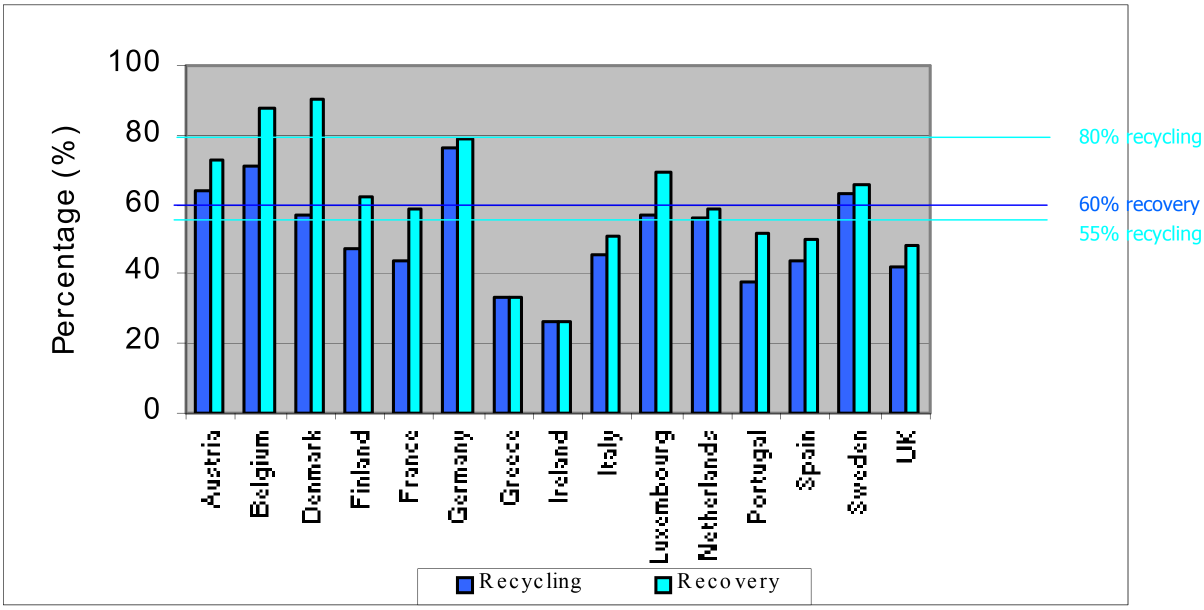


Figure 6: Achievements against revised recovery and recycling targets

1.6 GENERAL COMMENTS RELATING TO THE PACKAGING AND PACKAGING WASTE DIRECTIVE

Section 1.4 above presents official figures relating to achievements to date in terms of the amount of packaging waste arising, recovered and recycled. Taking the EU15 as a whole, (Table 12) it appears that while the amount of packaging being placed on the market (and hence therefore packaging waste arisings) increased up until 2000, the percentage recovered and recycled also increased. Actual tonnages indicate an increase in the overall amount of packaging recovered from 31 million tonnes in 1997 up to 39million tonnes in 2001 with a corresponding increase in recycling from 27 to 34 million tonnes.

Table 7 : Packaging Waste Arising, Recovered and Recycled in the EU15

Packaging Waste Arising, Recovered and Recycled (Tonnes)					
	1997	1998	1999	2000	2001
Packaging placed on the market	59,830,871	63,003,154	63,498,735	65,494,821	64,875,949
Recovery	31,024,674	33,817,707	35,735,802	38,116,757	39,150,555
Recycling	27,165,196	29,786,293	31,448,862	33,251,450	34,310,927

These figures show success in terms of increasing levels of packaging recovery and recycling.

In Figure 1, packaging waste generation is related to the development in the total GDP in the EU Member States. Although the time series is short, the figure indicates that packaging waste generation is almost following the growth in GDP, even though there seems to be some relative de-coupling. From 1997 to 2001, the packaging waste generation and the GDP had increased 8,3% and 11% respectively.

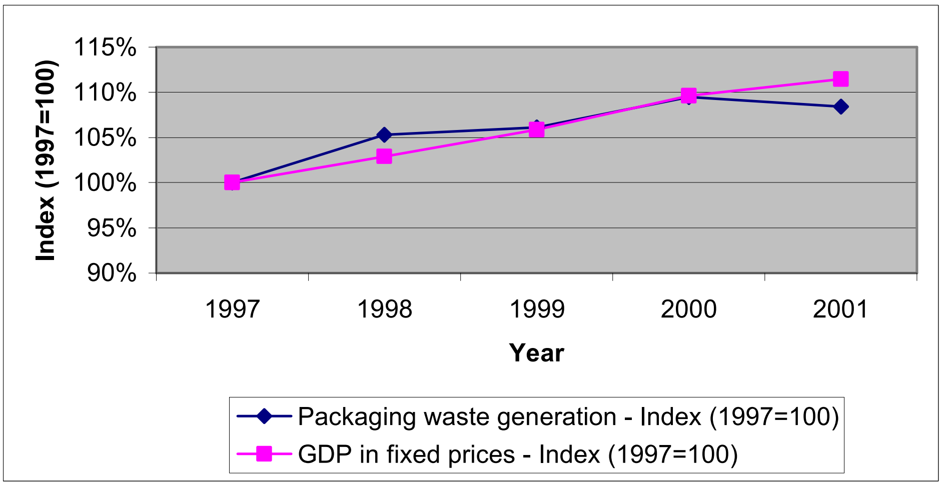


Figure 7: Packaging waste arisings vs. GDP

Commentary on the success of the implementation of the PPWD has already been put forward in many quarters. The report of the "Packaging Our Futures" conference[15] reported that there was general agreement that the Packaging and Packaging Waste Directive had been a success. Some of the comments made at the conference are outlined below:

[15] Shinn M. Report of Packaging our Futures conference. 1-2 March 2004. Brussels. European Voice.

There was general agreement that the PPWD had been a success for a variety of reasons:

- Graham Tombs, Head of Waste, Recycling and Environment, Essex County Council, UK: 'If it wasn't for packaging legislation we wouldn't have the rates of recycling that we do'.
- Susanne Hempden, EEB: 'One of the biggest achievements has been to help establish the concept of producer responsibility'.
- Mark Downs, DTI, UK: 'The Packaging Directive had resulted in increased dialogue between industry and enforcement agencies'.

A further report from Ecologic on Packaging Waste[16] reported that "although the [Packaging] Directive's implementation at Member State level has been slow and difficult, it has durably changed the way packaging waste issues are addressed in Europe and provoked major changes in the relations between the various actors in the packaging chain, governments and in the structure of waste treatment systems and secondary material markets in all European countries, as well as for the countries economically depending on them".

In addition to the above, PRO Europe, in their stakeholder comments to the authors also added that "the PPWD has led to a strong improvement of the environmental awareness of the European citizens. Sorting packaging waste has become a daily habit for millions of European households."

Clearly a Directive such as the PPWD will have both positive and negative effects on different actors. Information received from one of the projects sub-contractors (PTR ry, Finland) outlined some of the positive and negative effects of the PPWD in Finland but these are also applicable across many of the other Member States:

Positive effects of the PPWD

- The introduction of the Packaging and Packaging waste Directive 94/62/EC has led to more uniform legislation in the EU Member countries, even though there are different implementations of the legislation;
- Packers and fillers have increased their packaging knowledge;
- Packaging manufacturers, packer/fillers and trade have adopted more transparent methods of operation such as management standards;
- Data collection and statistics on packaging use, reuse and recovery have improved;
- In Finland:
  - Recycling and recovery of metals and plastics have increased; and
  - There are new job opportunities within recovery and recycling.

Negative effects of the PPWD

- Bureaucracy, especially with exports, has increased;
- Rising expenses;
- No Directive on marking of recyclability; and
- No precise definition of packaging although some examples are provided in the revised Directive 2004/12/EC.

[16] Eichstädt T et al. Packaging Waste: The Euro-level policy making process Final report for TEP project European Commission Framework Programme IV (1994-1998) Environment and Climate Programme of DG XII. Ecologic. June 2000.

The following sections of this chapter analyse the success of the implementation of the Directive 94/62/EC from an environmental, economic and social perspective.

1.7 IMPACTS OF THE DIRECTIVE EVALUATED FROM ENVIRONMENTAL PERSPECTIVE

1.7.1 Introduction

This sub-section of Task 1 investigates the environmental impact of the Packaging and Packaging Waste Directive 94/62/EC in relation to the recovery and recycling targets set. As the targets relate to the waste management of packaging waste, this sub-section will focus only on this part of the life cycle of packaging. To accommodate the full life cycle of packaging, section 1.8 has been included in order to put packaging waste arisings into context by including raw material production.

To achieve the objective of this part of Task 1, the environmental impacts have been assessed using a life cycle approach. As the study only considers the waste management of packaging waste, the study is not a life cycle assessment (LCA) in accordance with the ISO 14040ff standards on LCA, but a so-called gate-to-grave study. Nevertheless, the LCA technique and the methodology as laid out in the ISO standards have been applied.

It should be noted that due to financial and time constraints a detailed assessment of each packaging type has not been conducted. Instead selected packaging materials have been assessed representing a suitable range of household and industrial packaging waste streams.

As the aim is not to make exact calculations of the environment impacts but rather to estimate the magnitude of impact that the Directive has had, only existing data has been used in order to achieve this. Specific data such as energy mixes and transport distances by Member State along with the individual collection methods have not been used within the models.

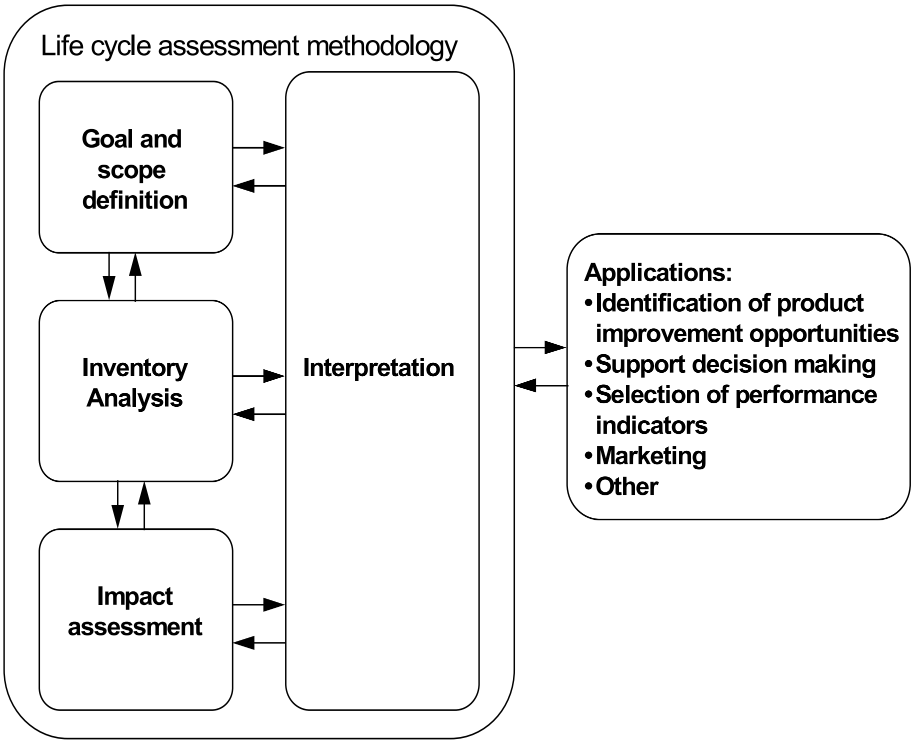
1.7.1.1 Life Cycle Assessment (LCA)

Life Cycle Assessment (LCA) is defined by ISO[17] as the "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle".

An LCA consists of several inter-related stages: goal and scope definition, inventory analysis, impact assessment and interpretation of results as shown in **Figure** 8 below.

[17] ISO 14040:1997 Environmental management – Life cycle assessment – Principles and framework.

Figure 8: The Phases of an LCA



Source: ISO 14040

The ***goal and scope definition*** involves identifying the intended purpose of the study, the functional unit, systems to be studied, system boundaries and issues relating to data quality.

In the ***inventory analysis***, data is collected and relevant inputs and outputs of the product system under study are quantified.

The ***impact assessment*** evaluates the magnitude and significance of potential environmental impacts using the life cycle inventory results. Impact assessment consists of three mandatory elements:

- Selection of impact categories, category indicators and characterisation models;
- Assignment of LCI results (classification) to the impact categories; and
- Calculation of category indicator results (characterisation)

In the ***interpretation*** stage of an LCA the results are analysed, conclusions are made, limitations are explained and recommendations are provided.

1.7.1.2 Goal and scope

GOAL

The goal of this section of the study is to evaluate the environmental impact/benefit associated with the implementation of the Packaging and Packaging Waste Directive 94/62/EC, in particular in relation to the recovery and recycling targets. The findings will feed into the report to be produced by the European Commission as a requirement of the PPWD (94/62/EC).

The aim of the study is not to make exact calculations but rather to estimate the magnitude of the impact that the Directive has had. To achieve this the environmental impacts have been assessed using a life cycle approach. As the targets relate to the waste treatment of packaging waste, this section will only consider this part of the life cycle of packaging. The assessment is therefore not a life cycle assessment in accordance with the ISO 14040ff standards on LCA, but a so-called gate-to-grave study. Nevertheless, the LCA technique and the methodology as laid out in the ISO standards have been applied.

It is important to note also that the analysis conducted is not a detailed assessment of each packaging type. Instead selected packaging materials have been assessed representing a suitable range of household and industrial packaging waste streams.

The environmental impact of the Directive is assessed through the use of three scenarios. The three scenarios used are outlined below.

The tonnage of packaging waste arising is assumed to be equivalent to the tonnage of packaging put on the market as shown in table 4 in section 1.4.2. For all three scenarios, the same tonnages of packaging waste arising have been used i.e. it has been assumed that the implementation of the Directive has had no influence on the tonnage of packaging waste arising.

All three scenarios utilise the same basic system with quantities to waste treatment (recycling, incineration and landfill) changing according to the waste treatment division in each scenario. For example, in Scenario 1, all waste treatment is either landfill or incineration with energy recovery, whereas in Scenarios 2 and 3, recycling is also included.

Scenario 1: Zero Recovery

Scenario 1, the Zero Recovery scenario, describes a hypothetical situation with no packaging recovery, no recycling and no individual Member State national measures on packaging and packaging waste management. Although a Zero Recovery scenario is unlikely to ever have occurred as several Member States already had recovery and recycling systems in place prior to the introduction of the Directive, the scenario provides a theoretical worst case scenario.

For scenario 1, packaging waste arising has been assumed to be disposed of according to the waste disposal split outlined in Table 8.

The data used for scenario 1 has been sourced from the RDC/Pira study[18] and is shown in Table 8 below. The percentage of municipal solid waste sent to landfill or incineration with energy recovery in each Member State was determined by RDC through consultation with a network of consulting companies. The data were based on data and forecasts for 2000.

Table 8 : Waste management split used for scenario 1

Member State	*Waste fraction incinerated*	*Waste fraction landfilled*
Austria	30%	70%
Belgium	50%	50%
Denmark	100%	0%
Finland	5%	95%
France	47%	53%
Germany	40%	60%

18 RDC /Pira. Evaluation of costs and benefits for the achievement of reuse and recycling targets for the different packaging materials in the frame of the packaging and packaging waste directive 94/62/EC. Final consolidated report. March 2003

Member State	*Waste fraction incinerated*	*Waste fraction landfilled*
Greece	0%	100%
Ireland	3%	97%
Italy	8%	92%
Luxembourg	70%	30%
Netherlands	50%	50%
Portugal	9%	91%
Spain	7%	93%
Sweden	65%	35%
UK	7%	93%

Scenario 2: Baseline Policy

Scenario 2, the Baseline Policy scenario, describes the possible situation in the absence of the Directive. It includes possible individual Member State recycling and recovery rates and other national measures as would have been likely based on estimates and extrapolations of the situation prior to the Directive. For example, for some Member States such as Germany, Finland and Sweden, collection and recovery systems (especially for materials such as glass, corrugated board and paper) were developed before the implementation of the Directive. For these Member States this scenario is considered unlikely to be different from the actual situation.

Work was conducted with the consultants Perchards investigating the likely national legislation, which would have been in place in the individual Member States and the impact that this legislation would have had on the recovery and recycling rates. The EU15 estimated recovery and recycling rates are shown in table 9 below. The more detailed figures are outlined in Annex 1. The background information relating to the assumptions can be found in Annex 2. Annex 2 contains information relating to two estimated scenarios – scenario 2a and scenario 2b. Scenario 2a takes into account pre-existing legislation, but no new legislation in Member States. Scenario 2b takes into account pre-existing legislation plus new legislation in those Member States that opted to set stricter targets than those laid down in the Directive. As a result, where scenarios 2a and 2b differ, the higher recycling rates always appear in scenario 2b. For this reason, scenario 2a was chosen as it results in the greatest difference between this scenario and those obtained for scenario 3, the Packaging Directive scenario, as described below.

Table 9 : Estimated EU15 recovery and recycling for scenario 2 for the period 1997 to 2001

		1997 (tonnes)	1998 (tonnes)	1999 (tonnes)	2000 (tonnes)	2001 (tonnes)
Glass	Recovery	7,841,311	7,740,701	8,027,375	7,822,475	7,550,735
	Recycling	7,481,311	7,740,701	8,027,375	7,822,475	7,550,735
PET bottles	Recovery	2,848,413	3,190,914	3,451,481	3,746,993	3,978,638
	Recycling	1,521,040	1,674,677	1,760,805	1,858,572	1,999,579
Aluminium	Recovery	190,259	191,982	194,282	209,155	222,130
	Recycling	189,182	190,907	192,713	204,442	218,061
Steel	Recovery	1,712,331	1,727,841	194,2819	2,091,546	2,221,296
	Recycling	1,702,636	1,718,165	1,927,131	2,044,424	2,180,607

PE film	Recovery	2,848,413	3,190,914	3,451,481	3,746,993	3,978,638
	Recycling	1,521,040	1,674,677	1,760,805	1,858,572	1,999,579
Corrugated	Recovery	15,541,465	16,920,666	17,427,396	18,121,196	18,219,447
	Recycling	13,577,617	15,274,998	15,280,760	15,822,154	16,142,463

For waste arising above that recovered, the percentage split between landfill and incineration as outlined in scenario 1 has been used. For example, in Austria in 1997, 180,000t of plastic waste was generated of which 82,000t was recovered leaving 98,000t for disposal. The 98,000t will be assumed to be disposed of according to the fractions given for Austria above i.e. 70% to landfill and 30% being incinerated. The incinerated portion is assumed to be incinerated with energy recovery.

Scenario 3: Packaging Directive

Scenario 3, the Packaging Directive scenario, describes the actual situation with the Packaging and Packaging Waste Directive in place. Data are based on the data submissions made by Member States to the European Commission. The EU15 recovery and recycling rates are shown in Table 15 below. The more detailed figures are outlined in Annex 1.

Table 10 : Estimated EU15 recovery and recycling for scenario 3 for the period 1997 to 2001

		1997 (tonnes)	1998 (tonnes)	1999 (tonnes)	2000 (tonnes)	2001 (tonnes)
Glass	Recovery	7,394,077	7,926,978	8,454,130	8,503,259	8,215,579
	Recycling	7,394,077	7,926,978	8,454,130	8,503,259	8,215,579
PET bottles	Recovery	2,903,575	3,272,300	3727276	4,062,925	4,351,051
	Recycling	1,582,299	1,768,633	2,075,230	2,220,828	2448639
Aluminium	Recovery	192,997	194,999	210,813	247,525	250,108
	Recycling	191,790	193,924	209,339	244,825	248,404
Steel	Recovery	1,736,971	1,754,990	189,7313	2,227,721	2,250,975
	Recycling	1,726,106	1,745,314	1,884,055	2,203,421	2,235,635
PE film	Recovery	2,903,575	3,272,300	3,727,276	4,062,925	4,351,051
	Recycling	1,582,299	1,768,633	2,075,230	2,220,828	2,448,639
Corrugated	Recovery	15,793,695	17,419,053	17,987,589	19,057,315	19,512,610
	Recycling	1,3851,026	15,457,966	15,874,080	16,824,261	17,532,348

Similarly to scenario 2, for waste arising above that recovered, the disposal rates as outlined in scenario 1 have been used.

SCOPE

Function of the systems studied and functional unit

In order to enable the environmental impacts of the different systems to be studied, a functional unit was determined based on the function of the systems. The functional unit of each system studied was defined as ***the management of the total weight of packaging waste generated annually in the EU15***

under the three scenarios with the reference years being 1997 through to 2001 inclusive. The reference flows i.e. the tonnes of packaging waste arising by packaging type in the EU15 by year based on Member State submissions are shown in Table 16 below.

Table 11 : Reference flows (EU15 packaging waste arising by packaging type for the period 1997 to 2001)

	1997 *(t)*	*1998* *(t)*	*1999* *(t)*	*2000* *(t)*	*2001* *(t)*
Glass	14,986,689	15,148,101	15,378,179	14,903,182	14,611,610
PET bottles	9,662,216	9,856,749	10,093,441	10,294,880	10,707,805
Aluminium	439,557	457,942	441,688	462,838	463,100
Steel	3,956,015	4,121,474	3,975,195	4,165,541	4,167,896
PE film	9,962,216	9856749	10093441	10294880	10707805
Corrugated board	23,655,288	25,203,955	25,728,180	26,380,803	26,281,032

The quantity of packaging waste arising per year was chosen as the functional unit, as the goal of the study was to investigate the impacts/benefits of the implementation of the PPWD. Full packaging LCAs, considering the whole life cycle, generally use a certain quantity of product delivered as the functional unit. However this is not considered appropriate for the packaging systems studied as only the impacts of waste treatment is being considered.

Systems to be studied

Packaging is very diverse in nature and performs a number of different functions as outlined in section 1.3 Specific functions depend on the nature of the product and the level of packaging being discussed. For example, packaging may be primary packaging going into a household or transport packaging facilitating the collation and distribution of a number of discrete units, which is later removed in a distribution centre or back of store. Within each material type there are a vast array of different packaging systems, for example a steel primary pack could be a 200l steel drum for chemicals or a 200g food can being used in the household.

Given the scope of the project and data availability, it has been impossible to include all permutations of packaging within the models constructed and as a consequence only a limited number of packaging types are represented. Additionally, submissions by Member States relate to material only and are not split down by packaging type or origin i.e. household, commercial or industrial. The packaging systems studied were therefore chosen to represent a range of household, commercial and industrial systems and are outlined in the table below..

Table 12: Systems studied

Material	*Collection type*
Aluminium	Household Kerbside collection
Steel	Household Kerbside collection
PET bottle waste	Household Kerbside collection
Glass	Household Bring scheme
Corrugated board	Industrial collection
PE Film	Industrial collection

The collection methods chosen have been necessarily simplified and may therefore not represent actual collection methods in all Member States. For example, in Denmark cans are generally collected by deposit/return schemes rather than by kerbside collection.

System boundaries

The systems constructed include the waste management of packaging waste only. This includes the collection of the waste and the waste treatment. Production and use phases of the packaging have been excluded although these systems are put into the context of packaging production in section 1.8. Figure 9 illustrates a typical system.

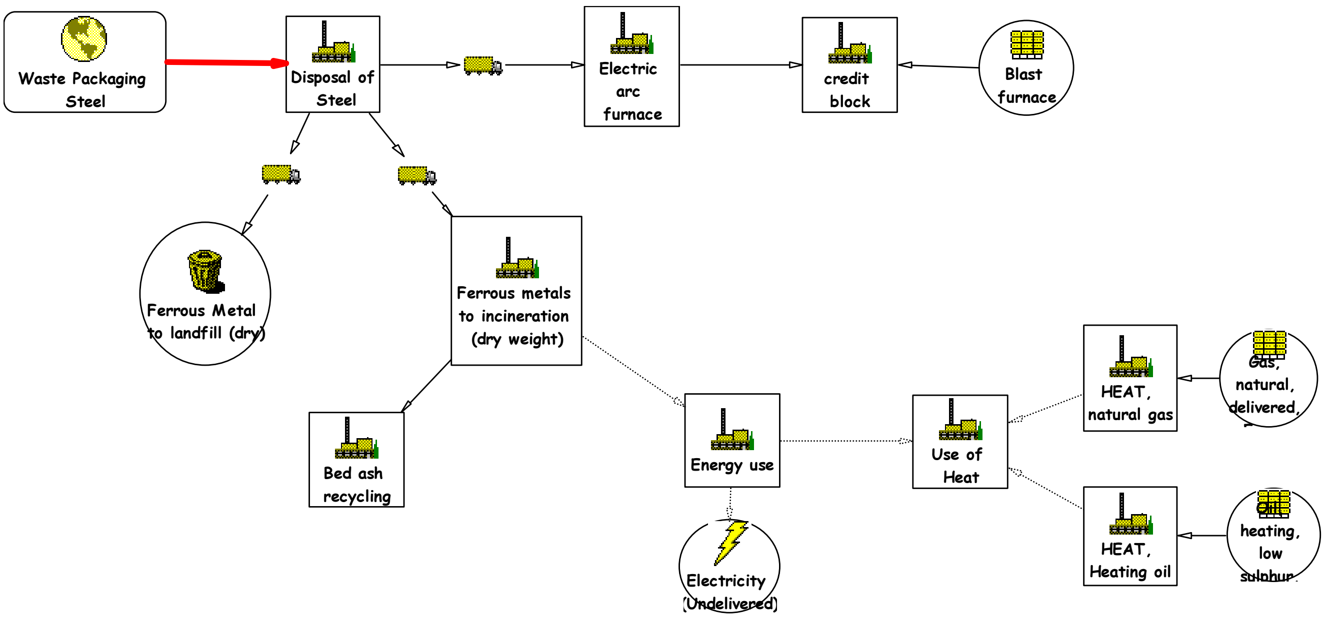


Figure 9 : Illustrative waste treatment system

The study concentrates on the impacts that have in the past resulted from the implementation of Directive 94/62/EC. As such, this section refers only to the EU15 and not the enlarged EU25.

Due to the lack of data transparency, it has been assumed that no transboundary movement of packaging waste occurs. Transboundary movement of packaging waste has been considered to some extent in the sensitivity analysis, however only to ascertain the impact of increased transport for packaging waste exported to the Far East.

Waste Treatment

Waste treatment is generally considered within the EU waste framework to include waste disposal and recovery operations. Within this context, disposal encompasses landfilling and incineration and excludes recovery. Incineration of unsorted MSW in waste-to-energy plants is normally classed as a disposal operation[19] whereas the incineration with energy recovery of separately collected fractions of packaging waste (for example, in cement kilns) is classed as recovery. However, as indicated above, for reasons of readability the term recovery as used in this study generally is meant to include incineration at waste incineration plants with energy recovery, even if this is not specifically indicated.

Recycling is defined in Article 3(7) of Directive 94/62/EC as

"recycling shall mean the reprocessing in a production process of the waste materials for the original purpose or for other purposes including organic recycling but excluding energy recovery"

Incineration

Due to lack of data availability, no differentiation has been made within this study of waste being disposed of within a MSW waste-to-energy plant or waste being recovered by co-incineration, for example in cement kilns.

Where material is incinerated, the production of useful energy (heat and electricity production) has been included with a split of 57% to heat and 28% to electricity with some losses[20] and has been included as a credit to the system. This split is considered by some stakeholders to be too high for the time frame studied. The sensitivity of the systems to this data has therefore been considered within sensitivity analysis.

Recycling

The recycling of source separated material reduces the need for the use of virgin material. Material recycling has therefore been included as a credit to the system as outlined in table 13.

Table 13 : Recycling credits

Packaging Material	
Glass	Credited against production of glass
PET bottles	Credited against the production of amorphous PET
Aluminium	Credited against the production of an aluminium ingot
Steel	Assumed to be recycled in an Electric Arc Furnace. This is credited against material produced in a Blast Furnace/BOF
PE Film	Recycled PE is credited against the production of LDPE film

[19] The European Court of Justice judgement in case C-458/00 was that the primary objective in a dedicated municipal waste incinerator is waste disposal. The Court added that this classification as a disposal operation is not changed if, as a secondary effect of the process, energy is generated and used.

[20] Percentages derived from ideal plant in Sundqvist JO. Life cycles assessment and solid waste – guidelines for solid waste treatment and disposal in LCA. Final Report December 1999. IVL, Swedish Environmental Research Institute.

Corrugated	Assumed that recycled test liner is produced and credited against virgin kraftliner

<u>Landfill</u>

Data relating to the disposal of material by landfilling was extracted from the Environment Agency study "Life Cycle Inventory Development for Waste Management Operations: Landfill".

Collection and transportation

The transport distances used were extracted from the RDC study[21] and are outlined in table 14 below. The transport distances chosen relate to areas with high population density (>200 inhabitants/km).

Table 14: Transport distances for collection of the different packaging waste materials (high population density areas)

Material	*Transport to landfill*	*Transport to incineration*	*Transport to recycling*
Aluminium	9.7km	9.7km	64.4km to sorting 53.35km to recycling
Steel	9.7km	9.7km	64.4km to sorting 12.5km to recycling
PET bottle waste	9.7km	9.7km	64.4km to sorting 23.05km to recycling
Glass	9.7km	9.7km	27.6km to sorting 5.8km to recycling
Corrugated board	4.2km	4.2km	4.2km
PE Film	4.2km	4.2km	39.6km

Energy data

Average European energy data has been used throughout. It is recognised that in reality different Member States have different energy mixes and hence different environmental impacts, however using average European energy data is considered appropriate considering the goal and scope of this study.

Capital equipment

The production and maintenance of capital equipment (factories, trucks etc) are excluded from the study.

[21] RDC/Pira. Evaluation of costs and benefits for the achievement of reuse and recycling targets for the different packaging materials in the frame of the Packaging and Packaging Waste Directive 94/62/EC. Final consolidated report. March 2003.

Overhead operations

Lighting, heating, and other overhead operations are not included in the study unless otherwise indicated. In general overhead operations do not contribute significantly to the environmental impact of industrial processes.

Impact categories

The impact categories chosen are shown in Table 15 below. They are based on a subset of the CML 1992 life cycle impact assessment method as applied in Pira International's LCA software, PEMS.

Table 15: Impacts reported

Impact categories	*Description*
Abiotic (resource) depletion potential (kg oil equiv.)	Refers to the depletion of abiotic resources such as fossil fuels, minerals, clay and peat.
Global warming potential (kg CO2 equiv.)	Greenhouse gases, such as CO2, methane, CFCs and HCFCs, all have the property of absorbing energy and emitting thermal infra-red radiation. An increase in the atmospheric concentration of these gases will change the absorption of infra-red radiation in the atmosphere, known as radiative forcing.
Acidification potential (kg SO2 equiv.)	Acidification is the process whereby air pollution, from, for example ammonia, sulphur dioxide and nitrogen oxides is converted into acid substances.
Aquatic ecotoxicity potential (m3 polluted water)	This category refers to the effects of various substances such as metals, hydrocarbons etc. on a population.
Human toxicity potential (kg/kg body weight)	This category refers to the effects of substances such as metals, hydrocarbons etc. on human health.
Nutrification potential (kg PO43- equiv.)	Nutrification is caused by the addition of nutrients to a soil or water system, which leads to an increase in biomass.
Ozone depletion potential (kg CFC-11 equiv.)	This category has been developed to express the potential contribution which gases such as CFCs contribute to the depletion of the ozone layer. Changes in atmospheric ozone will modify the amount of harmful UV radiation penetrating the earth's atmosphere.
Smog (Photochemical oxidant formation potential) (kg ethylene equiv.)	The formation of photochemical ozone is the result of complex reactions between VOCs and NOX under the influence of sunlight (UV radiation). The most important man-made emissions of VOCs derive from road traffic and the use of organic solvents. For NOX, the main contribution comes from energy production.

Note: No normalisation has been conducted on the results and therefore results should not be compared between categories.

Note: Energy (MJ) will also be included as it often provides a good indicator of impacts. However, it should be pointed out that energy is not an impact category in LCA terms.

Data requirements

As stated in goal section, the aim of the assessment is not to make exact calculations but rather to estimate the magnitude of the impact that the PPWD has had on packaging waste management within the EU15. For this purpose publicly available data that represent European averages has been used with no collection of new data.

Data relating to the waste treatment of packaging waste arisings was obtained from the RDC/Pira study. The sources used by RDC/Pira are outlined in Annex 21.

Energy data represent average European energy data obtained from the ETH-ESU 1996 dataset[22].

Assumptions

The results obtained will be dependent on the data used and the assumptions made. Some key assumptions relating to the models used are outlined below:

General

- All packaging waste is collected in areas of high population density
- All Member States utilise the same technologies
- It is assumed that the distances travelled are the same in all Member States although in reality this will vary depending on the type of collection system used and distances to disposal or recycling facilities
- Systems for both steel and aluminium were constructed from the data for "metals" provided by the Commission. It was assumed that 90% of "metals" is steel and 10% is aluminium
- The impacts of both PET bottles and PE film have been considered since PET bottles alone are not representative of the Packaging waste mix and represent the "best case" scenario[23].

Incineration

[22] Frischknecht, R., Bollens, U., Bosshart, S., Ciot, M., Ciseri, L., Doka, G., Dones, U., Hischier, R., Martin, A. (1996) Ökoinventare von Energiesystemen. Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. Auflage No. 3, Gruppe Energie - Stoffe - Umwelt (ESU), Eidgenössische Technische Hochschule, Zürich & Sektion Ganzheitliche Systemanalysen, Paul Scherrer Institut, Villigen/Würenlingen. Bundesamt für Energiewirtschaft, Bern.

[23] The assumption that all recycled plastics are PET/PE is necessary given the lack of data regarding the mix of plastics recycled. It is likely to be a fair assumption, since PET and PE are the most commonly recycled plastics. The assumption is less accurate for plastics placed on the market, but this is unlikely to be problematic since the environmental impacts are similar of most plastics during incineration and landfilling.

- The production of useful energy (heat and electricity production) has been included with a split of 57% to heat (with 30% losses) and 28% to electricity
- Waste not recovered is assumed to be managed through incineration with energy recovery and landfilling according to the data outlined in Table 8
- Material recovered but not recycled has been assumed to be processed via incineration with energy recovery in all cases
- Incineration via MSW incinerators and co-incineration in cement kilns has been assumed to produce the same impacts

Recycling

- Glass recycling is not colour specific
- Aluminium recycling has been considered as aluminium beverage can recycling
- Steel recycling has been considered as steel can recycling
- Paper recycling has been considered as corrugated board recycling
- It has been assumed that all recycling has been carried out domestically, whereas in reality significant quantities of some materials will have been exported from Member States, for example, plastic film from the UK to China (this aspect has not been taken into account due to a lack of readily available data relating to the percentage of waste material exported etc)

Limitations

The study aims only to provide an overview of the magnitude of the impact that the PPWD has had on packaging waste management within the EU15. It does not make detailed calculations based on technologies used within individual Member States.

Critical review

No provisions were made for critical review.

1.7.2 Results and discussion

This section presents the life cycle impact assessment (LCIA) results generated for each scenario for each of the systems outlined in table 12. The results are discussed taking into consideration the life cycle inventory results and the goal and scope.

It must be emphasised that the intention of this assessment is to provide information relating to indicative trends for the EU15 rather than absolute data. Absolute data would require, for example, a detailed investigation of the collection scenarios of each Member State by material, detailed information relating to technologies used in recycling, incineration and landfill, accurate data relating to exported material and transportation distances etc, which was not possible for this study. The intended purpose of this study and its application, its goal and scope, very much dictates the interpretation of the results and the conclusions that can be drawn. Due to the streamlined nature of the study, detailed conclusions cannot be drawn.

1.7.2.1 Results for glass

The LCIA results generated for the glass system are outlined in the graphs in Figure 10-Figure 18. They are based on the waste treatment of the total weight of glass packaging waste arising annually from the EU15 under the three scenarios outlined in section 1.7.1.2. Reference years are 1997 through to 2001. For detailed data relating to the quantity of material by waste treatment method per year see Annex 1.

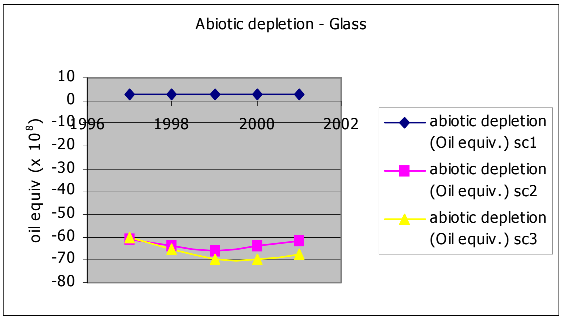


Figure 10: Abiotic depletion – Glass

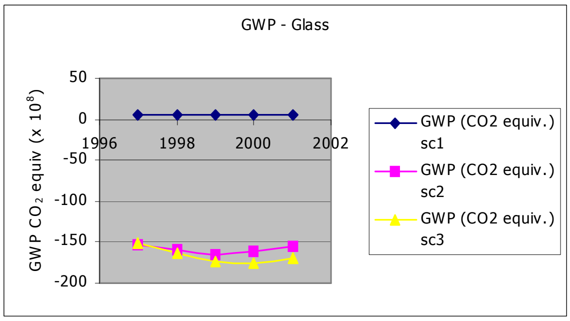


Figure 11: GWP – Glass

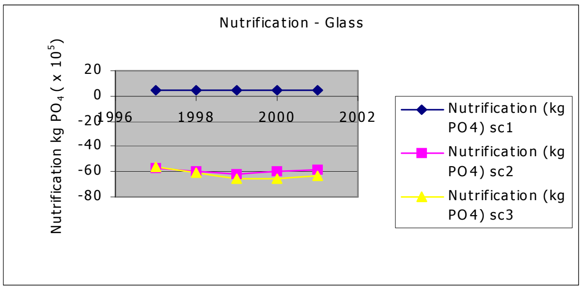


Figure 12: Nutrification – Glass

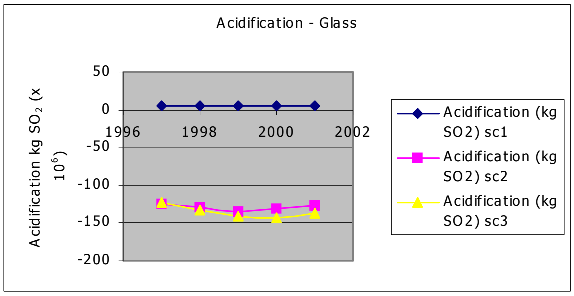


Figure 13: Acidification – Glass

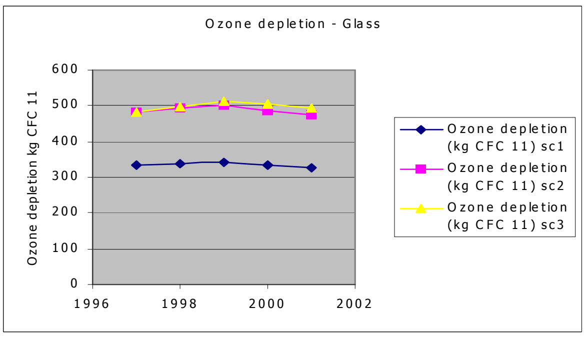


Figure 14: Ozone depletion – Glass

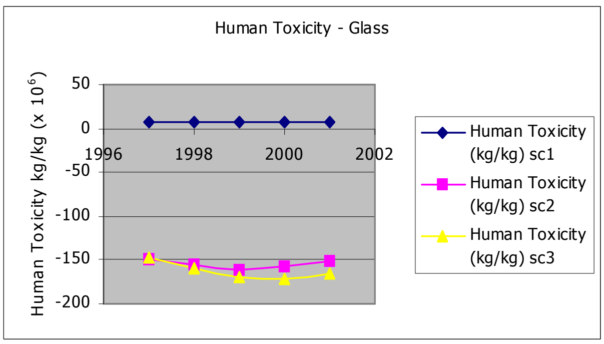


Figure 15: Human Toxicity – Glass

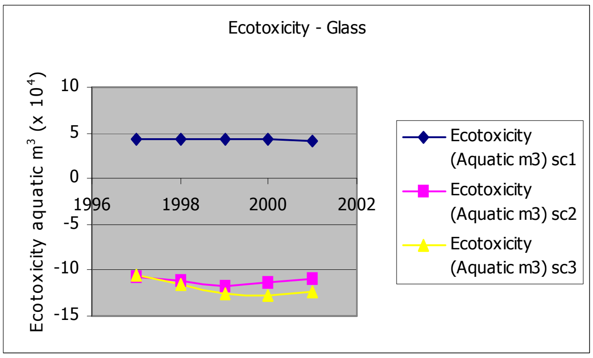


Figure 16: Ecotoxicity - Glass

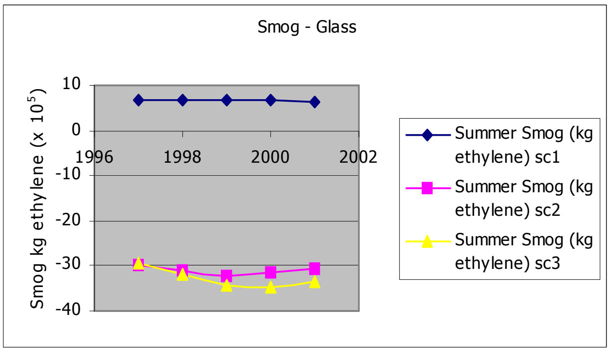


Figure 17: Smog - Glass

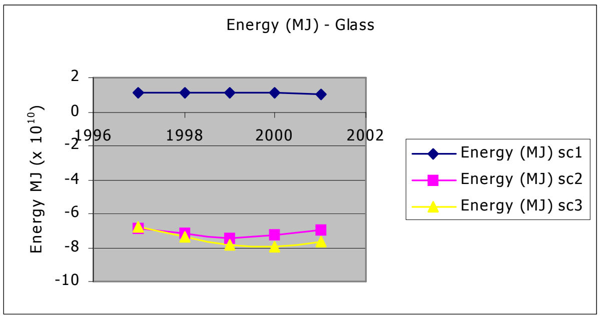


Figure 18: Energy - Glass

As expected, scenario 1, which considers only landfill and incineration, has a higher environmental impact than scenario 2 and 3 which both also include recycling. Of scenario 2 and 3, scenario 2 has a higher environmental impact than scenario 3 due to the lower quantity of waste going to recycling compared to scenario 3.

The trend of the graphs is a function of the amount of packaging waste arising and the quantity going to landfill, incineration and recycling respectively. For example, for scenario 3, the graph shows decreasing impacts from 1997 to 2000 followed by a slight increase in impacts in 2001. Table 16 shows that the amount of glass being recycled follows this same trend with increasing quantities of material being recycled from 1997 to 2001.

Table 16: Glass recovery and recycling 1997-2001 (tonnes) (Scenario 3)

	1997	*1998*	*1999*	*2000*	*2001*
Packaging waste arising	14,986,689	15,148,101	15,378,179	14,903,182	14,611,610
Recovery	7,394,077	7,926,978	8,454,130	8,503,259	8,215,579
Recycling	7,394,077	7,926,978	8,454,130	8,503,259	8,215,579
Disposal	7,592,612	7,221,123	6,924,049	6,399923	6,396,031

The recovery and recycling figures for glass used in scenario 2 are shown in Table 17 and indicate a similar trend to scenario 3. In this case however, the amount of material being recycled reaches a peak in 1999 before dropping down to 2001 levels.

Table 17: Glass recovery and recycling 1997-2001 (Scenario 2)

	1997	*1998*	*1999*	*2000*	*2001*
Packaging waste arising (t)	14,986,689	15,148,101	15,378,179	14,903,182	14,611,610
Recovery	7,481,311	7,740,700	8,027,375	7,822,473	7,557,609
Recycling	7,481,311	7,740,700	8,027,375	7,822,473	7,557,609
Disposal	7,505,378	7,407,401	7,350,804	7,080,709	7,054,001

Table 18 provides an example illustrating where the main impacts arise for the waste management of glass and shows the LCIA results for scenario 3 for the year 2001. As can be seen, all of the impacts associated with glass recycling (with the exception of ozone depletion) are negative. This is a result of the system boundaries for recycling which credits the system for avoided burdens associated with the production of virgin material (ie recycled material is replacing the production of virgin material and therefore the burdens associated with it). For scenario 3, the credits obtained through recycling of glass outweigh the impacts associated with other waste treatment options and transportation of material to waste treatment.

Table 18: Glass waste treatment – scenario 3, 2001

	Total	*Transport*	*Glass to landfill*	*Glass recycling*	*Glass to incineration*
Abiotic depletion (million tonnes Oil equiv.)	-6.8	1.2×10^{-1}	4.0×10^{-2}	-7.0	4.3×10^{-2}
Energy (million MJ)	$-7.7 \times 10^{+4}$	$5.0 \times 10^{+3}$	$8.8 \times 10^{+2}$	$-8.5 \times 10^{+4}$	$2.3 \times 10^{+3}$
GWP (million tonnes CO_2 equiv.)	$-1.7 \times 10^{+1}$	3.5×10^{-1}	4.7×10^{-2}	$-1.7 \times 10^{+1}$	1.2×10^{-1}
Acidification (million tonnes SO_2)	-1.4×10^{-1}	1.4×10^{-3}	6.2×10^{-4}	-1.4×10^{-1}	1.1×10^{-3}
Ecotoxicity (Aquatic million m^3)	-1.2×10^{-1}	1.3×10^{-2}	1.1×10^{-2}	-1.5×10^{-1}	4.4×10^{-3}
Human Toxicity (million tonnes/kg)	-1.6×10^{-1}	3.8×10^{-3}	8.0×10^{-4}	-1.7×10^{-1}	1.5×10^{-3}
Nutrification (million tonnes PO_4)	-6.4×10^{-3}	2.0×10^{-4}	6.5×10^{-5}	-6.7×10^{-3}	6.6×10^{-5}
Ozone depletion (million tonnes CFC 11)	4.9×10^{-7}	3.7×10^{-7}	2.1×10^{-8}	5.9×10^{-8}	4.6×10^{-8}
Summer Smog (million tonnes ethylene)	-3.4×10^{-3}	5.1×10^{-4}	1.2×10^{-4}	-4.1×10^{-3}	6.2×10^{-5}

Looking more closely at Table 18, using the global warming potential as an example, the recycling credit is –17.4million tonnes CO2 equivalent. This far outweighs the impacts of transport, landfill and incineration combined, leaving the total global warming potential for scenario 3 for glass for 2001 t –16.8 million tonnes CO2 equivalents. The principal reason for the large negative figure for recycling is the energy requirement for recycling glass which is much lower than that required for producing virgin glass. By crediting the avoided virgin glass production, a large overall negative figure is obtained.

As mentioned earlier, the graph of the impact category ozone depletion follows a different trend from those of the other impact categories and energy. Generally, packaging LCA's show very low results for the impact category ozone depletion as the production, use and disposal of packaging results in the release of very few ozone depleting gases (such as CFC's, tetrachloromethane, HCFCs and halons). This is also the case for glass in this study where the ozone depletion potential only amounts to around 500kg CFC-11 equivalents for the total amount of glass packaging waste arising in the EU15 for the year 2001. The impacts associated with ozone depletion arise from the disposal processes and from transport, with the largest single quantity from transport. This accounts for the higher ozone depletion potential results arising from scenarios 2 and 3 as compared to scenario 1 as material is transported further for disposal via recycling than for either incineration or landfill. The ozone depletion potential will have higher results for scenario 3 compared to scenario 2 as scenario 3 has higher quantities of material being recycled than scenario 2 and hence higher impacts. The decrease in the overall amount of material being recovered and recycled in 2001 is translated into a decreased impact for this category as compared to previous years.

Conclusion

The generated LCIA results indicate that, using the systems as set up in this study, glass recycling had a clearly positive effect on the environment. Among the 14.6 million tonnes of glass waste arisings in 2001, 8.2 million tonnes or 56.2% have been diverted from landfills to recycling. This has led to resource savings of around 7 million tonnes of oil equivalent and reduced greenhouse gas emissions of EU15 by around 17 million tonnes of CO_2 equivalent compared to a scenario of no recycling. This is mainly related to the energy savings by replacing glass production from virgin materials by recycling.

However, only a small part of these savings is directly related to the effects of the Packaging and Packaging Waste Directive. Most of the glass recycling would also have taken place in the absence of the Directive, either because it is economically profitable or because of pre-existing national legislation. The direct effect of the Packaging and Packaging Waste Directive is estimated at reducing glass waste to landfill by around 0.66 million tonnes or around 8% of total glass recycling in EU15. Among the total resource savings around 0.6 million tonnes of oil equivalent or 9% and among the total reduction of CO_2 emissions around 1.5 million tonnes of CO_2 equivalent or 9% can be attributed to the direct effect of the Packaging and Packaging Waste Directive.

Transport impacts seem to play a relatively small role. For example, the transport related greenhouse gas emissions during the entire waste treatment are around 2% of the greenhouse gas savings related to the replacement of virgin material by recycled glass. Only at transport distances far beyond 1000 km, impacts may become more significant.

The percentage improvements compared to scenario 1 are shown in table 19.

Table 19: Percentage improvements compared to scenario 1 (2001)

Impact	*Unit*	*Scenario 2*	*Scenario 3*	*Improvement Scenario 3 compared to Scenario 2*
Abiotic depletion	*Kg oil equiv*	2389	2606	9%

GWP	*Kg CO2 equiv*	2596	2931	9%
Acidification	*Kg S)2*	2529	2758	9%
Energy	*MJ*	652	716	10%
Ozone depletion	*Kg CFC11*	45	51	4%
Human Toxicity	*Kg/Kg*	2001	2184	9%
Ecotoxicity	*Aquatic m3*	264	295	12%
Summer smog	*Kg ethylene*	475	524	10%

1.7.2.2 Results for PET

The LCIA results generated for PET bottle system are shown in the graphs in Figure 19-Figure 27. They are based on the waste treatment of the total weight of plastic packaging waste arising annually from the EU15 (assumed to be all PET) under the three scenarios described in section 1.7.1.2. Reference years are 1997 through to 2001. For detailed data relating to the quantity of material by waste treatment method per year see Annex 1.

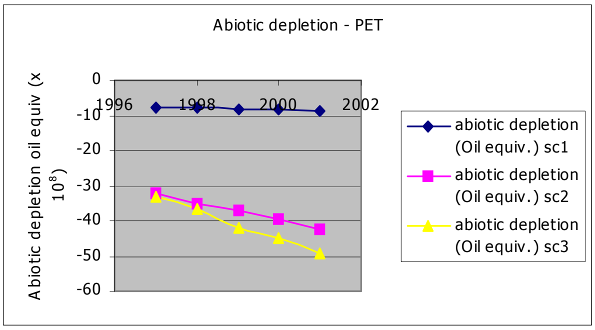


Figure 19: Abiotic depletion - PET

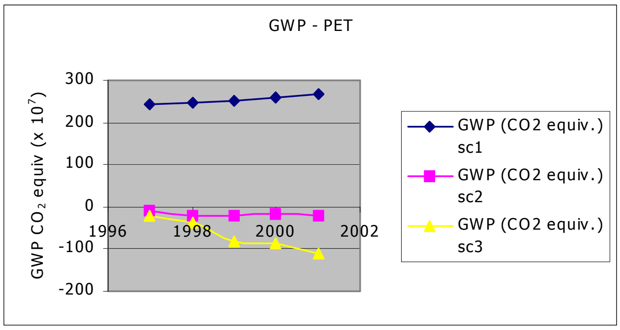


Figure 20: GWP - PET

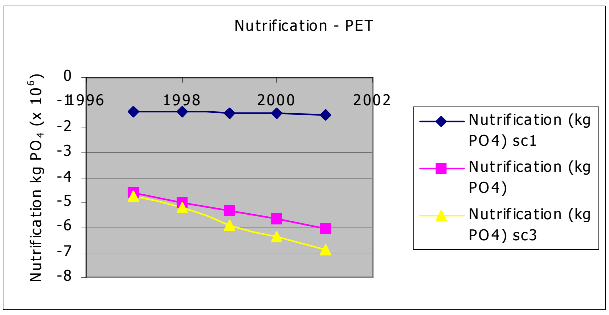


Figure 21: Nutrification - PET

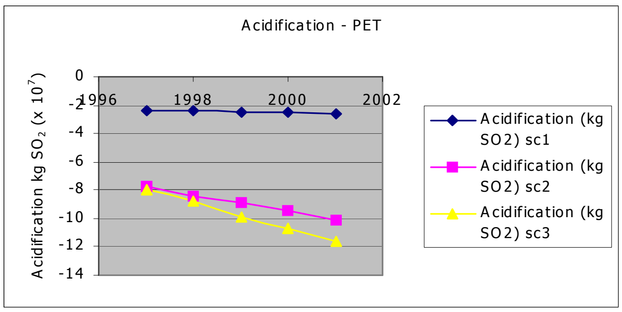


Figure 22: Acidification - PET

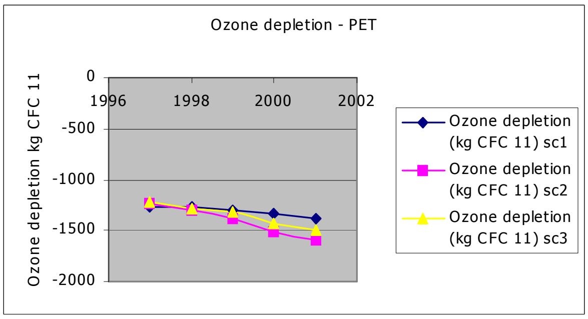


Figure 23: Ozone depletion - PET

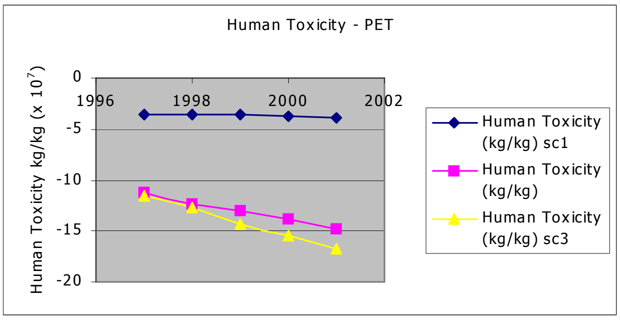


Figure 24: Human Toxicity - PET

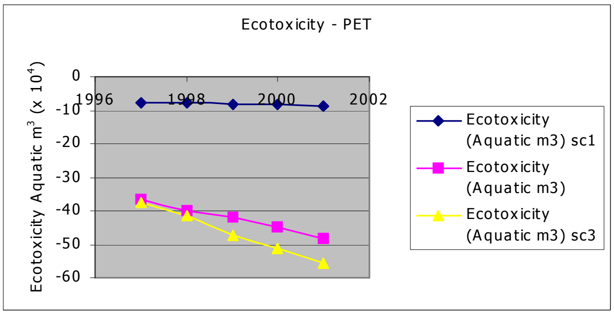


Figure 25: Ecotoxicity - PET

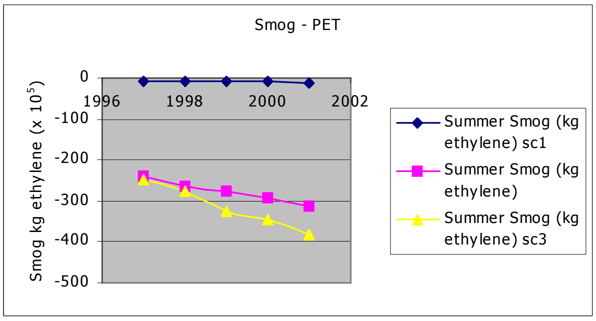


Figure 26: Smog - PET

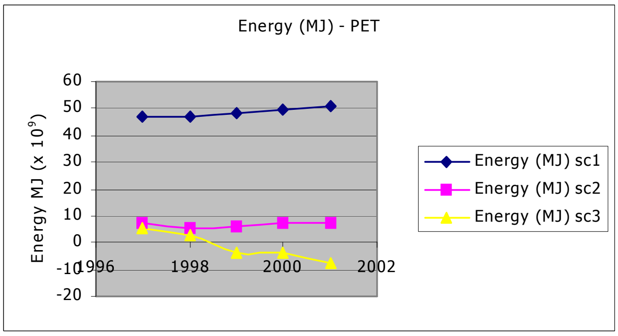


Figure 27: Energy - PET

As expected, and similar to the results for glass, scenario 1 has a significantly higher environmental impact than either scenario 2 or 3.

Scenario 2, and to some extent, scenario 3 shows significant year on year decrease in environmental impacts, which is generally due to an increase in the recycling rate year on year. In general terms, the graphs for the impact categories abiotic depletion, nutrification, acidification, human toxicity, ecotoxicity and smog follow very similar trends with the overall impact of scenarios 2 and 3 decreasing over time as levels of recovery and recycling increase. Table 20 and Table 21 show the steady increase in plastics recovery and recycling over the reference period.

Table 20: Plastic recovery and recycling 1997-2001 (Scenario 3)

	1997	*1998*	*1999*	*2000*	*2001*
Recovery (t)	2,903,575	3,272,300	3,727,276	4,062,925	4,351,051
Recycling (t)	1,582,299	1,768,633	2,075,230	2,220,828	2,448,639
Packaging waste arising(t)	9,662,216	9,856,749	10,093,441	10,294,880	10,707,805

Table 21: Plastic recovery and recycling 1997-2001 (Scenario 2)

	1997	*1998*	*1999*	*2000*	*2001*
Recovery (t)	2,848,412	3,190,913	3,451,481	3,746,993	3,978,638
Recycling (t)	1,521,041	1,674,677	1,760,805	1,858,572	1,999,578
Packaging waste arising(t)	9,662,216	9,856,749	10,093,441	10,294,880	10,707,805

Table 22 provides an example illustrating where the main impacts arise for the waste treatment of PET bottles and shows the LCIA results for scenario 3 for the year 2001. As can be seen, all of the impacts associated with PET recycling, with the exception of ozone depletion, and all of the impacts associated with PET incineration with energy recovery, except for global warming, show an environmental benefit (ie the figures are negative). This is due to the crediting for avoided virgin material for PET recycling and for avoided fossil fuel extraction for incineration. Considering the whole of scenario 3, the table shows that the credits obtained from the recycling and recovery for 2001 outweighs the environmental impacts.

Table 22 : PET waste treatment - scenario 3, 2001

	Total	*Transport*	*PET to landfill*	*PET recycling*	*PET to incineration*
Abiotic depletion (million tonnes Oil equiv.)	-4.9	$1.0x10^{-1}$	$4.9x10^{-2}$	-3.9	-1.2
Energy (million MJ)	$-7.5x10^{+3}$	$4.3x10^{+3}$	$1.2x10^{+3}$	$-7.1x10^{+4}$	$5.8x10^{+4}$
GWP (million tonnes CO_2 equiv.)	-1.1	$3.0x10^{-1}$	$6.1x10^{-2}$	-4.5	3.0
Acidification (million tonnes SO_2)	$-1.2x10^{-1}$	$1.2x10^{-3}$	$8.4x10^{-4}$	$-8.4x10^{-2}$	$-3.4x10^{-2}$
Ecotoxicity (Aquatic million m^3)	$-5.6x10^{-1}$	$1.1x10^{-2}$	$1.3x10^{-2}$	$-4.5x10^{-1}$	$-1.3x10^{-1}$
Human Toxicity (million tonnes /kg)	$-1.7x10^{-1}$	$3.2x10^{-3}$	$1.0x10^{-3}$	$-1.2x10^{-1}$	$-5.0x10^{-2}$
Nutrification (million tonnes PO_4)	$-6.9x10^{-3}$	$1.7x10^{-4}$	$9.4x10^{-5}$	$-5.1x10^{-3}$	$-2.1x10^{-3}$
Ozone depletion (million tonnes CFC	$-1.5x10^{-6}$	$3.1x10^{-7}$	$2.5x10^{-8}$	$7.0x10^{-9}$	$-1.8x10^{-6}$

11)					
Summer Smog (million tonnes ethylene)	-3.8×10^{-2}	4.4×10^{-4}	1.4×10^{-4}	-3.7×10^{-2}	-1.7×10^{-3}

As mentioned above, incineration of PET shows an environmental benefit in all impact categories except for global warming. The environmental impact associated with global warming is due in part to the amounts of CO2 being emitted from the incineration process. The difference shown between scenario 2 and scenario 3 (figure 20) is due to the relative amounts of material going to recycling and incineration (Table 23).

Table 23: Tonnage differences between 1997 and 2001 levels for material to recycling, incineration and landfill

	Difference 1997-2001 Scenario 2	*Difference 1997-2001 Scenario 3*
Material to recycling (t)	478,537	866,340
Material to incineration with energy recovery (MSW and co-incineration) (t)	735,932	644,030
Material to landfill (t)	-168,882	-464,781

In figure 28, sensitivity analysis has been conducted on scenario 2 (1997) to analyse the overall change in global warming as a result of changes in the percentage material going to incineration and recycling. (Note, the quantity of material sent to landfill remained the same). The x axis indicates the percentage material sent to recycling. The graph in figure 28 shows that, as the percentage recycling increases, global warming potential reduces.

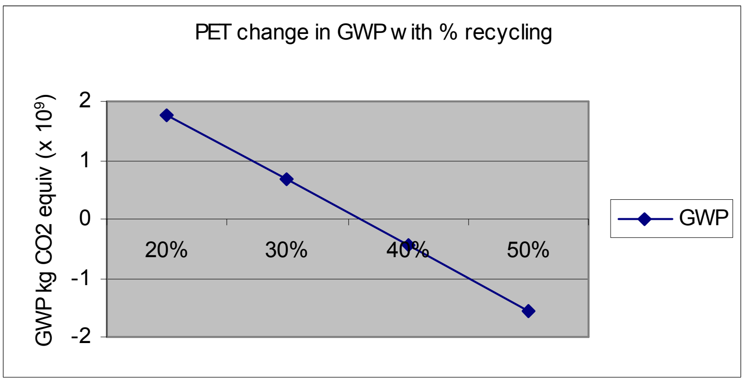


Figure 28 : Change in global warming potential with change in % change in recycling vs incineration

This shows the importance of recycling on the system (as constructed in this study) in terms of global warming potential. If recycling does not continue to increase relative to the amount of material being incinerated, reductions in global warming will not be achieved.

The amount of incineration increases year on year due to an increase in the tonnage difference between recovery and recycling as shown in table 24. Table 24 also shows the difference between packaging plastics waste arisings and recovery.

Table 24 : Tonnage differences - plastic packaging (scenario 3)

	1997	*1998*	*1999*	*2000*	*2001*
Recovery minus recycling (t)	1,321,276	1,503,667	1,652,046	1,842,097	1,902,412
Packaging waste arisings minus recovery (t)	6,758,641	6,584,449	6,366,165	6,231,955	6,356,754

In terms of scenario 1, there are increasing levels of material being disposed of to incineration and landfill year on year (table 25) due to increasing amounts of plastic packaging waste arising. However the benefits associated with energy recovery from the incineration process are not sufficient to outweigh impacts associated with landfill and transport, resulting in the much higher environmental impacts seen from this scenario.

Table 25 : Waste management (scenario 1)

	1997	*1998*	*1999*	*2000*	*2001*
material to recycling (t)	0	0	0	0	0
material to incineration (with energy recovery MSW) (t)	2,457,377	2,471,385	2,524,545	2,609,850	2,683,783
material to landfill (t)	7,204,839	7,385,364	7,568,896	7,685,030	8,024,022

As discussed, figures 19-27 indicate that the impacts associated with PET waste disposal generally decrease as the level of recycling increases. For all impact categories, except for ozone depletion, scenario 1 has the highest impact and scenario 3 the lowest. However for the impact category ozone depletion scenario 2 has the lowest environmental impact of the three scenarios. The main contributor by far to the result for ozone depletion relates to credits given for energy recovery in the incineration process. The data in table 26 shows that scenario 2 had the highest levels of incineration of the three scenarios, followed by scenario 3 then 1 which correlates with the results shown in figure 23 for ozone depletion.

Table 26 : Quantities of plastic to incineration (t) 1997-2001

Scenario	*1997*	*1998*	*1999*	*2000*	*2001*
scenario 1	2,457,377	2,471,385	2,524,545	2,609,850	2,683,783
scenario 2	2,632,181	2,787,265	2,946,408	3,179,437	3,368,113
scenario 3	2,615,731	2,763,525	2,882,715	3,104,644	3,259,761

Conclusion

The generated LCIA results indicate that, using the systems as set up in this study, plastics recycling (assuming that the recycled plastics is PET) had a positive effect on the environment. Among the 10.7 million tonnes of plastics waste arisings in 2001, 4.4 million tonnes or 41% have been diverted from landfills and 2.5 million tonnes or 23% have been sent to recycling. Assuming that this material is PET, this has led to resource savings of around 4.1 million tonnes of oil equivalent and reduced greenhouse gas emissions of EU15 by around 3.8 million tonnes of CO_2 equivalent compared to a scenario of no recycling. This is mainly related to the energy savings by replacing plastics production from virgin materials by recycling.

However, only a small part of these savings is directly related to the effects of the Packaging and Packaging Waste Directive. Most of the plastics recycling would also have taken place in the absence of the Directive, probably mostly because of pre-existing national legislation. The direct effect of the Packaging and Packaging Waste Directive in reducing plastics waste to landfill is estimated at around 0.53 million tonnes or around 12% of total plastics recovery in EU15. The direct effect of the Packaging and Packaging Waste Directive in increasing plastics recycling is estimated at around 0.45 million tonnes or around 18% of total plastics recycling in EU15. Among the total resource savings around 0.7 million tonnes of oil equivalent or 17% and among the total reduction of CO_2 emissions around 1.5 million tonnes of CO_2 equivalent or 24% can be attributed to the direct effect of the Packaging and Packaging Waste Directive.

Transport impacts seem to play a relatively small role. For example, the transport related greenhouse gas emissions during the entire waste treatment are around 7% of the greenhouse gas savings related to the replacement of virgin material by recycled plastics. However, at transport distances far beyond 1000 km, impacts may be more significant. Due to the absence of data, this could however not be verified in detail. Nevertheless, the sensitivity analysis in chapter 1.7.2.7 indicates that changes in the relative positions of the scenarios are unlikely to change.

1.7.2.3 Results for aluminium

The LCIA results generated for aluminium are shown in the graphs in figures 29-37. They are based on the waste treatment of the total weight of aluminium packaging waste arising annually from the EU15 under the three scenarios described in section 1.7.1.2. Reference years are 1997 through to 2001. For detailed data relating to the quantity of material by waste treatment method per year see Annex 1.

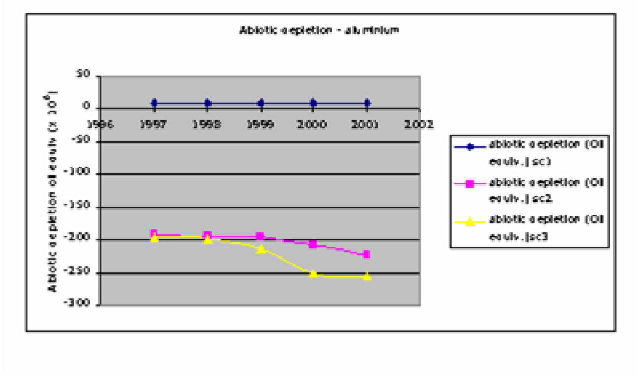


Figure 29: Abiotic depletion - Aluminium

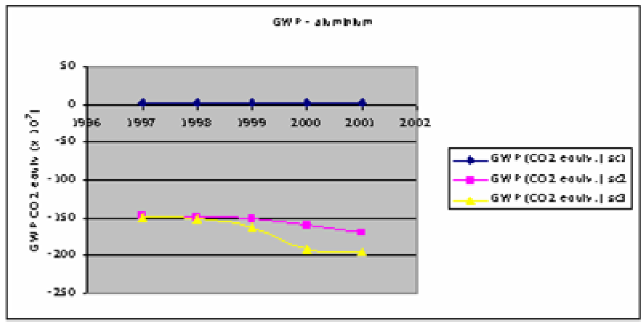


Figure 30: GWP - Aluminium

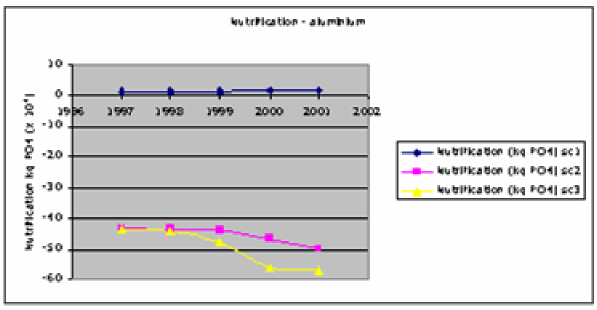


Figure 31: Nutrification – Aluminium

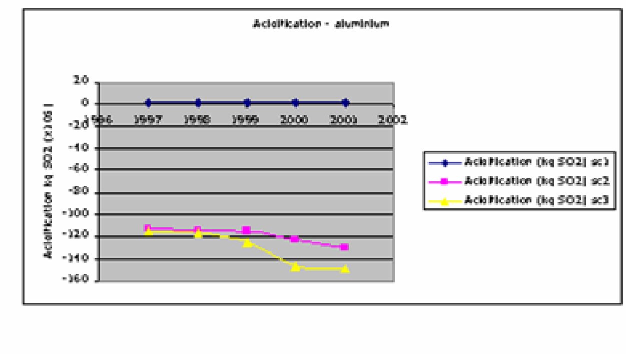


Figure 32: Acidification - Aluminium

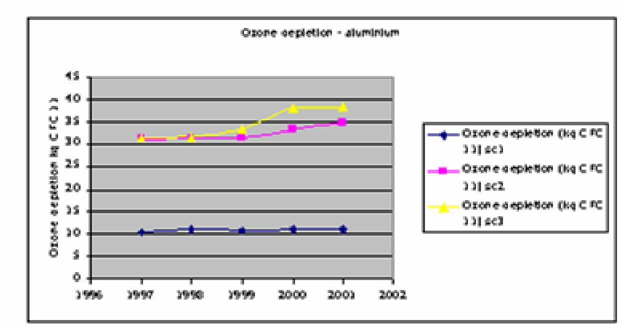


Figure 33: Ozone depletion - Aluminium

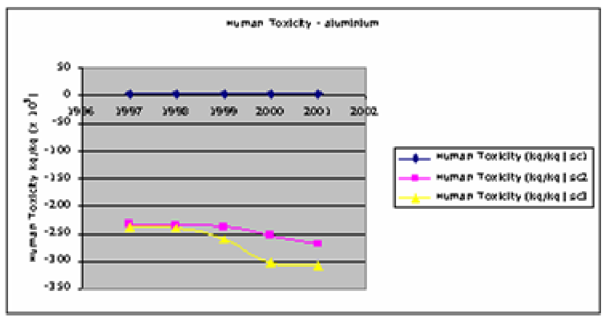


Figure 34: Human toxicity - Aluminium

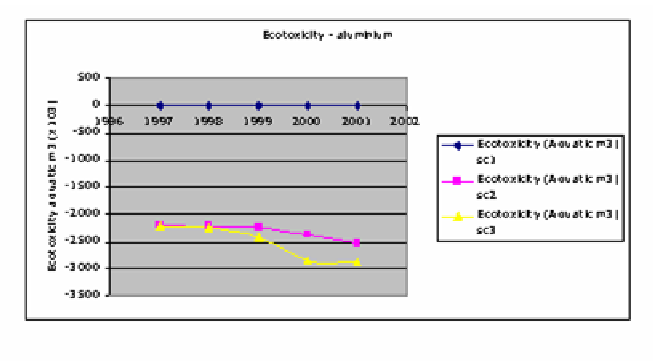


Figure 35: Human toxicity - Aluminium

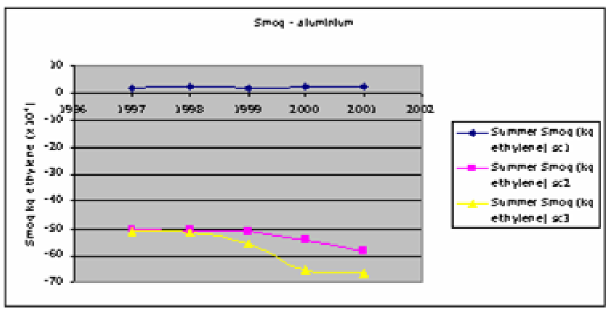


Figure 36: Smog - Aluminium

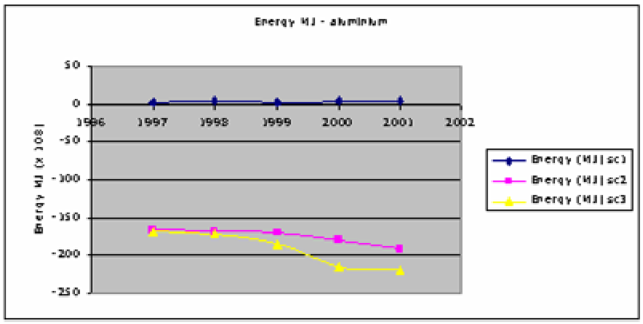


Figure 37: Energy - Aluminium

As Member States do not submit recovery and recycling data for aluminium and steel separately but as the combined category "metals" (see Annex 3), assumptions with regard to the relative proportions of aluminium and steel had to be made. It was therefore assumed that 10% of the metal packaging waste arising was aluminium with the remaining 90% being steel. This assumption also implies that the recovery and recycling rates for aluminium and steel are the same, whereas in reality this is not necessarily the case.

As for the other materials discussed so far, scenario 1 has a much higher environmental impact than either scenario 2 or 3. The only impact category that shows a different outcome is that of ozone depletion. The graph for ozone depletion (figure 33) shows scenario 3 with the highest impact and scenario 1 the lowest. The greatest impact for scenario 3 in terms of ozone depleting potential is from transport as can be seen from table 27. Interrogation of the raw data for scenario 3 reveals that the transport steps with the greatest impact are those associated with recycling (this would be expected as the distances involved in transport to sorting and recycling are greater than to landfill or incineration). Transport has a much lower impact on ozone depletion in scenario 1 (table 27) as would be expected given no recovery or recycling of aluminium is taking place.

The trend of the graphs is a function of the amount of packaging waste arising and the proportion going to each of the waste treatment methods. For example, for scenario 3, the sudden decrease in environmental impact in 1999 and 2000 for most of the impact categories is due to the increase achieved in recycling rates for these years

Table 27: Aluminium recovery and recycling 1997-2001 (Scenario 3)

	1997	*1998*	*1999*	*2000*	*2001*
Recovery (t)	192,997	194,999	210,813	247,525	250,108
Recycling (t)	191,790	193,924	209,339	244,825	248,404
Packaging waste arising (t)	439,557	457,942	441,688	462,838	463,100

Table 28 provides an example illustrating where the main impacts arise for the waste treatment of aluminium for scenario 3 in 2001. As can be seen, all of the impacts associated with aluminium recycling are negative. This is a result of the system boundaries for recycling which credits avoided production of virgin aluminium. It is widely reported[24] that recycling aluminium can save up to 95% of the energy needed to make the primary product and therefore this result is not unexpected, especially in terms of energy and CO_2. Additionally, incineration of aluminium (other than very thin foil) does not produce any useful energy and therefore, overall, energy is consumed within the process. Overall for scenario 3, table 28 shows that the credit associated with material recycling outweighs the impacts associated with incineration, landfill and transport.

Table 28 : Aluminium waste treatment - scenario 3, 2001

	Total	*Transport*	*Aluminium to landfill*	*Aluminium recycling*	*Aluminium to incineration*
Abiotic depletion (million tonnes Oil equiv.)	$-2.5x10^{-1}$	$1.1x10^{-2}$	$1.6x10^{-3}$	$-2.7x10^{-1}$	$1.6x10^{-3}$
Energy (million MJ)	$-2.2x10^{+4}$	$4.8x10^{+2}$	$3.8x10^{+1}$	$-2.3x10^{+4}$	$8.7x10^{+1}$
GWP (million tonnes CO_2 equiv.)	-1.9	$3.3x10^{-2}$	$2.0x10^{-3}$	-2.0	$4.6x10^{-3}$
Acidification (million tonnes SO_2)	$-1.5x10^{-2}$	$1.4x10^{-4}$	$2.8x10^{-5}$	$-1.5x10^{-2}$	$4.0x10^{-5}$
Ecotoxicity (Aquatic million m^3)	-2.9	$1.2x10^{-3}$	$4.3x10^{-4}$	-2.9	$1.6x10^{-4}$
Human Toxicity (million tonnes/kg)	$-3.1x10^{-2}$	$3.6x10^{-4}$	$3.2x10^{-5}$	$-3.1x10^{-2}$	$5.5x10^{-5}$
Nutrification (million tonnes PO_4)	$-5.7x10^{-4}$	$2.0x10^{-5}$	$3.1x10^{-6}$	$-6.0x10^{-4}$	$2.5x10^{-6}$
Ozone depletion (million tonnes CFC 11)	$3.8x10^{-8}$	$3.5x10^{-8}$	$1.0x10^{-9}$	0	$2.0x10^{-9}$
Summer Smog (million tonnes ethylene)	$-6.7x10^{-4}$	$4.9x10^{-5}$	$4.6x10^{-6}$	$-7.2x10^{-4}$	$2.3x10^{-6}$

Conclusion

The generated LCIA results indicate that, using the systems as set up in this study, aluminium recycling had a clearly positive effect on the environment. Among the estimated 0.46 million tonnes of aluminium waste arisings in 2001, 0.25 million tonnes or 53.6% have been deviated from landfills to recycling. This has led to resource savings of around 0.26 million tonnes of oil equivalent and reduced greenhouse gas emissions of EU15 by around 1.9 million tonnes of CO_2 equivalent compared to a scenario of no recycling. This is mainly related to the energy savings by replacing aluminium production from virgin materials by recycling.

However, only a small part of these savings is directly related to the effects of the Packaging and Packaging Waste Directive. Most of the aluminium recycling would also have taken place in the absence of the Directive, either because it is economically profitable or because of pre-existing national legislation. The direct effect of the Packaging and Packaging Waste Directive is estimated at reducing aluminium waste to landfill by around 0.03 million tonnes or around 12% of total aluminium recycling in EU15. Among the total resource savings around 0.03 million tonnes of oil equivalent or 12% and among the

[24] www.eaa.net

total reduction of CO_2 emissions around 0.2 million tonnes of CO_2 equivalent or 11% can be attributed to the direct effect of the Packaging and Packaging Waste Directive.

Transport impacts seem to play a relatively small role. For example, the transport related greenhouse gas emissions during the entire waste treatment are less than 2% of the greenhouse gas savings related to the replacement of virgin material by recycled aluminium. Only at transport distances far beyond 5000 km, impacts may become more significant.

1.7.2.4 Results for steel

The LCIA results generated for steel are shown in the graphs in figures 38-46. They are based on the waste treatment of the total weight of steel packaging waste arising annually from the EU15 under the three scenarios described in section 1.7.1.2. Reference years are 1997 through to 2001. For detailed data relating to the quantity of material by waste treatment method per year see Annex 1.

As highlighted in the results section for aluminium, an assumption has been made between the split of aluminium and steel based on the metals data supplied by Member States to the European Commission(see Annex 3). Steel has been assumed to be 90% of the total quantity of metal packaging waste arising. Additionally, the recycling and recovery rates have also been assumed the same for both aluminium and steel and this may not necessarily reflect reality. For example, it is recognised that in reality the recovery processes differ for the two materials: aluminium of less than 50 microns can be incinerated with energy recovery, whereas steel cannot. However, for the purposes of this streamlined investigation both materials have been assigned recovery and recycling quantities in line with the reported figures for metals.

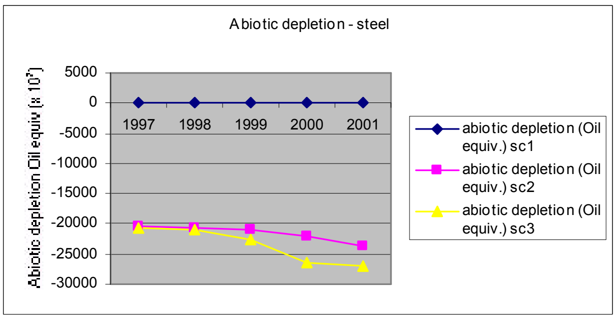


Figure 38: Abiotic depletion - Steel

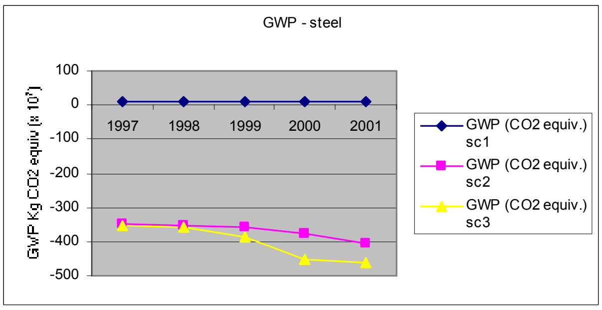


Figure 39: GWP - Steel

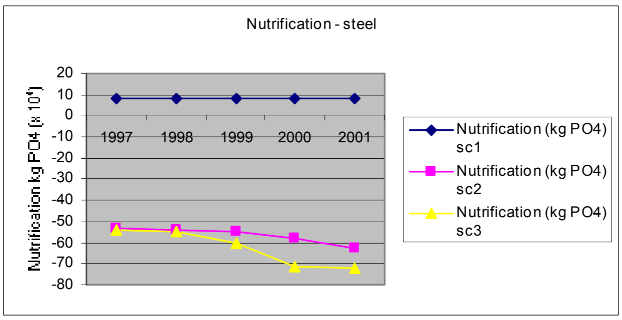


Figure 40: Nutrification - Steel

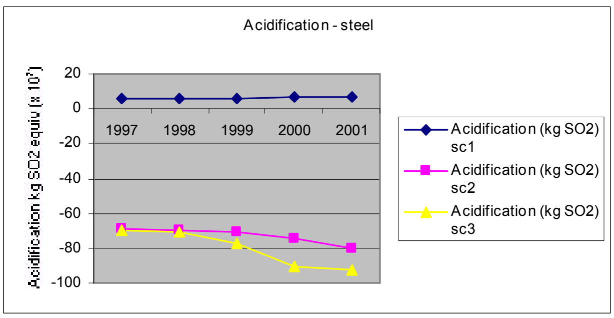


Figure 41: Acidification - Steel

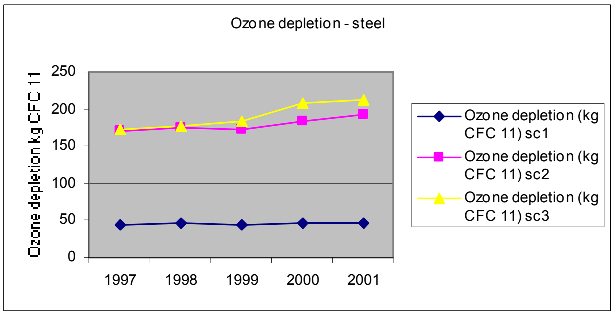


Figure 42: Ozone depletion - Steel

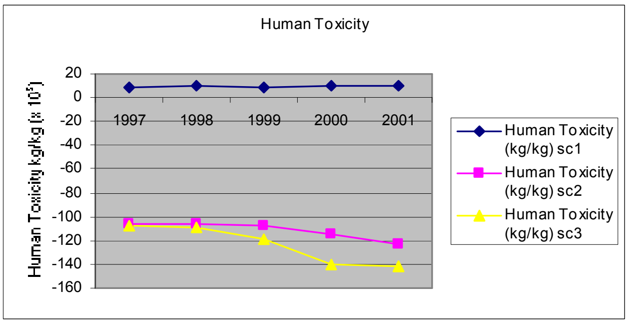


Figure 43: Human toxicity - Steel

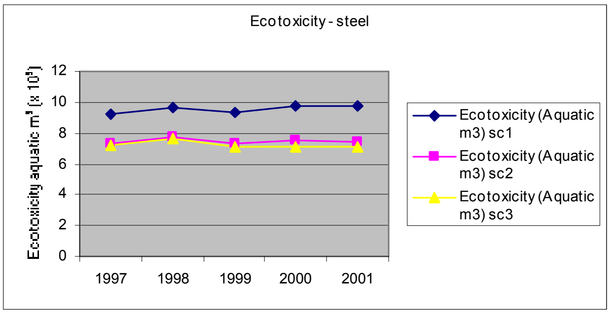


Figure 44: Ecotoxicity - Steel

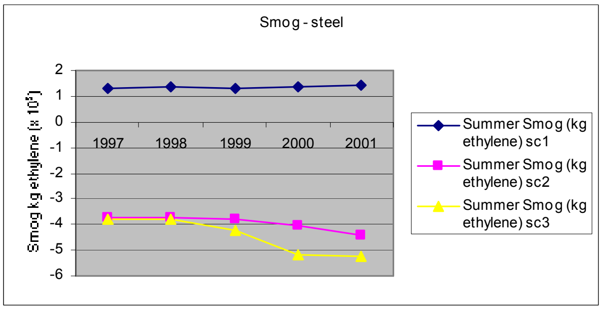


Figure 45: Smog - Steel

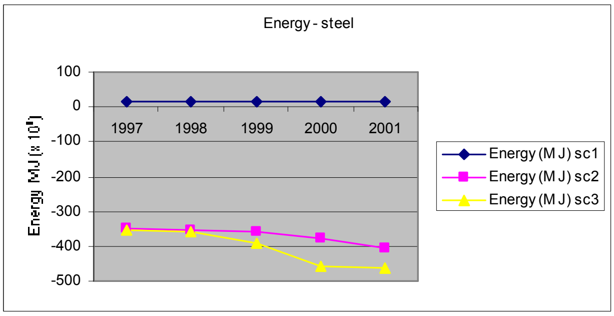


Figure 46 : Energy - Steel

As for the other materials, the graphs indicate that for the all categories except ozone depletion, scenario 1 has a much higher environmental impact than either scenario 2 or scenario 3. Of scenario 2 and 3, scenario 2 has a higher impact than scenario 3. In all cases except ecotoxicity, impacts decrease with increasing levels of recycling. Table 29 illustrates this for scenario 3 where the increased recycling year on year corresponds to the decreasing environmental impacts in the graphs.

Table 29 : Steel recovery and recycling 1997-2001 (Scenario 3)

	1997	*1998*	*1999*	*2000*	*2001*
Recovery (t)	1,736,971	1,754,990	1,897,313	2,227,721	2,250,975
Recycling (t)	1,726,106	1,745,314	1,884,055	2,203,421	2,235,635
Packaging waste arising (t)	3,956,015	4,121,474	3,975,195	4,165,541	4,167,896

The shape of the curves for scenario 3 can be explained by the yearly percentage increase in steel packaging recycling over the reference years (table 30). For example the decrease in environmental impact from 1999 to 2000 corresponds to a 17% increase in recycling seen over this period.

Table 30 : Percentage increase in steel recovery over the reference years

	1997-1998	*1998-1999*	*1999-2000*	*2000-2001*
Recovery (%)	1	8	17	1
Recycling (%)	1	8	17	1

Table 31 provides an example of where the main impacts arise for the waste treatment of steel (scenario 3) in 2001. As can be seen, the recycling process provides an overall credit to the system in all categories except ozone depletion where the impact is zero. The credit obtained from recycling outweighs the impacts generated from the other processes within the system (except for ozone depletion and ecotoxicity.

Table 31 : Results for Steel waste treatment – scenario 3, 2001

	Total	*Transport*	*Steel to landfill*	*Steel to recycling*	*Steel to incineration*
abiotic depletion (million tonnes Oil equiv.)	$-2.7x10^{+2}$	$6.7x10^{-2}$	$1.3x10^{-2}$	$-2.7x10^{+2}$	$2.0x10^{-3}$
Energy (million MJ)	$-4.6x10^{+4}$	$2.8x10^{+3}$	$2.8x10^{+2}$	$-5.0x10^{+4}$	$1.5x10^{+2}$
GWP (million tonnes CO_2 equiv.)	-4.6	$2.0x10^{-1}$	$1.5x10^{-2}$	-4.8	$5.6x10^{-3}$
Acidification (million tonnes SO_2)	$-9.2x10^{-3}$	$7.9x10^{-4}$	$2.0x10^{-4}$	$-1.0x10^{-2}$	$2.9x10^{-5}$
Ecotoxicity (Aquatic million m^3)	$7.1x10^{-3}$	$7.1x10^{-3}$	$3.5x10^{-3}$	$-4.1x10^{-3}$	$5.0x10^{-4}$
Human Toxicity (million tonnes/kg)	$-1.4x10^{-2}$	$2.1x10^{-3}$	$2.5x10^{-4}$	$-1.7x10^{-2}$	$1.4x10^{-5}$
Nutrification (million	$-7.2x10^{-4}$	$1.1x10^{-4}$	$2.1x10^{-5}$	$-8.7x10^{-4}$	$6.4x10^{-6}$

tonnes PO_4)					
Ozone depletion (million tonnes CFC 11)	$2.1x10^{-7}$	$2.1x10^{-7}$	$6.0x10^{-9}$	0	$-3.0x10^{-9}$
Summer Smog (million tonnes ethylene)	$-5.2x10^{-4}$	$2.9x10^{-4}$	$3.7x10^{-5}$	$-8.5x10^{-4}$	$2.3x10^{-6}$

As can be seen from table 31, the impacts associated with ozone depletion mainly arise from transport in this system. The transport distance assumed for recycling is higher than the transport distance assumed for collection for incineration or landfill (table 14, section1.7.1.2). Therefore, with increased recycling the impact for transport increases. As mentioned in section 1.7.2.1 – glass, in general packaging LCA's show very low results for the impact category ozone depletion as the production, use and disposal of packaging results in the release of very few ozone depleting compounds. This is also the case for the steel system with only 212kg CFC-11 equivalents for the total amount of steel packaging waste arising in the EU15 for the year 2001. The graph for ecotoxicity (figure 44) has a different shape to the other graphs. This is due to the impacts for this category mainly arising from landfill and transport. Therefore increasing recycling rates will lead to increasing impacts from the transport of material to recycling but this will be countered by decreasing levels of material to landfill (table 32). It must be emphasised that the results both for ozone depletion and ecotoxicity are very low therefore any variation in the results will seem significant.

Table 32 : Quantities of steel to waste treatment options (1997 – 2001)

	1997	*1998*	*1999*	*2000*	*2001*
material to recycling (t)	1,726,106	1,745,314	1,884,055	2,203,421	2,235,635
material to incineration (with energy recovery MSW) (t)	463,803	454,428	443,101	444,069	409,779
material to landfill (t)	1,766,105	1,921,732	1,648,040	1,518,051	1,522,482

Conclusion

The generated LCIA results indicate that, using the systems as set up in this study, steel recycling had a clearly positive effect on the environment. Among the estimated 4.2 million tonnes of steel waste arisings in 2001, 2.2 million tonnes or 47.8% have been diverted from landfills to recycling. This has reduced greenhouse gas emissions of EU15 by around 3 million tonnes of CO_2 equivalent compared to a scenario of no recycling. This is mainly related to the energy savings by replacing steel production from virgin materials by recycling.

However, only a small part of these savings is directly related to the effects of the Packaging and Packaging Waste Directive. Most of the steel recycling would also have taken place in the absence of the Directive, either because it is economically profitable or because of pre-existing national legislation. The direct effect of the Packaging and Packaging Waste Directive is estimated at reducing steel waste to landfill by around 0.27 million tonnes or around 12% of total steel recycling in EU15. Among the total reduction of CO_2 emissions around 0.4 million tonnes of CO_2 equivalent or 13% can be attributed to the direct effect of the Packaging and Packaging Waste Directive.

Transport impacts seem to play a relatively small role. For example, the transport related greenhouse gas emissions during the entire waste treatment are less than 4% of the greenhouse gas savings related to the replacement of virgin material by recycled steel. Only at transport distances far beyond 2000 km, impacts may become more significant.

INDUSTRIAL PACKAGING SYSTEMS

1.7.2.5 Results for PE film

The LCIA results generated for the PE film system are outlined in figures 47-55. They are based on the waste treatment of the total weight of plastics packaging waste (assumed to be all PE film) arising annually from the EU15 under the three scenarios outlined in section 1.7.1.2. Reference years are 1997 through to 2001. For detailed data relating to the quantity of material by waste treatment method per year see Annex 1.

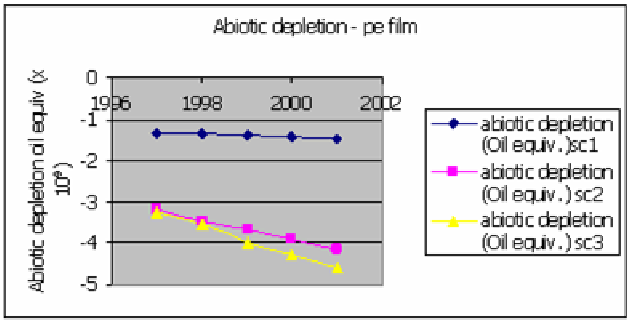


Figure 47: Abiotic depletion – PE film

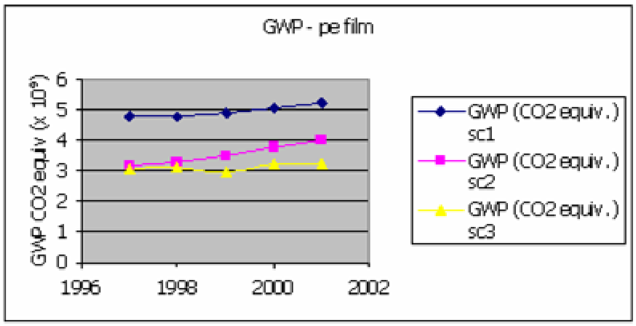


Figure 48: GWP – PE film

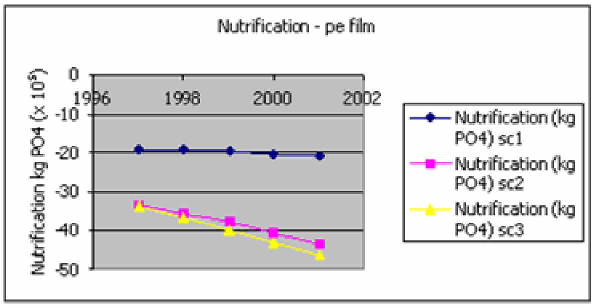


Figure 49: Nutrification – PE film

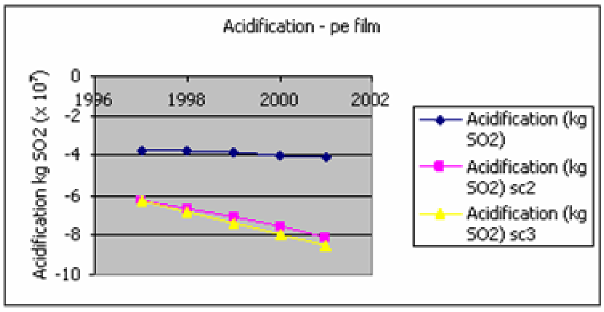


Figure 50: Acidification – PE film

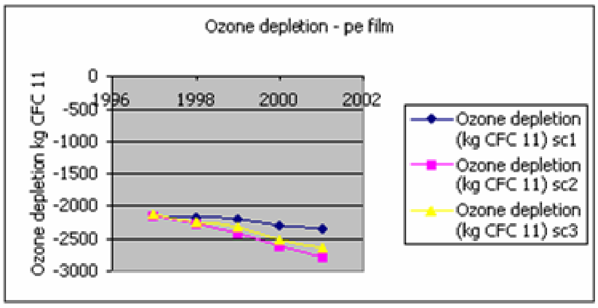


Figure 51: Ozone depletion – PE film

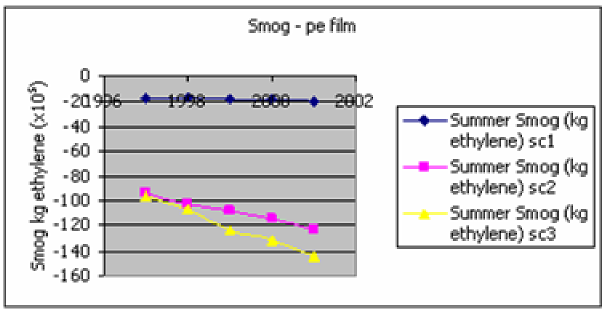


Figure 52: Smog – PE film

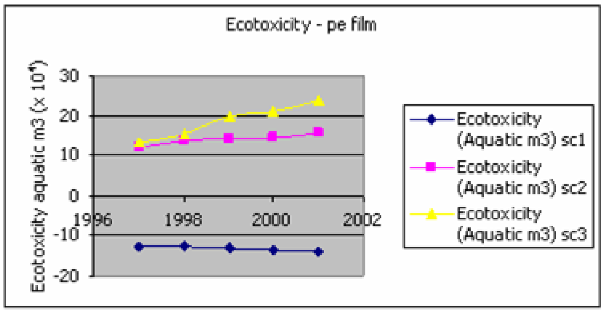


Figure 53: Ecotoxicity – PE film

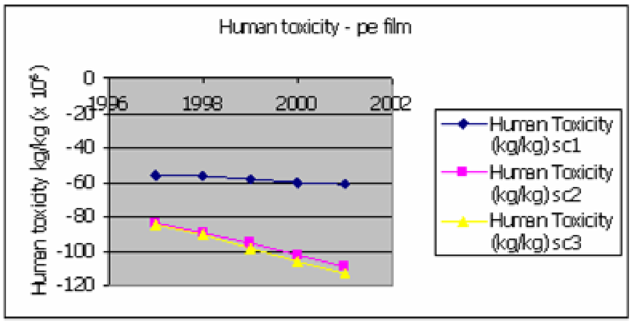


Figure 54: Human toxicity – PE film

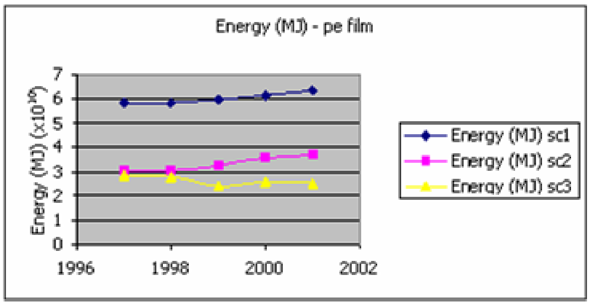


Figure 55: Energy – PE film

For the majority of impact categories, the graphs (figures 47-55) indicate that scenario 1 has a much higher environmental impact than either scenario 2 or scenario 3. In turn, scenario 2 generally has a higher impact than scenario 3.

For the categories abiotic depletion, acidification, nutrification, human toxicity and smog, the results follow a similar trend with scenarios 2 and 3 showing decreasing impacts with increases in recycling. Table 33 shows plastics waste arisings, recovery and recycling over the reference period for scenario 3.

Table 33 : Plastic recovery and recycling 1997-2001 (Scenario 3)

	1997	*1998*	*1999*	*2000*	*2001*
Recovery (t)	2,903,575	3,272,300	3,727,276	4,062,925	4,351,051
Recycling (t)	1,582,299	1,768,633	2,075,230	2,220,828	2,448,639
Packaging waste arising(t)	9,662,216	9,856,749	10,093,441	10,294,880	10,707,805

Table 34 provides an example of where the main impacts arise for the waste treatment of PE film in 2001 for scenario 3. Changing the waste management mix therefore has a significant influence on the environmental impacts.

Table 34 : Results for PE film waste treatment – scenario 3, 2001

	Total	*Transport*	*PE film to landfill*	*PE film to recycling*	*PE film to incineration*
abiotic depletion (million tonnes Oil equiv.)	-4.6	7.9×10^{-2}	6.1×10^{-2}	-2.8	-1.9
Energy (million MJ)	$2.7 \times 10^{+4}$	$3.3 \times 10^{+3}$	$1.6 \times 10^{+3}$	$-5.0 \times 10^{+4}$	$7.3 \times 10^{+4}$
GWP (million tonnes CO_2 equiv.)	3.4	2.3×10^{-1}	8.4×10^{-2}	-3.0	6.1
Acidification (million tonnes SO_2)	-8.5×10^{-2}	9.2×10^{-4}	1.3×10^{-3}	-3.5×10^{-2}	-5.3×10^{-2}
Ecotoxicity (Aquatic million m^3)	2.5×10^{-1}	8.4×10^{-3}	1.6×10^{-2}	4.2×10^{-1}	-2.0×10^{-1}
Human Toxicity (million tonnes/kg)	-1.1×10^{-1}	2.5×10^{-3}	1.3×10^{-3}	-3.7×10^{-2}	-7.8×10^{-2}
Nutrification (million tonnes PO_4)	-4.5×10^{-3}	1.3×10^{-4}	1.5×10^{-4}	-2.0×10^{-3}	-2.9×10^{-3}
Ozone depletion (million tonnes CFC 11)	-2.4×10^{-6}	2.4×10^{-7}	3.3×10^{-8}	2.7×10^{-7}	-3.0×10^{-6}
Summer Smog (million tonnes ethylene)	-1.4×10^{-2}	3.4×10^{-4}	1.7×10^{-4}	-1.2×10^{-2}	-2.7×10^{-3}

Figure 48 indicates that global warming potential showed increasing levels for all three scenarios over the period 1997 to 2001. Emissions affecting global warming arise from various processes including the incineration, landfill and transport and outweigh the credit given for energy recovery during incineration and the credit for recycling (table 35). Transport is the same in all scenarios due to equal distances being assumed for landfill, incineration and recycling. The high levels of global warming attributed to incineration can be traced back to CO2 production during the process of incineration itself.

Table 35: Total GWP impact for years 1997 through to 2001 by process (scenarios 1-3)

	Total GWP	*Transport*	*PE Film to landfill*	*PE Film to Recycling*	*PE Film to Incineration*
GWP (kg CO2 equiv.) scenario 1	24749938436	296252274	635013107	0	23818673056
GWP (kg CO2 equiv.) scenario 2	17724146922	296252274	450869817	-10889858692	27866883523
GWP (kg CO2 equiv.) scenario 3	15588623645	296252280	434202572	-12472382586	27330551380

For ozone depletion, impacts reduce with increasing levels of incineration. This is due to the credit given for energy recovery within this process. Scenario 2 has the highest levels of incineration and hence the lowest impacts for this category (table 36).

Table 36: Quantities of plastic to incineration (tonnes) (Scenarios 1-3)

	1997	*1998*	*1999*	*2000*	*2001*
scenario 1	2,457,377	2,471,385	2,524,545	2,609,850	2,683,783
scenario 2	2,632,181	2,787,265	2,946,408	3,179,437	3,368,113
scenario 3	2,615,731	2,763,525	2,882,715	3,104,644	3,259,761

In terms of ecotoxicity, the main impacts arise from the recycling process. The recycling process for film as compiled in these scenarios includes a proportion (10%) of virgin material. It is this input plus use of electricity within the process which impacts most on ecotoxicity. Scenario 1, as it includes no recycling, has much lower impact than scenario 1 or 2 for this category.

Conclusion

The generated LCIA results indicate that, using the systems as set up in this study, the recycling of packaging plastics (assuming that the recycled plastics is clean PE film) had a positive effect on the environment. Among the 10.7 million tonnes of plastics waste arisings in 2001, 4.4 million tonnes or 41% have been diverted from landfills and 2.5 million tonnes or 23% have been sent to recycling. Assuming that this material is PE, this would have led to resource savings of around 3.1 million tonnes of oil equivalent and reduced greenhouse gas emissions of EU15 by around 2.0 million tonnes of CO_2 equivalent compared to a scenario of no recycling. This is mainly related to the energy savings by replacing plastics production from virgin materials by recycling.

However, only a small part of these savings is directly related to the effects of the Packaging and Packaging Waste Directive. Most of the plastics recycling would also have taken place in the absence of the Directive, probably mostly because of pre-existing national legislation. The direct effect of the Packaging and Packaging Waste Directive in reducing plastics waste to landfill is estimated at around 0.53 million tonnes or around 12% of total plastics recovery in EU15. The direct effect of the Packaging and Packaging Waste Directive in increasing plastics recycling is estimated at around 0.45 million tonnes or around 18% of total plastics recycling in EU15. Among the total resource savings around 0.5 million tonnes of oil equivalent or 16% and among the total reduction of CO_2 emissions around 0.9 million tonnes of CO_2 equivalent or 45% can be attributed to the direct effect of the Packaging and Packaging Waste Directive.

Transport impacts seem to play a relatively small role. For example, the transport related greenhouse gas emissions during the entire waste treatment are around 8% of the greenhouse gas savings related to the replacement of virgin material by recycled plastics. However, at transport distances far beyond 1000 km, impacts may be more significant. Due to the absence of data, this could however not be verified in detail. Nevertheless, the sensitivity analysis in chapter 1.7.2.7 indicates that changes in the relative positions of the scenarios are unlikely to change.

1.7.2.6 Results for corrugated

The LCIA results generated for the corrugated system are shown in figures 56-64. They are based on the waste treatment of the total weight of paper based packaging waste (assumed in these systems to be all corrugated) arising annually from the EU15 under the three scenarios outlined I section 1.7.1.2. Reference years are 1997 through to 2001. For detailed data relating to the quantity of material by waste treatment method per year, refer to Annex 1.

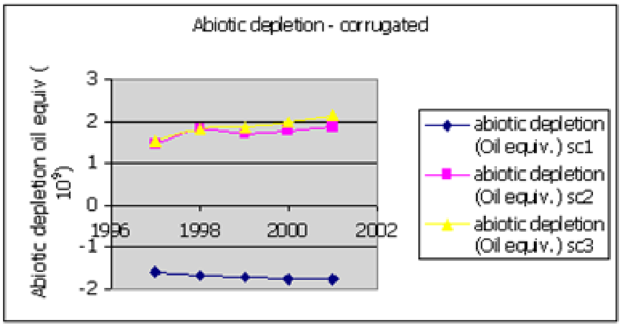


Figure 56: Abiotic depletion - corrugated

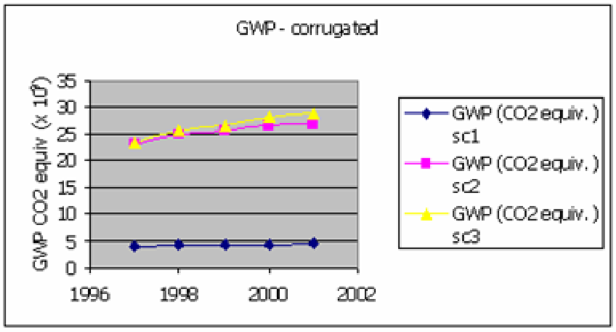


Figure 57: GWP - corrugated

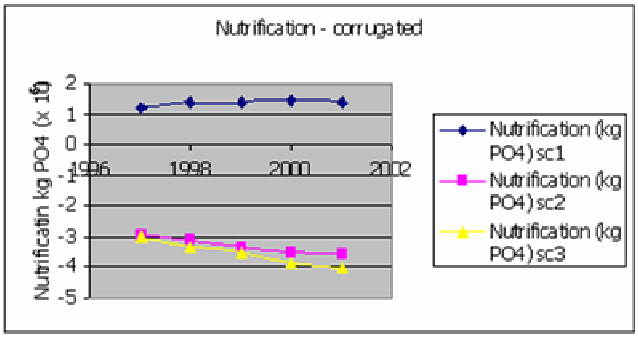


Figure 58: Nutrification - corrugated

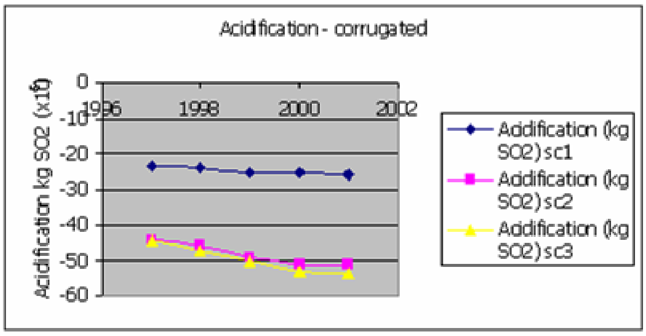


Figure 59: Acidification - corrugated

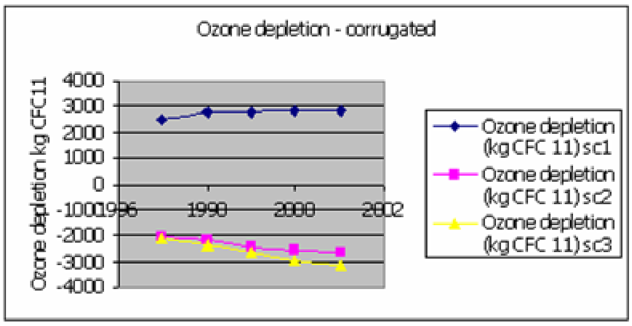


Figure 60: Ozone depletion - corrugated

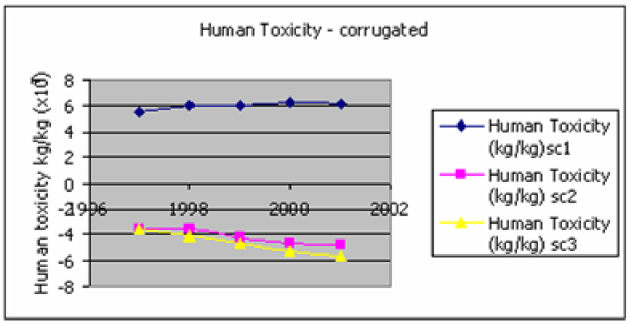


Figure 61: Human toxicity - corrugated

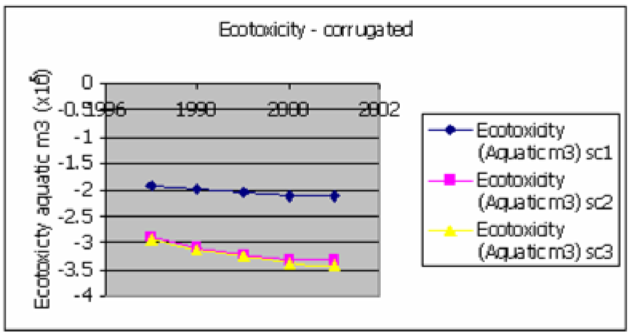


Figure 62: Ecotoxicity - corrugated

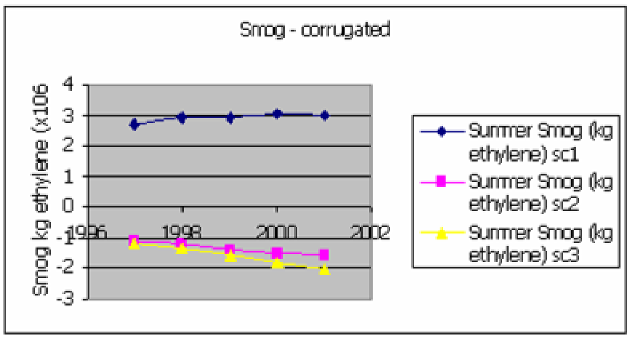


Figure 63: Smog - corrugated

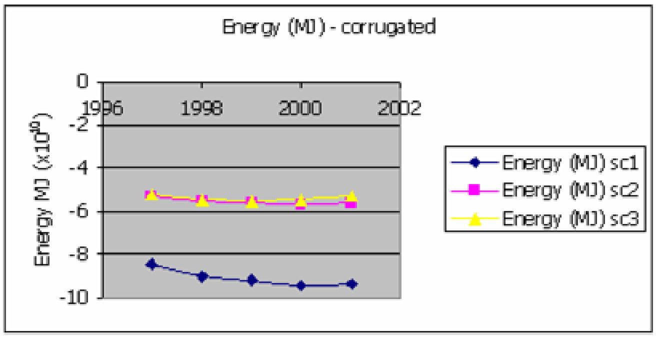


Figure 64: Energy (MJ) - corrugated

Graphs for abiotic depletion, global warming potential and energy show similar trends with scenario 3 having the highest impacts and scenario 1 the lowest. For the remaining impact categories, scenario 1 has the highest environmental impact and scenario 3 the lowest. These categories show decreasing impacts with increasing levels of recycling (table 37).

Table 37 : Paper recovery and recycling 1997-2001 (Scenario 3)

	1997	*1998*	*1999*	*2000*	*2001*
Recovery (t)	1,5793,695	17,419,053	17,987,589	19,057,315	19,512,610
Recycling (t)	1,3851,026	15,457,966	15,874,080	16,824,261	17,532,348
Packaging waste arising(t)	23,655,288	25,203,955	25,728,180	26,380,803	26,281,032

Table 38 provides an example of where the main impacts arise for the waste treatment of corrugated board (scenario 3) in 2001. The actual recycling and incineration processes have the greatest impact on these categories (table 37).

Table 38 : Results for corrugated board waste treatment – scenario 3, 2001

	Total	*Transport*	*Corrugated to landfill*	*Corrugated to recycling*	*Corrugated to incineration*
abiotic depletion (million tonnes Oil equiv.)	2.2	$2.4x10^{-1}$	$-9.9x10^{-2}$	2.7	$-6.5x10^{-1}$
Energy (million MJ)	$-5.3x10^{+4}$	$1.0x10^{+4}$	$-2.2x10^{+4}$	$-3.3x10^{+4}$	$-7.7x10^{+3}$
GWP (million tonnes CO_2 equiv.)	$2.9x10^{+1}$	$7.1x10^{-1}$	$-6.2x10^{-1}$	$2.6x10^{+1}$	2.9
Acidification (million tonnes SO_2)	$-5.4x10^{-2}$	$2.8x10^{-3}$	$4.2x10^{-3}$	$-4.3x10^{-2}$	$-1.8x10^{-2}$
Ecotoxicity (Aquatic million m^3)	$-3.4x10^{-1}$	$2.6x10^{-2}$	$-1.7x10^{-2}$	$-2.8x10^{-1}$	$-6.8x10^{-2}$
Human Toxicity (million tonnes/kg)	$-5.7x10^{-2}$	$7.7x10^{-3}$	$3.5x10^{-2}$	$-7.3x10^{-2}$	$-2.7x10^{-2}$
Nutrification (million tonnes PO_4)	$-4.1x10^{-3}$	$4.1x10^{-4}$	$1.0x10^{-3}$	$-4.5x10^{-3}$	$-9.9x10^{-4}$
Ozone depletion (million	$-3.2x10^{-6}$	$7.5x10^{-7}$	$1.5x10^{-6}$	$-4.3x10^{-6}$	$-1.0x10^{-6}$

tonnes CFC 11)					
Summer Smog (million tonnes ethylene)	$-2.0x10^{-3}$	$1.0x10^{-3}$	$1.4x10^{-3}$	$-3.5x10^{-3}$	$-9.3x10^{-4}$

The system boundaries have an impact on the results for global warming as all of the credit for take up of CO2 by the biomass has been credited to the virgin system and none to the recycled system. As more material is recycled, the apparent production of CO2 increases leading to increased impacts from increasing recycling.

To assess how this impacts on the system, sensitivity analysis was carried out on scenario 3 with the credit for CO2 take up being split between the virgin and the recycled processes. The results are shown in figure 65. As can be seen, this decision impacts to a very large extent on the global warming potential of the system with impact decreasing with increased recycling once the sensitivity analysis had been performed.

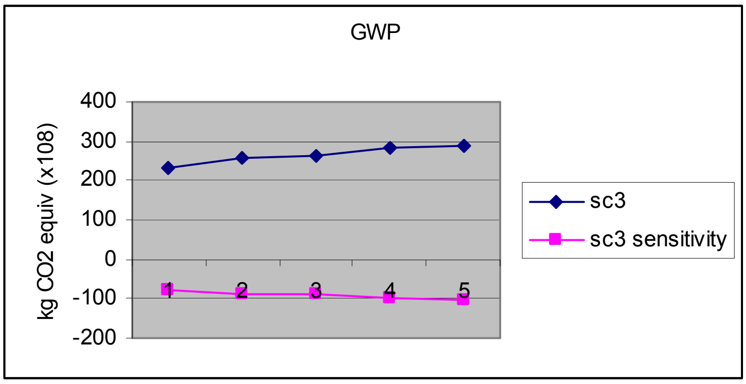


Figure 65 : Results of sensitivity analysis on Global Warming Potential

In terms of abiotic depletion, in the systems used, the recycled process requires utilises more energy from gas reserves than the virgin system and this is the major contributor to abiotic depletion within these systems. It therefore follows that as recycling increases, so does abiotic resource depletion. The recycled testliner system also requires more energy than alternative waste management options.

Nutrification, Ozone depletion, Human toxicity Ecotoxicity and smog show very similar trends and benefit from energy recovery from incineration and the credit from the material recycling process.

In terms of energy, scenario 1 has the largest energy credit (due to the greatest amount of incineration) and therefore the lowest impact(table 39).

Table 39 : Quantities of corrugated to incineration (tonnes) (Scenarios 1-3)

	1997	*1998*	*1999*	*2000*	*2001*
scenario 1	6,715,331	6,972,773	6,413,874	7,371,607	7,403,110
scenario 2	3,393,172	2,952,720	3,601,362	3,728,833	3,554,838
scenario 3	3,261,676	3,156,146	3,440,226	3,525,086	3,284,280

Conclusion

Paper is specific compared to other packaging materials due to the renewable nature of its raw material. Therefore, the results are less clear than for the other materials and should be treated with some degree of caution. They are sensitive to a number of assumptions and will be influenced by the modelling choices made and system boundaries drawn. Among the 26.3 million tonnes of paper waste arisings in 2001, 19.5 million tonnes or 74% have been diverted from landfills and 17.5 million tonnes or 67% have been sent to recycling. Under the assumption that virgin paper is made from biogenic material (i.e. neutral with respect to abiotic depletion and greenhouse gas emissions) whereas recycled material requires more energy from gas reserves and no biomass credit is applied for greenhouse gas emissions to the recycled system, both categories show a significantly higher environmental impact for the recycled than for the virgin system. However, if the the credit for CO2 take up is split between both systems, the picture reverses for global warming. Therefore, no clear evaluation can be given for paper for these two categories. However, the results indicate significant reductions of all other impact categories (nutrification, acidification, ozone depletion, human toxicity, ecotoxicity, smog) as a result of increased recycling and recovery.

As for the other materials, only a small part of paper recovery and recycling is directly related to the effects of the Packaging and Packaging Waste Directive. Most of the paper recycling would also have taken place in the absence of the Directive, either because it is economically profitable or because of pre-existing national legislation. The direct effect of the Packaging and Packaging Waste Directive in reducing paper waste to landfill is estimated at around 1.3 million tonnes or around 7% of total paper recovery in EU15. The direct effect of the Packaging and Packaging Waste Directive in increasing paper recycling is estimated at around 1.4 million tonnes or around 8% of total paper recycling in EU15.

1.7.2.7 Sensitivity analysis

EXPORT

Packaging waste is often transported outside of the EU15 for recycling, typically to countries in the Far East. Reasons for this include lack of capacity, quality/contamination issues, demand for materials and costs. Countries such as China, which imports more than 3m tonnes of waste plastic and 15m tonnes of paper and board a year, use very cheap labour to sort the material. One article in The Guardian newspaper quotes UK plastics recyclers as saying that one of the reasons for exporting is "agents for Chinese companies are offering £120 a tonne for mixed plastic bottles, far more than British companies can pay. The industry here can only support £50 per tonne."

Costs for shipping the waste material to China and the Far East are reduced by back loading the containers that bring in vast amounts of imported goods from the region. To investigate the sensitivity of the results to the fact that exports have been excluded from the system boundaries, this sensitivity analysis investigates a typical journey from Southampton, UK to Shanghai, China was calculated using an Internet based World Ports Distance Calculator. This distance associated with this journey was 10299 nautical miles or 19074km. It is assumed that all material sent to recycling is exported.

The results obtained indicate that increased transportation either reduces the benefit gained by recycling or increases the impacts of the system. The graph for global warming potential is shown in figure 66

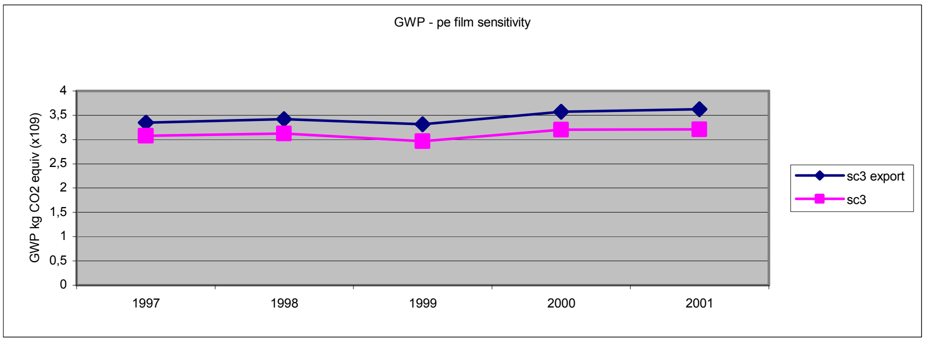


Figure 66 : Comparison of global warming potential for scenario 3 with an alternative scenario 3 with exports to China.

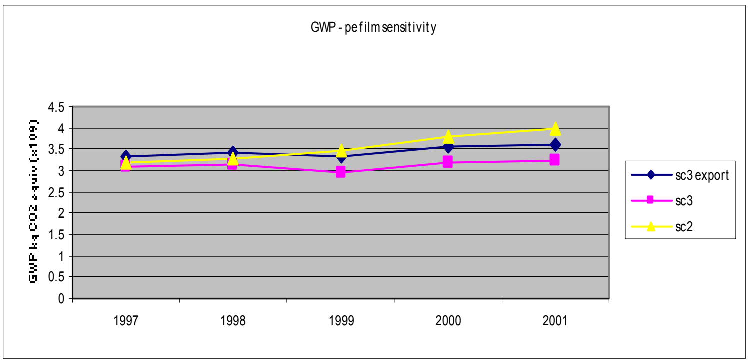
The percentage change has been calculated for all impact categories and is shown in table 40.

Table 40 : Percentage change in impact categories

Category	*Percentage change*				
	1997	*1998*	*1999*	*2000*	*2001*
Abiotic resource depletion	3	3	3	3	3
GWP	8	10	12	10	13
Acidification	11	12	13	13	13
Ecotoxicity	65	62	57	58	56
Human toxicity	18	19	20	20	21
Nutrification	12	12	13	13	13
Smog	3	3	3	3	3

Comparing the results with scenario 2 indicates that the relative position of scenario 3 taking into account export does not change (figure 67) except in the cases of the impact categories acidification, nutrification and human toxicity.

Figure 67 : Comparison of global warming potential for scenarios 2 and 3 with an alternative scenario 3 with exports to China



EFFICIENCY OF ELECTRICITY PRODUCTION FROM INCINERATORS

The production of useful energy from incineration was included within the systems produced with a split of 57% to heat and 28% to electricity. A number of stakeholders considered the electricity efficiency to be too high for the timeframe studied and has therefore been considered within the sensitivity analysis. For this purpose alternative data for energy recovery from incineration was sourced[25] ie 83% heat and 13% electricity.

The sensitivity analysis was conducted on the scenario 3 PE film system for each of the years studied (ie 1997 through to 2001). The results indicate that energy efficiency used in energy production from incineration does influence the results obtained. For global warming potential, reducing the percentage of electricity produced as compared to heat leads to increases in the global warming potential of the systems studied of between 20-24%. Other impact categories however favour heat. This depends on the impacts associated with the different forms of energy.

[25] Environment Agency. Life Cycle Inventory development for Waste Management Operations: Incineration. Research and Development Project Record P1/392/6Tebodin UK, Chem Systems, Vogel WIS, PD Consulting

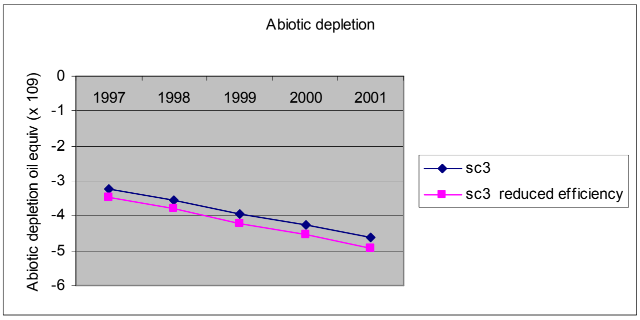


Figure 68 : Abiotic depletion

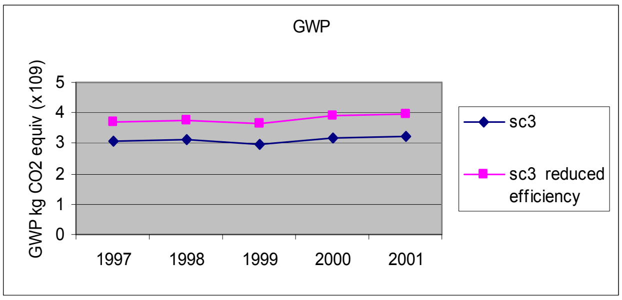


Figure 69 : GWP

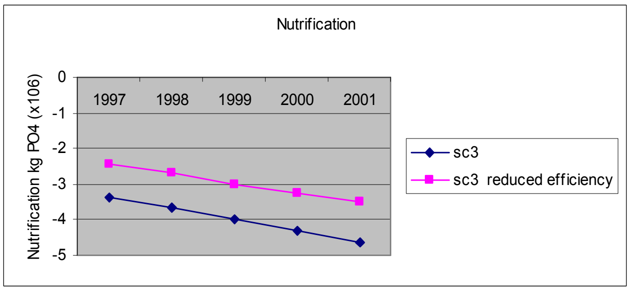


Figure 70 : Nutrification

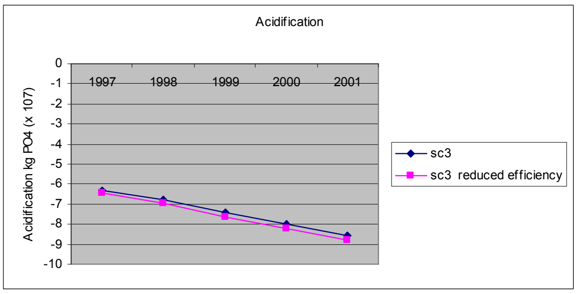


Figure 71 : Acidification

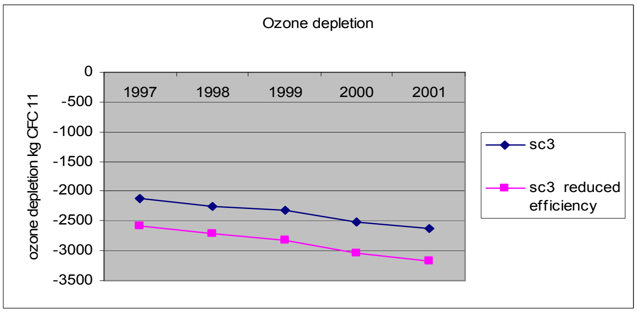


Figure 72 : Ozone depletion

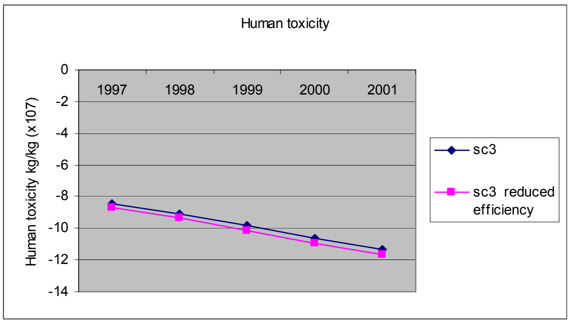


Figure 73 : Human toxicity

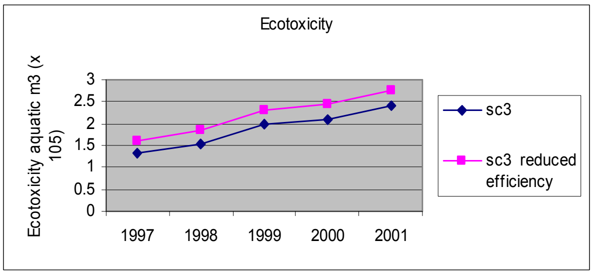


Figure 74 : Ecotoxicity

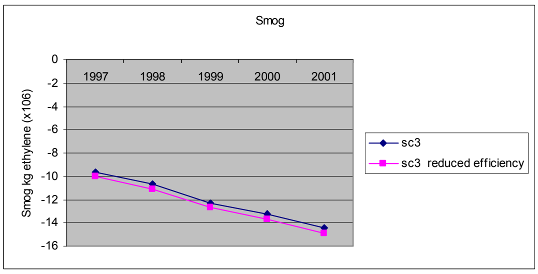


Figure 75 : Smog

1.7.3 Conclusion

The results generated in section 1.7.2 provide a broad brush overview of the impacts associated with the systems studied. The results are not definitive in nature due to the streamlined approach which was taken as a result of data and time limitations. The results of any LCA study will be dependent on the data used and the assumptions made (as shown by the corrugated system) but the results here are indicative of the trends which can be seen in terms of the environmental impacts of the implementation of the Packaging and Packaging Waste Directive.

For the majority of the systems studied, the results generated indicate a lower impact on the environment as a result of packaging recovery and recycling and the PPWD. The results for the four materials indicate that among 56.3 million tonnes of packaging waste, 34.6 million tonnes (61.4%) have been diverted from landfills and 30.7 million tonnes (54.5%) have been recycled. However, only a small part of packaging recovery and recycling is directly related to the effects of the Packaging and Packaging Waste Directive. Most of the packaging recycling would also have taken place in the absence of the Directive, either because it is economically profitable or because of pre-existing national legislation. A major factor in this calculation is that for half of the Member States, the Packaging Directive is assumed to have had no effect. This is because they had national policy measures in place before the Directive which guaranteed at least the same recovery and recycling rates as the Directive. Even for the remaining Member States, significant amounts of packaging waste were recovered or recycled before the transposition of the Directive in national law. Therefore, the direct effect of the Packaging and Packaging Waste Directive in reducing packaging waste to landfill is estimated only at around 2.8 million tonnes or around 8% of total packaging recovery in EU15. The direct effect of the Packaging and Packaging Waste Directive in increasing packaging recycling is also estimated at around 2.8 million tonnes or around 9% of total packaging recycling in EU15.

The environmental impact of packaging waste management was significantly reduced through packaging recovery and recycling. The results showed a significant variation between the various packaging materials. As shown in other studies, this variation also exists within the various packaging material categories, depending on the specific application. Therefore, the results are approximations only based on certain assumptions. In particular, it should be taken into account that, the higher recycling targets and rates are, the more it will be necessary to collect packaging fractions which are less suitable for recycling and which will not correspond to the patterns assumed for the purpose of the following estimations.

On the basis of the assumptions underlying this study, all packaging recovery and recycling together has saved roughly 10 million tonnes of oil equivalent and 25 million tonnes of CO_2 equivalent compared to a scenario where all packaging waste was sent to landfill or incineration without energy recovery. However, only around 1 million tonnes of oil equivalent and 3 million tonnes of CO_2 equivalent, i.e. roughly 8-9% of these savings are the direct result of the implementation of the Packaging Directive[26]. Additionally, significant reductions have been identified for several other impact categories (nutrification, acidification, ozone depletion, human toxicity, ecotoxicity, smog) as a result of increased recycling and recovery.

[26] In these calculations, the effect of paper recycling was assumed to be neutral because CO_2 emissions from paper come from biogenic sources. Equally, the figures for abiotic depletion do not include the data for steel and paper due to methodological problems.

1.8 COMPARISON OF ENVIRONMENTAL IMPACTS ASSOCIATED WITH THE PACKAGING AND PACKAGING WASTE DIRECTIVE WITH TWO SCENARIOS

The impacts discussed in section 1.4 of the Packaging Directive were then put into the context of

- All impacts of the EU economy;
- The overall impacts of all packaging.

Unfortunately due to lack of data availability, it was impossible to assess the impacts of packed goods due to the sheer variety of goods available.

1.8.1 Packaging waste in context of the impacts of the EU economy

In terms of overall impacts of the EU economy, data is available from the European Environment Agency relating to emissions of specific pollutants for the EU15 (table 41).

Table 41 : Anthropogenic annual emissions from the EU15 1997 - 2000[27]

	1997	*1998*	*1999*	*2000*
CH4 (‘000s tonnes)	17321	17039	16702	16275
CO (‘000s tonnes)	37423	35673	33848	30817
CO2 (‘000s tonnes)	3280000	3330000	3308000	3325000
SOx (as SO2) (‘000s tonnes)	8071	7665	6932	5750
NOx (as NO2) (‘000s tonnes)	10896	10556	10215	9497

The emissions from the systems studied in the previous sections can be extracted from the inventories in order to put into perspective emissions from packaging waste management activities in terms of emissions from the EU15 as a whole.

Emissions for the systems in scenario 3 are shown in table 42 below and assume that all plastics packaging disposal is PE film.

Table 42 : Emissions from packaging waste disposal across the EU (assuming plastic packaging is PE film) – scenario 3

	1997	*1998*	*1999*	*2000*
CH4 (‘000s tonnes)	-15.67	-17.50	-18.26	-20.40
CO (‘000s tonnes)	-48.35	-49.06	-53.18	-62.08
CO2 (‘000 tonnes)	7484.67	9152.18	8101.96	8973.15
SOx (as SO2) (‘000s tonnes)	-202.09	-216.52	-229.27	-238.52

[27] Gugele B and Ritter M. Annual European Community CLRTAP emission inventory 1990-2000. Submission on Long-range Transboundary Air Pollution. European Topic Centre on Air and Climate Change

NOx (as NO2) (‘000s tonnes)	-58.76	-65.19	-70.98	-75.88

The results in table 43 are again for scenario 3 but assume that all plastic packaging is PET. The reality is therefore likely to be somewhere between these two.

Table 43 : Emissions from packaging waste disposal across the EU (assuming plastic packaging is PET) – scenario 3

	1997	*1998*	*1999*	*2000*
CH4 (‘000s tonnes)	-13.47	-15.28	-16.19	-18.15
CO (‘000s tonnes)	-70.27	-73.58	-81.98	-92.90
CO2 (‘000s tonnes)	4158.41	5591.95	4277.62	4862.23
SOx (as SO2) (‘000s tonnes)	-206.16	-221.89	-237.43	-247.12
NOx (as NO2) (‘000s tonnes)	-69.47	-77.26	-85.38	-91.28

These tables (PE film or PET) indicate decreasing (and negative) levels of all emissions over the period 1997 to 2000 with the exception of CO2 which has seen an overall rise since 1997.

Taking scenario 1 where no packaging was recovered or recycled, emissions from EU15 packaging waste management would be as shown in tables 44 and 45:

Table 44 : Emissions from packaging waste disposal across the EU (assuming plastic packaging is PE film) – scenario 1

	1997	*1998*	*1999*	*2000*
CH4 (‘000s tonnes)	6.44	7.56	7.28	7.09
CO (‘000s tonnes)	0.11	0.01	-0.23	-0.36
CO2 (000s tonnes)	7709.56	7827.05	7904.66	8172.69
SOx (as SO2) (‘000s tonnes)	-90.67	-96.37	-102.06	-107.32
NOx (as NO2) (‘000s tonnes)	14.89	15.6	13.25	12.58

Table 45 : Emissions from packaging waste disposal across the EU (assuming plastic packaging is PET) – scenario 1

	1997	*1998*	*1999*	*2000*
CH4 (‘000s tonnes)	8.93	10.47	10.2	10.59
CO (‘000s tonnes)	1.48	1.53	1.54	1.54

CO_2 (‘000 tonnes)	7015.98	7095.97	7384.73	7488.08
SOx (as SO_2) (‘000s tonnes)	-63.26	-65.51	-67.57	-69.28
NOx (as NO_2) (‘000s tonnes)	29.01	31.51	31.69	32.55

These tables indicate that packaging waste management (without recycling) is responsible for a very small percentage of EU emissions. The tables also indicate that the recovery and recycling of packaging waste leads to an overall reduction in the amount of emissions from packaging waste management.

1.8.2 Packaging waste in the context of packaging production

To put the impact of packaging waste into context, results have been generated which include production of packaging as well as packaging waste management for each material for scenario 3. These results appear in Annex 5.

The results generated are different for different materials and different for different impact categories but generally show that including manufacture often at least doubles the environmental impact. This indicates that the environmental impacts associated with the packaging manufacture itself represent a significant portion of the life cycle impacts of a packaging system and it is therefore questionable as to whether waste management should be considered in isolation from the remainder of the system. It should also be considered as to whether efforts should be concentrated more on packaging optimisation as this may have a greater potential to reduce overall environmental impact than waste management.

1.9 IMPACTS OF THE DIRECTIVE EVALUATED FROM ECONOMIC PERSPECTIVE

1.9.1 Introduction

An attempt has been made to provide a full overview of the achievements, the costs and the benefits from the Directive, in an easily explainable format.

In this economic evaluation, an effort is made to quantify the economic impacts as much as possible. This applies especially to direct revenues and costs that can be associated with the Directive. In an economic evaluation, it has to be considered that direct revenues and costs may be passed on to upstream suppliers and downstream users, including consumers, thus altering the distribution of any benefit or burden that may occur. Due to limited data availability regarding demand and supply elasticities, these secondary effects can, in most cases, only be described in a qualitative way (see also section 1.7.3 on distributional implications).

The methodology for this assessment is based on the "Handbook for (Extended) Impact Assessment in the Commission". This handbook is designed for the impact assessment of proposed measures as opposed to the ex post evaluation of the impact of the Packaging Directive, but has been re-interpreted accordingly. It is important to note that the ambition is not to make exact calculations of the costs, but rather to estimate the magnitude of the costs. In this respect, this is not a full-fledged cost-benefit analysis.

1.9.2 Some types of economic impacts and definitions

1.9.2.1 Private versus social impacts

The costs incurred by a particular sector or group (e.g. packaging manufacturers, packers/fillers and retailers on the one hand, and waste collectors, recyclers and other businesses specialising in waste management on the other hand) because of the Directive are called private costs. By contrast, the social costs are the costs of the Directive to society as a whole. Private and social costs differ because of externalities: The decisions that an economic actor takes as a reaction to the policies and measures associated with the Directive affect other companies and households which face modified wages, prices, product quality, environmental quality etc. An important positive externality of recycling activities, which needs to be taken into account, are associated savings in disposal costs. In general, the focus of the impact assessment should ultimately be on impacts on society. Nevertheless, the effects on different groups are also important. In principle no taxes should be included in the social cost, as those return to society. Taxes include VAT, landfill tax, packaging tax and tax on incineration of waste.

1.9.2.2 Incremental impacts

We are only concerned about incremental impacts. That is, we only consider the additional impacts that are directly attributable to the Directive, as opposed to changes that would have occurred anyway. This is ensured by using a "baseline scenario with recycling and recovery rates as well as other national measures that would have been likely in the absence of the Directive." Specifying such a baseline helps to think explicitly about what would have happened in the absence of the Directive. The impact of the Directive is then evaluated relative to this baseline. Investment costs made before the Directive are sunk costs and these should not be included in the study.

1.9.2.3 Definitions

In determining the direct costs and benefits of packaging recovery, the following three types of costs need to be distinguished[28]:

- The *gross costs of packaging recovery* (all costs from the moment a packaging becomes waste to the moment when, after recovery, it becomes a recycled product or turns into energy) ;
- The *financing need* (the gross costs minus the revenue from the sale of secondary raw materials or energy): The financing need equals the funds that need to be injected into the market in order to render recovery economical or, in other words, to make recovery happen. This is the relevant cost from the point of view of the recovery chain.
- The *net internal costs for society* (the financing need minus the saved disposal costs): Depending on the material and the circumstances, recovery may be cheaper or more expensive than disposal. This is the relevant financial cost from the point of view of society (this does not take into account external costs such as the effects of environmental degradation). In principle no taxes should be included in any of the costs here, as those return to society.

1.9.3 Economic Impact Matrix

The "impact matrix" assists in structuring the task of identifying the more important impacts. This involves the following steps:

1. Break the Directive down into its main actions (the rows of the matrix);
2. Identify the main types or categories of impacts (the columns of the matrix);

Table 46 : Schematic representation of the economic impact matrix

Actions	*Economic impacts*				
	1. changes in compliance costs	*2. changes in output,*	*3. Impact on the internal market*	*4. impacts on innovation*	*5. economic cohesion*
Packaging prevention : Art. 4					
Encouragement of reuse systems : Art. 5					
Recovery and recycling and targets/systems					
Information duty					
Essential requirements: Art. 9.4 Safeguard mechanisms					

[28] Sofres 2000

1.9.3.1 The main actions of the Directive (the rows of the matrix)

PREVENTIVE MEASURES

The Directive provides that the Member States shall take measures to prevent the formation of packaging waste which may include national programmes.

ENCOURAGEMENT OF REUSE SYSTEMS

Member States may encourage the reuse of packaging.

The Directive does not impose any "hard" obligations on the Member States as regards the encouragement of reuse systems. It merely provides that "Member States may encourage reuse systems of packaging, which can be reused in an environmentally sound manner, in conformity with the Treaty" (Art. 5).

RECOVERY AND RECYCLING AND TARGETS/SYSTEMS

The Member States must introduce systems for the return and/or collection of used packaging to attain the following targets:

- recovery: 50% to 60%;
- recycling: 25% to 45%, with a minimum of 15% by weight for each packaging material.

INFORMATION DUTY

To provide the necessary Community data on waste management, the Member States must ensure that databases on packaging and packaging waste are established on a harmonised basis so that the implementation of the objectives of the Directive can be monitored.

The Member States are to report regularly to the Commission on the application of the Directive.

Member States will ensure that users of packaging are given the necessary information about the management of packaging and packaging waste.

ESSENTIAL REQUIREMENTS: ART. 9.4 SAFEGUARD MECHANISMS

The Directive lays down essential requirements as to the composition and the reuse, recovery and recycling of packaging; the Commission was to promote the preparation of European standards relating to the essential requirements. Provisions concerning proof of conformity with national standards had to be applied immediately.

See also task 2.c.

1.9.3.2 The main types or categories of economic impacts (the columns of the matrix)

The main types or categories of economic impacts are the following:

1. changes in compliance costs
    1.1. investment costs
    1.2. operating costs

   1.3. administrative burden to companies/SME's
   1.4. implementation costs for public authorities
2. changes in output
3. Impact on the internal market : changes in market shares and trade patterns
4. impacts on innovation and technological development
5. economic cohesion

1.9.4 Identification and quantification of the most important impacts

The structure of this paragraph follows the structure of the economic impact matrix.

- The first level of subdivisions follows the main types or categories of economic impacts: the columns of the impact matrix.
- The second level of subdivisions follows the main actions of the directive: the rows of the matrix.

Each economic impact is first described qualitatively for each action of the Directive. Changes in compliance costs are quantified, using literature results and extrapolations where necessary.

The resulting figures are most often not split up according to the individual actions, because the data available in the literature do not allow for doing so. While it is difficult to identify and quantify the changes in the economy which reflect the impact of the Directive, attributing these changes to individual actions such as the "Encouragement of reuse systems" and the "Essential requirements: Art. 9.4 Safeguard mechanisms" seems rather arbitrary. Having said that, it may be reasonable to attribute the largest part of the economic impacts of the Directive to "Recovery and recycling and targets/systems", because this is the only action that imposes "hard" obligations on the Member States.

1.9.4.1 changes in compliance costs

INVESTMENT COSTS

Encouragement of reuse systems

The Directive does not impose any "hard" obligations on the Member States as regards the encouragement of reuse systems. It merely provides that "Member States may encourage reuse systems of packaging, which can be reused in an environmentally sound manner, in conformity with the Treaty" (Art. 5).

Reuse (quantitative) targets have been set in Germany, Denmark, Portugal, Sweden and Austria.[29]

Some potential impacts:

- Fixed-capital investment for the establishment of deposit and collection systems (packaging recycling industry and industry sectors using packaging);
- Investment in storage space (retailers and non-household waste holders).
- Quantification/measurement of the investment cost for reuse systems based on literature. (cf. paragraph 3.2.9).

[29] Argus, February 2001

Recovery and recycling and targets/systems

- Institutional development of the recovery and recycling system (belonging to the packaging recycling industry);
- Increase of capacities, new plants and machinery e.g. bring banks, automatic sorting, 3 colour glass collection (packaging recycling industry);
- Avoided investments in alternative waste treatment infrastructure (negative cost)(waste management industry);
- Changes in packaging lines (industry sectors using packaging);
- Purchase of containers for separate collection of packaging waste (industry sectors / waste holders)

Information duty

- Set up of :
  - Identification system for packaging materials in accordance with Commission Decision 97/129/EC;
  - Database system using the formats in accordance with Commission Decision 97/138/EC

Essential requirements: Art. 9.4 Safeguard mechanisms

Cf. paragraph 2.2

Quantification

WRc 2000 [30] estimates the total investment costs across the EU-15 around 29 billion €, mainly in relation to new plants and machinery. This is an overall investment cost, so non-recurring. The approach taken was a rather theoretical one. This study has determined the minimum expenditure necessary to achieve the minimum targets of the Packaging Directive 94/62/EC, compared to a baseline of no pre-existing packaging recycling. This approach is only theoretical because it does not take into account the real recycling and recovery rates that have been achieved in the Member States.

In Sofres 2000 the investment costs are quantified as part of the total cost together with the operating costs (cf. the next paragraph). All investment costs have been converted to yearly costs and have been included in the total yearly cost.

The cost of setting up a database system using the formats in accordance with Commission Decision 97/138/EC for the UK is estimated at 75.000 UK Pounds per year (1998)[31].

OPERATING COSTS

Encouragement of reuse systems

Some potential impacts:

- Operating cost of the deposit and collection systems;

[30] WRc 2000

[31] Europen personal communication

- storage and collection cost for retailers
- Quantification/measurement of the operating cost of reuse systems based on literature (cf. paragraph 3.2.10).

Recovery and recycling and targets/systems

- Payment of fee and/or tax/charge for putting a packaging on the market/ to cover the recovery costs (packer/filler/importer);
- Overhead costs of compliance schemes (belong to the packaging recycling industry);
- Operational costs of packaging recycling industries;
- Sale of recycled material = market revenues (negative cost for packaging recycling industry);
- Savings in alternative waste treatment costs (negative cost for packaging industry and waste owners)

Information duty

Some potential impacts:

- Operation of :
  - Identification system for packaging materials in accordance with Commission Decision 97/129/EC;
  - Database system using the formats in accordance with Commission Decision 97/138/EC;
- Reporting on the implementation of the Packaging Directive using the questionnaire defined by Commission Decision 97/622/EC

Quantification element

- The cost for the packaging manufacturers of identification system for packaging materials in accordance with Commission Decision 97/129/EC is reported to be low[32], provided it is not added in later on (once the mould for plastic packaging is made). A lot is already happening anyway (cf. SPI system from US).
- The running costs of the database system using the formats in accordance with Commission Decision 97/138/EC for the UK is estimated at 30.000 UK Pounds per year (1998)[33].

Essential requirements: Art. 9.4 Safeguard mechanisms

Cf. paragraph 2.2.

Quantification

There are few complete evaluations of financial costs and benefits of current recycling activities on a macroeconomic level[34]. The most complete study in this respect is SOFRES 2000[35]. It contains a relatively

[32] Europen, personal communication

[33] Europen personal communication

[34] Explanatory Memorandum to the "Proposal for a new Directive of the European Parliament and the Council amending Directive 94/62/EC on packaging and packaging waste – COM(2001)729 final.

[35] Sofres 2000

exact empirical evaluation of the various costs for packaging recycling of household packaging waste in four countries (France, Germany, the Netherlands and the United Kingdom) as well as estimates for the costs of recycling of non-household packaging waste[36][37].

Calculation method 1 and assumptions

We have made an extrapolation of data, based on the methodology of SOFRES 2000.

The calculation has been made for :

- **Scenario 1:** Zero Recovery;
- **Scenario 2:** Baseline Policy
  - This scenario is especially important since it will enable an evaluation of the incremental effect of the Packaging and Packaging Waste Directive. It will be based on an extrapolation of the situation of 1994-1995.
- **Scenario 3:** Packaging Directive

Two calculations have been made for Scenario 3 : a detailed one, based on packaging waste quantities per Member State and an aggregated one, based on aggregated waste quantities for the EU15. The detailed calculation is more exact, but is not really useful for the estimated waste quantities of Scenario 2. Therefore only the aggregated calculation method was used for Scenarios 1 and 2.

The waste disposal costs for France, Germany, the Netherlands and the UK are based on Sofres 2000. The waste disposal costs for the other countries are based on Eunomia 2000 [38] (which uses more recent values).

Total financing need for packaging waste management for the EU15

The results of the estimation of the total financing need for packaging waste management for the EU15 for the 3 scenarios are presented in Table 47.

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[36] Some stakelholders argue regarding the use of the Sofres study as the data relating to costs pre-date the Directive. The study has been analysed by one stakeholder, INCPEN, who concluded that much more work needed to be done in order to yield useful results.

[37] Stakeholder comment from PRO EUROPE : "It must be taken into account that the SOFRES study only gives information on four countries that cannot be extrapolated for other member states. Moreover, the information in the SOFRES study is out of date."

[38] Eunomia Research & Consulting Ltd., "Costs for Municipal Waste Management in the EU – Final Report to Directorate General Environment, European Commission", Bristol, 2000.

Table 47 : Total financing need for packaging waste management for the EU 15

		Year	1997	1998	1999	2000	2001
Scenario 1	Zero Recovery	bn. Euros/y (1)	5,8	6,0	6,14	6,17	6,17
		% of Scenario 3	96%	96%	94%	93%	91%
Scenario 2	Baseline Policy	bn. Euros/y	6,0	6,3	6,4	6,5	6,6
		% of Scenario 3	99%	99%	97%	97%	97%
Scenario 3	Packaging Directive						
	Aggregated calculation	bn. Euros/y	6,0	6,3	6,6	6,7	6,8
		% of Scenario 3	100%	100%	100%	100%	100%
	Detailed calculation	bn. Euros/y	6,1	6,3	6,5	6,5	6,6
Incremental cost : Scenario 3 minus Scenario 2		Mio Euros/y	50	46	176	185	227
		% of Scenario 3	0,8%	0,7%	2,7%	2,8%	3,3%

(1) In real prices of 1998

The total financing need for packaging waste management for the EU15 for 1998 for Scenario 3 amounts to 6,3 bn. Euro. This represents around 0,08% of European GDP[39] and 8% of total environmental expenditure[40]. The easiest way to compare the Scenarios is by calculating which % of Scenario 3 they represent.

The incremental cost of Scenario 3 (Packaging Directive) compared to Scenario 2 (Baseline) varies from 50 million Euros or 0,8% in 1997 to 227 million Euros or 3,3% in 2001. This means that in 2001 only 3,3% of the total cost of packaging recycling is due to the effects of the Packaging Directive. The conclusion could be that PPWD implementation has achieved its goals without significant macro economical impact.

The 3 scenarios are represented graphically in Figure 76:

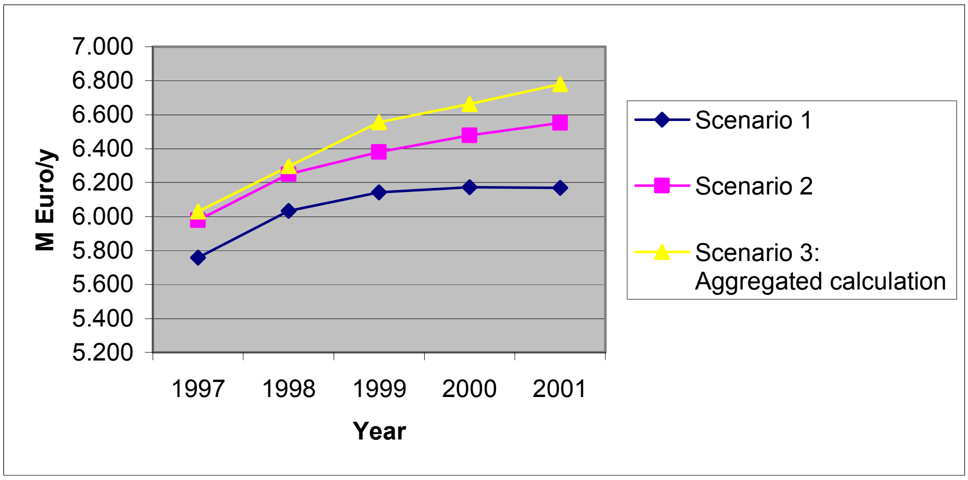

Figure 76 : Total financing need for packaging waste management for the EU 15

[39] The GDP of the EU15 countries in 1998 was 7.637,- billion Euro (Source : Eurostat)

[40] Total environmental expenditure of the EU15 countries in 1998 is estimated at 1,02% of GDP (Source : Eurostat)

Composition of the total financing need for packaging waste management.

The total financing need for packaging waste management for Scenario 3 is composed of :

Table 48 : Composition of total financing need for packaging waste management for Scenario 3

		Year	1997	1998	1999	2000	2001
Total financing need for recycling		bn. Euros/y (1)	**2,9**	**3,1**	**3,3**	**3,5**	**3,7**
	the gross costs of packaging recycling	bn. Euros/y (1)	4,1	4,4	4,8	5,0	5,3
	minus the revenue from the sale of secondary raw materials	bn. Euros/y (1)	-1,16	-1,3	-1,4	-1,5	-1,6
Total financing need for incineration with energy recovery		bn. Euros/y (1)	**0,52**	**0,52**	**0,55**	**0,57**	**0,55**
Total financing need for disposal of remaining packaging waste		bn. Euros/y (1)	**2,6**	**2,7**	**2,6**	**2,4**	**2,3**
Total financing need for packaging waste management		bn. Euros/y (1)	**6,1**	**6,3**	**6,5**	**6,5**	**6,6**

(1) In real prices of 1998

The composition of the total financing need for packaging waste management for Scenario 3 is represented graphically in Figure 77 :

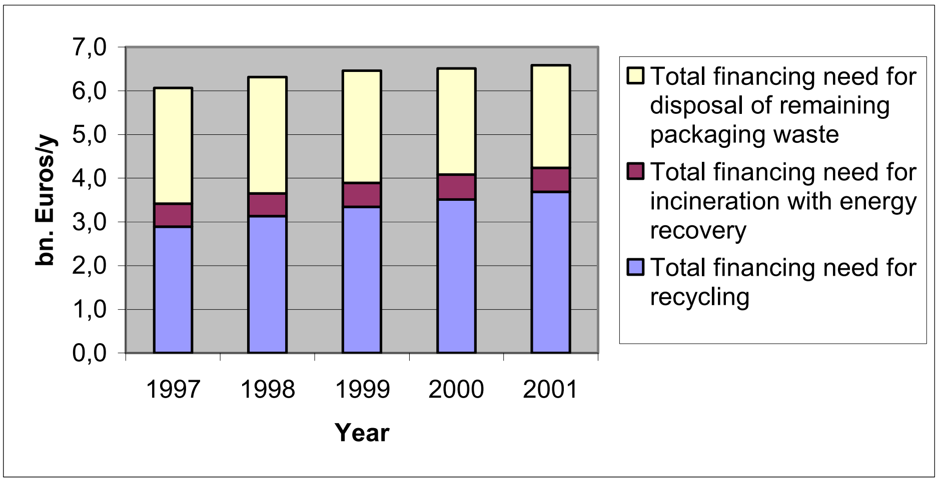

Figure 77 : Composition of total financing need for packaging waste management for Scenario 3

Uncertainty

The above calculation is based on unit costs for recycling of household packaging waste and unit costs for the recycling of non-household packaging waste. The accuracy of the cost estimates can be considered to be within a range of 10% to 15% for household packaging. For non-household packaging, the accuracy "may be much lower"[41]. Additional uncertainties are introduced by the artificial split up of packaging in household / non-household based on assumptions for the 11 countries other than Germany, France, the Netherlands and the UK. The resulting overall uncertainty must be above 30%.

Net internal cost for society of packaging recycling and recovery

The comparison of Scenario 3 with Scenario 1 (no packaging recycling and recovery) throws light on the net internal cost for society of packaging recycling and recovery.

Table 49 : Difference in financing need between Scenarios 1 and 3

		Year	1997	1998	1999	2000	2001
Scenario 1	Zero Recovery	bn. Euros/y (1)	5,8	6,0	6,14	6,17	6,17
		% of Scenario 3	96%	96%	94%	93%	91%
Scenario 3	Packaging Directive	bn. Euros/y	6,0	6,3	6,6	6,7	6,8
Difference in financing need between Scenarios 1 and 3		bn. Euros/y	0,27	0,26	0,42	0,49	0,61
		%	4,5%	4,2%	6,3%	7,4%	9,0%

Conclusion

The difference in financing need between Scenarios 1 (Zero Recovery) and 3 (Packaging Directive) varies from 0,27 bn. Euros or 4,5% in 1997 to 0,61 bn. Euros or 9,0% in 2001. We have been unable to subtract the taxes. We dispose of the taxes levied on Waste management from the OECD website, and we dispose of the unit waste management costs of the Eunomia study[42], but we do not know which of the Eunomia study unit costs include taxes and which do not.

In other words the alternative waste disposal costs (Scenario 1) is of the same order of magnitude and slightly lower than the packaging waste management cost including (partly) recovery and recycling (Scenario 3). Packaging recovery causes a 4 – 9% additional cost compared to no packaging recovery. This extra cost cannot be attributed to the Packaging Directive however, as Scenario 3 is very close to the baseline scenario (cf. above)

Calculation method 2 and assumptions

A more theoretical approach to evaluating the costs of packaging recycling was taken by WRc 2000[43]. This study has determined the minimum expenditure necessary to achieve the minimum targets of the Packaging Directive 94/62/EC, i.e. 15% recycling of each material, 25% total recycling and 50% recovery

[41] Sofres 2000

[42] Eunomia Research & Consulting Ltd., "Costs for Municipal Waste Management in the EU – Final Report to Directorate General Environment, European Commission", Bristol, 2000.

[43] WRc 2000

compared to a baseline of no pre-existing packaging recycling. This approach is more theoretical because it does not take into account the real recycling and recovery rates that have been achieved in the Member States.

The study estimates the following costs across the EU-15:

- total annualised costs of around 6,8 billion € per year (total investment costs around 29 billion € (i.e. annualised over 10 years at 3,1 billion € per year), mainly in relation to new plants and machinery; operational costs of 3,7 billion € per year, of which 1,6 billion € are salaries)
- income from the sales of recycled materials and energy produced at a level of 3,0 billion € per year.

ADMINISTRATIVE BURDEN TO COMPANIES /SME'S

Encouragement of reuse systems

Potential impacts :

- Identification of packaging for reuse (packagers/fillers/importers);
- Additional bookkeeping (packagers/fillers/importers) (if they must meet a reuse target);
- Drawing up of a packaging prevention plan (cf. task 2)

Recovery and recycling and targets/systems

Potential impacts :

- Administrative burdens regarding membership of a compliance scheme (packagers/fillers/importers);
- Identification of packaging materials in accordance with Commission Decision 97/129/EC;

Information duty

- Nil, this is a task for the authorities.

Essential requirements: Art. 9.4 Safeguard mechanisms

Cf. paragraph 2.2.

Quantification

- Monitoring and the formulation of prevention plans in the Netherlands (under the covenant of 1991) is estimated to represent a burden of 5,5 million Euro per year, to be borne by the industry[44]

ADMINISTRATIVE BURDENS FOR PUBLIC AUTHORITIES

Encouragement of reuse systems

- Organisation of information and awareness campaigns.

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[44] Explanation of the Dutch PPWD in the DPPWD guide: information for the submission of a notification, VROM, directorate waste, Den Haag 1998

Recovery and recycling and targets/systems

- Enforcement of the system;
- Organisation of information and awareness campaigns;
- Cf. paragraph 1.2 - distributive effects : cost for tax payer

Information duty

- Set-up and operation of :
  - Database system using the formats in accordance with Commission Decision 97/138/EC;
- Reporting on the implementation of the Packaging Directive using the questionnaire defined by Commission Decision 97/622/EC

Essential requirements: Art. 9.4 Safeguard mechanisms

Potential impacts :

- Market surveillance

Quantification

The information duty is a task for the authorities. This is often delegated to the compliance schemes, who invest a lot of money in awareness campaigns and information towards the consumers:

- In the Spanish National Plan for Municipal Waste for the period 2000-2006, 72 million Euros is foreseen for sensitisation and information.[45] This includes – but is not limited to – sensitisation and information related to packaging waste.
- FOST Plus (Belgium) spends yearly more than 5,7 million euro on Communication [46]
- In 1998 Adelphe (France) spent 0,53 million Euro on communication[47]
- In 1999 DSD (Germany) spent 43 million Euro on "Other costs", which includes R&D and public relations[48]
- Valorlux (Luxembourg) spent 0,35 million Euro on communication in 1999[49]

1.9.4.2 changes in output

Encouragement of reuse systems

Some potential impacts:

- Increase in turnover for companies that design new reusable packages (these companies belong to the packaging industry);

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[45] Argus, 2001

[46] Stakeholder contribution from PRO EUROPE

[47] Argus, 2001

[48] Argus, 2001

[49] Argus, 2001

- Decrease in turnover for companies who are active in the design and production of one-way packaging;
- Increase in turnover for re-conditioners of reusable packs :
  - Increased turnover for existing deposit and collection;
  - establishment of deposit and collection systems;
- Decrease of turnover for raw material producers (= due to decreased packaging production) ;
- Decrease of turnover of classic waste management sector
- Quantification/measurement of the output of reuse systems based on literature (Cf. paragraph 3.2.10).

Recovery and recycling and targets/systems

Some potential impacts:

- Increase in turnover for companies that design new recoverable and recyclable packages (these companies belong to the packaging industry) ;
- Increase in turnover for packaging recyclers :
  - Increased turnover for existing businesses;
  - New businesses;
- Decrease of turnover for raw material producers (= substitution by recycled material) ;
- Decrease of turnover of classic waste management sector

Compliance systems

In all Member States, except for Denmark[50], economic operators within the packaging chain (manufacturer, packer/filler, distributor, importer) are responsible for packaging waste management, and for providing data on the amount of packaging put on the market. Except for Denmark, the industry has built up organisations in all Member States to comply with the obligations imposed by national packaging regulations on behalf of the individual businesses affected. However, economic operators generally have the option of transferring their obligations to an external organisation (hereafter called compliance scheme) or fulfilling their obligations by themselves. The schemes co-ordinate the activities necessary for the recovery of packaging waste and have an essential interface role to play between the different actors within the packaging life cycle (industries, public legal entities, consumers, recycling and recovery operators).

In ten Member States a "green dot" system has been established. By contracting with the green dot system, the companies responsible for producing packaging entrust their take-back obligation to the scheme in return for an annual fee based on the types of packaging materials used, and on the amount of packaging put on the market.

The green dot systems are predominantly - but not exclusively - in charge of the management of household/municipal packaging waste. But, as is demonstrated by Austria and Ireland, this is not always the case. The table below lists the main national packaging waste management organisations and summarises the responsibility of these systems according to municipal/industrial packaging waste [51]. The

[50] In Denmark the municipalities are responsible for the packaging waste management

[51] Argus, February 2001

cost basis of the different schemes vary, for example, for some schemes, payments by industry cover the costs of recovery and recycling and for some the payments are merely a contribution.

In many countries municipalities are responsible for the (separate) collection of waste fractions, cleaning streets, littering, emptying waste bins or even have a wider responsibility for waste management.

Table 50: Areas of activities of main compliance schemes

Country	Organisation	Responsible for		Green Dot
		Municipal packaging	Industrial packaging	
Austria	Branch organisations	x	x	x
Belgium	Fost+	x	no	x
	Val-I-Pack	no	x	
Denmark	Municipalities	x	(x)(1)	no
Finland	PYR	x	x	no
France	ECO-Emballages	x	no	x
	Adelphe	x	no	x
Germany	DSD	x	no	x
	Different organisations	X (2)	x	
Greece	HERRCO			
Ireland	Repak	x	x	x
Italy	CONAI	x	x	
Luxembourg	Valorlux	x	x	x
The Netherlands	SVM-Pact	x	x	no
Portugal	SPV	x	x	x
Spain	Ecoembalajes	x	no	x
	Ecovidrio	x	no	x
Sweden	REPA	x	no	x
UK	Different organisations, e.g. Valpak	x	x	no

(1) Municipalities are obliged to assign industrial waste to recycling, which means that they have to prepare regulations that oblige enterprises to recycle their packaging waste.

(2) Since the amendment of the Packaging Ordinance in 1998, systems for self-compliers are in operation in competition with the DSD.

Essential requirements: Art. 9.4 Safeguard mechanisms

Cf. paragraph 2.2.

Quantification

Packaging recovery industry:

The turnover of the compliance schemes may be an indication of the turnover of the whole packaging recovery sector. In Table 51 the figures available from Pro-Europe are presented.

Country	*System*	*Revenues*						*Expenses*					
		1998	*1999*	*2000*	*2001*	*2002*	*2003*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
		Mio Euro	*Mio Euro*	*Mio Euro*	*Mio Euro*	*Mio Euro*	*Mio Euro*	*Mio Euro*	*Mio Euro*	*Mio Euro*	*Mio Euro*	*Mio Euro*	*Mio Euro*
Austria	ARA Altstoff Recycling Austria AG	194,3	195,8	184,8	162,7	156	148,5	App. 194	App. 195	App. 184	App. 162	App. 156	App. 148
Belgium	Asbl FOST Plus vzw	48,6	64,9	81,2	85,4	89	80	58,2	65,8	73,7	83,7	95,6	99,9
Denmark	municipalities												
Finland													
France	ECO-Emballages sa	76,8	91,5	171	198,8	304		118	156	182	283	296	
Germany	Der Grüne Punkt-Duales System Deutschland AG (DSD)	2.130	2.003	2.035	1.879	1.874	1.697	2.063	1.989	2.018	1.879	1.874	1.697
Greece	He.R.R. Co						App. 16						App. 1,7
Ireland	Repak Ltd.	2,3	8,1	10,9	11,7	13,5		2,3	2,04	6,07	12,5	15,4	
Italy[52]	CONAI	200	216,5	227,9	231,1	233,8							
Luxembourg	Valorlux asbl	1,23	1,86	2,72	3,15	3,71	4,56	1,23	1,86	2,7	3,14	3,71	4,55
Portugal[53]	Sociedade Ponto Verde sa	6,1	10										
Spain	Ecoembalajes Espana sa	39,7[54]	106,2	118,8	131	137,5		20,3[55]	51,3	91,4	134,9	160,6	

[52] Data for Italy available from CONAI (Piano Generale di Prevenzione 2003)

[53] Data for Portugal are available from Argus, February 2001

[54] EcoEmbes started business in May 1998

[55] EcoEmbes started business in May 1998

		Revenues						*Expenses*					
Sweden	Repa Registered	43	44	47	48	51	56	43	44	47	48	51	56
The Netherlands													
UK[56]	Different organisations, e.g. Valpak	173,8	78	81	156,1								

Table 51: Turnover of compliance schemes

[56] Data for UK are available from Defra, GBP were converted to € using the current exchange rate

An indicative total over the EU-15 based on Table 51 amounts to 2,9 billion Euro for 1998. This figure should be compared to the total financing need for packaging recycling, which was estimated by us at 3,1 billion Euro for 1998 (Cf. Table 48). It is normal that the figures do not correspond because[57]:

- The figures for the compliance schemes are incomplete;
- The compliance schemes do not cover all packaging recovery;
- The self controllers are not served by the compliance schemes;
- Different costs are covered by the fees of the compliance schemes in each country.

Packaging industry:

To put the turnover of the packaging recovery industry and the total cost for packaging recovery into perspective, it should be compared with the turnover of the packaging industry.[58]

The turnover of the packaging industry was analysed using the Amadeus database.

The analysis of the turnover (operating revenue) and employment of the packaging industry from 1996 to 2002 (see detailed results from Amadeus in Annex) indicates that for 2002 the summarized turnover of this industry amounts to 90 billion euro. According to the Amadeus results the packaging industry was growing from 1996 till 2001. There appears to be a decline of total number of firms, total turnover and number of employees in 2002 (Figure 78). The financing need for packaging recycling in 1998 (3,13 billion €) represented 4 % of the turnover of the packaging industry in that year (79,7 billion €).

[57] According to a stakeholder contribution from PRO EUROPE "The indicative cost of 2.9 billion euro (based on the figures of the compliance schemes) and the comments concerning the comparison with the total financing need, clearly show that 3.1 billion euro is an underestimation of the total financing need."

[58] Stakeholder contribution PRO EUROPE : "It must be mentioned though that in most countries the companies that produce packaged products pay the recovery cost (and not the packaging industry).

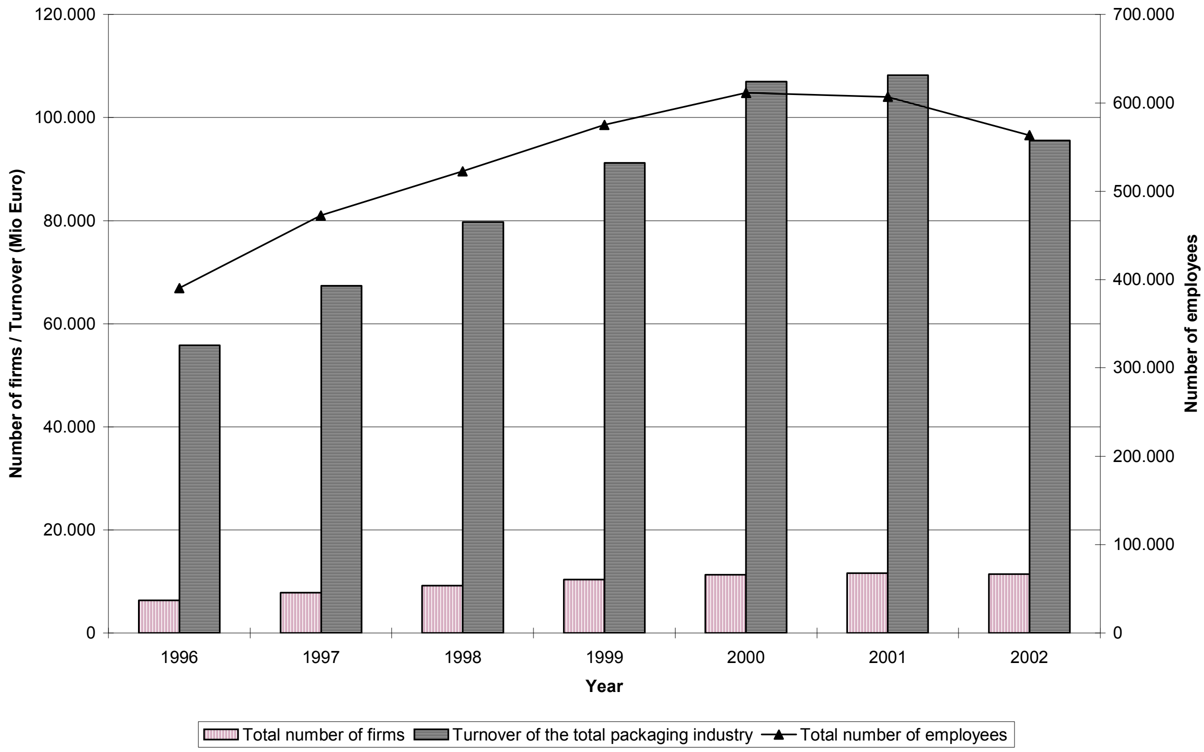

Figure 78: Number of firms, number of employees and turnover of the packaging industry

The split-up of the turnover of the packaging industry per NACE code (material/activity) (Table 52) shows that the manufacturing paper packaging represents 38% of the total operating revenue, followed in line of importance by the manufacturing of plastic packaging goods (26%) and the manufacture of light metal packaging (17%). The proportion of the turnover of manufacturers of hollow glass (10%) and of the packaging activities (packers fillers: 9%) is considerably lower, while the manufacture of steel drums and similar containers is almost inexistent (approximately 0%).

NACE Code	*Description*	*Operating revenue/Turnover (mio €) in 2002*	*Percentage*
21.21	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	34.433	38%
25.22	Manufacture of plastic packing goods	23.829	26%
26.13	Manufacture of hollow glass	8.976	10%
28.71	Manufacture of steel drums and similar containers	2	0%
28.72	Manufacture of light metal packaging	14.973	17%
74.82	Packaging activities	7.830	9%
TOTAL of the packaging industry		90.043	100%

Table 52: Turnover of the packaging industry split-up according to NACE code

Solid waste management industry and recycling industry:

The turnover of the waste management and recycling industries was analysed using the Amadeus database.

Recycling industry

Unfortunately the relevant NACE sectors are not limited to packaging recycling, but cover the whole recycling sector. The question was raised if there was a risk of double counting, if certain compliance schemes (and the recycling companies they have contracts with) would be included in the list. We verified that this is certainly not the case for the compliance schemes as for example Fost Plus is listed in Amadeus under the NACE code 91.12 'Activities of professional organisations'

The analysis of the turnover (operating revenue) and employment of the recycling industry (NACE codes 37.1 and 37.2) from 1996 to 2002 (see detailed results from Amadeus in Annex) indicates that for 2002 the summarized turnover of this industry amounts to approximately 18 billion euro. According to the Amadeus results the packaging industry is growing (total number of firms and number of employees) since 1996. Only the total turnover shows a small decline in 2002. The financing need for packaging recycling in 1998 (3,13 billion €) represented around 30 % of the turnover of the recycling industry in that year (10 billion €). The split-up of the turnover of the recycling industry per NACE code (metal versus non-metal) shows that both activities are almost in balance: 51% of metal waste and scrap recycling versus 49% of non-metal waste and scrap recycling.[59]

Waste management industry

The analysis of the turnover (operating revenue) and employment of the waste management industry (NACE codes 90.02, collection and treatment of other waste) from 1996 to 2002 (see detailed results from Amadeus in Annex) indicates that for 2002 the summarized turnover of this industry amounts to approximately 25,8 billion euro. According to the Amadeus results the waste management industry is growing (total turnover, total number of firms and number of employees) since 1996. The financing need for incineration of packaging waste with energy recovery in 1998 (520 million €) amounted to 3,5 % of the turnover of the waste management industry (15 billion €). The financing need for disposal of the rest fraction of packaging waste in 1998 (2,7 billion €) amounted to 18 % of the turnover of the waste management industry.

It has to be kept in mind that working with the Amadeus database has the several drawbacks (cf. Annex) insofar that the completeness of the figures cannot be guaranteed.

1.9.4.3 Impact on the internal market

- This impact is not included in the Terms of Reference of this project.

1.9.4.4 impacts on innovation

Qualitative description

Growing quantities of recovered (secondary) materials which replace primary (virgin) materials must be marketed to producers. These will require high and constant levels of quality and preferably, reliable supplies in terms of quantities and deadlines. These requirements in turn call for investments in sorting technologies and further processing technologies for specific streams of secondary materials. These sorting technologies are based upon optical (infrared and others) devices, laser technology, magnetic and eddy currents, wet technologies, blast technologies and mechanical processes (with crushing, grinding and separate recovery stages).

The development of sorting technologies is on the agenda of France and Germany.

It seems that the technological impact – in the sense of innovation – of the Directive is, at best, limited. In Germany and in Finland some technological innovation has been identified, but it is not clear to which extent this is the result of the Directive. Germany: national law is more stringent and in Finland the national policy of 'high quality valorisation' of secondary materials coincides with the Directive. In France,

[59] This proportion is not representative for packaging recycling. Packaging recycling is predominantly glass and paper/board (personal communication PRO EUROPE).

a deliberate policy option of not stimulating any innovation in the technology for the treatment of packaging waste was identified.[60]

As a complement to the above conclusion of Technology and Environmental Policy, we have obtained information from VALPAK (UK) stating that there are many examples in the UK where the packaging regulations have stimulated technology and investment. Some examples are provided in Annex 19.

1.9.4.5 economic cohesion

The economic impacts of the Directive may differ significantly between Member States. E.g. the effect of the directive may have been stronger in countries which had not achieved high recycling rates at the start. Under Art. 6(5) of the Directive Portugal, Ireland and Greece were allowed to postpone the attainment of the recovery and recycling targets.

[60] Technology and Environmental Policy "The implementation and technological impact of the Packaging and Packaging Waste Directive (94/62/EC) in France, Germany and Finland" (November 2000)

1.10 IMPACTS OF THE DIRECTIVE SCREENED FROM SOCIAL PERSPECTIVE

1.10.1 Introduction

Next to an investigation of distributional implications. the social evaluation relies on the screening of issues and available information. The social impacts are mostly discussed in a qualitative manner and put into their macro-economic context.

Examples of potential social impacts include :

1. Impacts on human capital
2. Impact on fundamental/human rights
3. Compatibility with Charter of Fundamental Rights of the European Union
4. Changes in employment levels or job quality (jobs created and jobs destroyed)
5. Changes affecting gender equality, social exclusion and poverty
6. Impacts on health, safety, consumer rights, social capital, security (including crime and terrorism, education, training and culture
7. Distributional implications such as effects on the income of particular sectors, groups of consumers or workers etc.

The information found was limited to issues no. 4 and no. 7. which are, however, considered by many to be very important.

1.10.2 Changes in employment levels or job quality

1.10.2.1 Approaches for assessing changes in employment level[61]

In a 2001 study for the European Commission "Employment Effects of Waste Management Policies", RPA presents the following introduction to approaches for assessing changes in employment level as a result of waste management policies in general :

To understand how employment effects can be better taken into account when evaluating policies, it is necessary to recognise the different levels at which impacts may arise. Policies that influence waste management practices can have both positive and negative direct effects. Expenditure on waste management generates direct employment in carrying out waste management activities. This employment may arise either in specialised waste management firms or in companies in other sectors. Such expenditure may also have direct negative effects for waste generators. For individual companies, higher waste management costs could potentially increase prices, reduce market share, lower output and potentially reduce employment. The negative effect for an individual firm, though, may be offset by gains in market share for other companies.

Indirect effects result from changes in direct employment and can also be either positive or negative. If direct employment increases, then there is a 'multiplier' effect because those people directly employed spend their salaries on goods and services. This can create additional employment in the sectors supplying those goods and services (or reduce employment if direct employment decreases). However, if increased expenditure on waste management means that there is less expenditure in other sectors, then jobs in those sectors may be lost. This is known as a 'crowding-out' effect.

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[61] RPA 2001 for the European Commission, Employment Effects of Waste Management Policies

The interaction between the direct and indirect effects changes the structure and composition of the overall demand for labour in the economy. This is termed the net macroeconomic effect and needs to be understood in order to evaluate the impact of waste management policies on total employment. Whether there is a net increase or reduction in aggregate employment depends upon two key factors. Firstly, whether waste management activities are more labour intensive than other activities, so that expenditure on waste management results in more jobs than equivalent expenditure elsewhere. Secondly, whether waste management expenditure feeds through into higher product prices and lower real wages, which may affect labour supply.

The current basis for policy appraisal is cost-benefit analysis (CBA) which usually focuses on the sectors that will be directly impacted by a policy. As a result, the analysis may fail to capture significant indirect effects on other sectors of the economy. There may be a need to supplement any CBA with information on either employment effects or wider macroeconomic effects. Potential approaches include:

- supply side approaches: using data on the supply of labour, for example the number of tonnes of waste per job for a particular type of treatment, to determine direct employment effects ;
- demand side approaches: using data on jobs per unit of expenditure, to estimate direct and first order indirect employment effects, but not overall net effects; and
- macroeconomic modelling approaches: modelling the interactions between direct and indirect employment effects to determine the impact that changes in a sector's supply and demand for goods and services will have on employment and the wider economy.

RPA has tested the 3 approaches on 3 case studies that have no direct relationship to our study : chemical industry, waste electrical and electronic equipment and secondary materials industry. This comparison raises questions as to when the various approaches might be the most appropriate as a means of supplementing the results provided by CBAs. RPA’s conclusion is that for those policies which are likely to have only small impacts on the prices faced in the directly regulated markets, use of the simpler methods for estimating changes in direct and indirect employment should be sufficient. However, where a policy will have significant compliance cost implications for one or more sectors of the economy, then use of the more sophisticated macroeconomic modelling approaches may be important for supplementing CBA results. This latter scenario is one that is likely to arise often in the context of waste management, and understanding the impact of a policy on the linkages between different sectors may be essential to understanding the overall employment and economic effects.

1.10.2.2 Job quality[62]

It has been argued that recycling and other waste management may provide initial routes into employment for the socially excluded or the low skilled. Information on the nature of waste management employment is limited however and appears somewhat contradictory. Some studies indicate that jobs are of a higher quality in waste management than in some other environment-sector activities. Other data indicate that waste management jobs are mainly low-skilled and low-paid. The poorest quality jobs appear to be in collection and transport, manual sorting and composting. Higher-quality jobs are associated with the more technology-intensive, specialised activities.

1.10.2.3 Conclusions[63]

A key finding of the RPA study[64] is that the relationship between waste management policies and employment is more complex than the ongoing debate might indicate. Although waste management

[62] RPA 2001 for the European Commission, Employment Effects of Waste Management Policies

[63] RPA 2001 for the European Commission, Employment Effects of Waste Management Policies

policies may increase demand for waste management services, this does not necessarily result in additional jobs. Instead, technology substitution for labour, increased productivity and consolidation in the waste management sector may severely constrain job creation. There is also some evidence that these factors could reduce employment opportunities for the socially-excluded in waste management.

The three case studies indicate that the impact of waste management policies on the competitive position of the sectors they regulate has been limited to date. Waste management accounts for a small proportion of total expenditure and companies subject to regulation naturally act to minimise the costs of compliance. Some companies also seem to have gained efficiency benefits through focusing on waste minimisation.

Overall, the study demonstrates that waste management measures are likely to have only a small effect, either positive or negative, on employment. The detailed way in which a policy is implemented and complied with is most likely to determine the direction and scale of the effect. The most significant effects may arise outside the directly-regulated sector, making the use of approaches that take account of indirect effects particularly important.

QUANTIFIED CONCLUSIONS ABOUT CHANGES IN EMPLOYMENT LEVELS

The probable level of employment in the EU in organisations for which waste management - as a whole - is a primary activity totals around 200,000 to 400,000[65]. This represents approximately 0.2-0.4% of total EU employment. There is also waste-related employment in other sectors, though numbers of jobs are small compared to the specialised waste management sector (possibly another 3000 to 12000 jobs). It should be noted however that the packaging recycling sector is not a sub-sector of the waste management sector. Sorting and collecting of packaging waste is likely to be included in the statistics for waste management, but packaging recycling/processing may partly be included in waste management sector and partly in the packaging sectors (e.g. glass recycling).

WRc[66] estimates the direct employment linked to the PPWD at around 50.000 FTE/y for the EU15. This is the employment related to operating expenditures and is complemented with 20.000 FTE/y as first round indirect employment (related to operating expenditures also). For capital expenditures the estimated linked employment is approximately 250.000 FTE years.

The calculation is based on the following assumptions and limitations:

- The study looks at the theoretical cost based on meeting the minimum requirements of the Directive, not at the real recovery rates achieved;
- It looks at the gross cost of packaging recovery, i.e.:
  - Gross cost of recycling of paper, glass and plastics (not metals);
  - Waste incineration with energy recovery.
- Employment related to the disposal of non-recovered packaging waste is not included;
- This is not incremental employment, as the employment for alternative packaging waste disposal is not subtracted.

[64] RPA 2001 for the European Commission, Employment Effects of Waste Management Policies

[65] RPA 2001 for the European Commission, Employment Effects of Waste Management Policies

[66] WRc 2000 for European Commission, Study on Investment and Employment Related to EU Policy on Air, Water and Waste

Because of these drawbacks, we have repeated the WRc calculation, using the figures of gross cost of packaging recycling of paragraph 1.9.4.1.

Table 53 : Recalculation of employment related to the PPWD for the EU15 for 1999

		WRc	Remark	Ecolas	Remark
		1999?		1999	
gross cost of packaging recovery	*Euro/yr*	6.800	(1)	4.024	(1)
gross cost of packaging recycling	*Euro/yr*	5.877	(3)	3.478	(1)
gross cost incineration	*Euro/yr*	923	(3)	546	(4)
operating expenditures packaging recovery	*Euro/yr*	3.720	(1)	2.201	(3)
Direct employment	*FTE/yr*	51.542	(1)	**30.501**	(3)
Indirect employment	*FTE/yr*	19.774	(1)	**11.702**	(3)

(1) : original value from the report

(3) : extrapolation

(4) : financing need as an estimate for the gross cost

Based on this recalculation we estimate the direct employment at 30.000 FTE/yr and the first round indirect employment at 12.000 FTE/yr. Further we note that this is a demand side approach and no conclusions can be drawn from this with regard to the macroeconomic net employment effect.

1.10.3 Distributional implications

Identifying the impacts on different groups in society is a crucial part of impact assessment. Even if the implementation of the Directive was beneficial for society as a whole it may have had positive or negative impacts to different groups in society.

It is an important issue who has to pay for the compliance costs that have been identified. The compliance costs do not necessarily remain a burden to those who have to pay for them in the first place. For example, some companies may be able to pass on some of the costs to the downstream users of their products. Despite this, the primary distribution of compliance costs gives a first indication which sectors may be affected.

Ultimately, benefits and costs accrue to people, not to institutions. Thus, what ultimately matters is the distribution of benefits and burdens to different types of households (poor versus rich, capital owners versus labourers, etc.). As indicated, the final distribution of benefits and burdens depends not only on the primary distribution of compliance costs, but also on the reactions of economic actors to these compliance costs. Most notably, changes in employment levels and in consumer prices greatly influence the final distributional impact of a certain policy.

1.10.3.1 Primary distribution of compliance costs

In a first step, we identify who has to pay for the compliance costs in the first place. The following sectors (including private households) have been considered (to the extent possible):

- Packagers/fillers/importers ;
- **Packaging manufacturers** : e.g. producers of paper packaging products ;

- **Raw material producers** : Production of virgin materials.[67] ;
- **Packaging chain** : raw material producers, packaging material producers, packagers/fillers/importers, sellers [68] ;
- **Packaging recycling industry**: recycling/processing, sorting and collection = Material producers.[69] ;
- re-conditioners of reusable packs ;
- Classical **waste treatment industry** : collectors, landfill, incineration ;
- Non household waste holders (industrial sectors) ;
- Private households ;
- Municipalities

In the table below an overview is given of which sectors experience which costs and benefits:

[67] In the glass sector the production of raw materials and packaging are integrated.

[68] Sofres, 2000

[69] For some materials the recycling is done by the raw material producers (e.g. paper) or packaging manufacturers (e.g. glass).

Table 54 : Overview which sectors experience which costs and benefits

Costs and benefits	*Amount in 1998 (bn. Euro)*	*Packaging manufacturers* (1)	*Packaging recycling industry*	*Raw material producers*	*Classical waste treatment industry*	*Packaging chain or Packers/fillers/ importers* (2)	*Private households*	*Municipalities*
Financing need for packaging recycling	3,1	Bear cost for x%	Benefit			Bear cost for y%	Bear cost for z%	Bear cost for w% (3)
Gross costs of packaging recycling	4,4		Cost (profit excluded)		Cost (profit excluded)			
Revenue from the sale of secondary raw materials	- 1,3		Benefit	Cost				
Total financing need for incineration with energy recovery	0,5	Bear cost for x%				Bear cost for y%	Bear cost for z%	Bear cost for w% (3)
Total financing need for disposal of remaining packaging waste	2,7				Cost (profit excluded)	Bear cost for y%	Bear cost for z %	Bear cost for w% (3)
Revenue from incineration with energy recovery	0,5				Benefit			
Revenue from the sale of the recovered energy	Not available				Benefit			
Revenue from disposal of remaining packaging waste	2,7							
Revenues from sales of virgin materials	1,3			Benefit (plus profit)				

Costs and benefits	*Amount in 1998 (bn. Euro)*	*Packaging manufacturers* [(1)]	*Packaging recycling industry*	*Raw material producers*	*Classical waste treatment industry*	*Packaging chain or Packers/fillers/ importers* [(2)]	*Private households*	*Municipalities*
Revenues from packaging sales	Not available	Benefit						
Revenues from sales of products						Benefit		

(1) Packaging manufacturers : (in most countries) contribute to the recovery cost by paying a fee or tax for putting a packaging on the market

(2) Packaging chain or Packers/fillers/importers (depending on the country: see further)

(3) In many countries the municipalities are responsible for the (separate) collection of waste fractions

The above list includes some double counting, e.g.

- Financing need for packaging recycling 3,1 bn. Euro;
- Total financing need for incineration with energy recovery 0,5 bn. Euro

are attributed both to the packaging manufacturers, to the households/tax payers, to the municipalities and to Packaging chain or Packers/fillers/importers. In effect the costs are split between them (cf. indications x%, y %, z% and w%) in accordance with the national systems for the financing of packaging waste management activities. Please not that x%+y%+z%+w% do not necessarily add up to 100%.

In the case of *non-household packaging waste*, the financing need for packaging recycling is in most Member States (but not for the UK) entirely covered by the waste holder (industry).

Regarding the financing of *household packaging waste* recycling, generally, three different types of systems can be broadly distinguished [70][71]:

- Packers/fillers/importers are fully responsible for covering all costs; municipalities can be involved in separate collection on behalf of Packers/fillers/importers: Austria, Germany, Sweden
- Packers/fillers/importers and municipalities share responsibility, Packers/fillers/importers cover costs of sorting and recycling; municipalities are in charge of separate collection and their costs are (completely or partially) reimbursed: Belgium, Finland, France, Ireland, Italy, Luxembourg, Portugal, Spain
- Packers/fillers/importers and municipalities share responsibility, Packers/fillers/importers cover the costs of recycling; municipalities are in charge of separate collection and receive revenues through selling the collected materials: United Kingdom, the Netherlands, Denmark

The difference between the three systems is quantified in Sofres 2000:

- The "financing need" is split differently between the various actors in the countries:
  - in France, split about half-half between fillers/importers and tax payers,
  - in Germany, fillers/importers support the "financing need" alone,
  - in the Netherlands, tax payers support the entire "financing need",
  - in the UK, split between packaging chain and tax payers.

[70] Argus, February 2001

[71] Stakeholder comment PRO EUROPE : "The (Argus) report is mixing two parameters that should be kept separated in the analysis: the competence to organise collection and recycling schemes and the financing of those schemes. In most countries the municipalities are in charge of the collection, but a lot of variation exists in the financing by industry.

Table 55 : Financing need break down for household packaging waste recycling per financer[72][73]

	Financing need	*Financers*		
	Total	*Tax payers/ charities* (1)	*Packers/fillers/ importers*	*Packaging chain* (2)
	Euros/t sorted	*Euros/t sorted*	*Euros/t sorted*	*Euros/t sorted*
France	82	41	40	0
Germany	315	0	315	0
The Netherlands	32	53 (3)	0	0,08
The United Kingdom	28	-10	0	38

(1) In the case of the UK, it appears that tax payers get some revenue from packaging waste collection. This is because people/organisations who bring back aluminium cans receive money. However, it should be noted this is not done exclusively by households/tax payers.

(2) The value for the Netherlands does not concern the packaging chain but the first producers of paper products, who participate into a paper fund.

(3) Part of the taxes are not used for waste management purposes.

The UK has adopted a unique approach to fulfilment of the European Union's packaging waste recovery and recycling targets. The UK has a system whereby all those involved in the packaging chain take on a share of the responsibility for ensuring fulfilment of the UK's target for the recovery of packaging waste. Responsibility for recovery and recycling of packaging waste is divided among the commercial enterprises which form part of the "packaging chain" (cf. Paragraph 0), raw material producers, packaging manufacturers, packer/fillers and sellers. The recovery and recycling targets are to be met according to a certain percentage obligation associated with the economic activity.

The financing need break down could be estimated for the EU-12, based on the division of the countries according to the three different types of systems and the % split up for France, Germany, the Netherlands and the UK.

1.10.3.2 Distributional effects according to different types of households taking into account economic behaviour

The distributional consequences of increased recovery schemes greatly depend on the associated financing mechanism. In principle, the recovery schemes can be financed by industry or from public budgets.

In cases where the recovery schemes are financed from a public budget, the distributional consequences depend on the way in which the budget is modified to accommodate the additional expenditure. If the additional expenditure remains unmatched by an increase in revenues or a cut in other expenditures, the result is an increase in public debt. The associated distributional effects depend much on the macroeconomic circumstances at the times (1) of the issuance of the debt titles, (2) of interest payments and (3) of re-payment of the debt. In general, it can be said that - unless an increase in public debt is matched by increased private savings - debt financing implies a shift of burden to future generations.

[72] Original table from Sofres, 2000

[73] Some stakeholders comment that these data are outdated.

Further, an increase in public debt often leads to higher interest rates, which tends to favour capital owners over households that receive their income through labour. Public expenditure cuts also tend to have regressive[74] distributional effects, as social expenditure is usually the part of the budget with the highest short-term potential for austerity measures. In the case of tax financing, much depends on the choice of taxes to be increased. Consumption taxes tend to have regressive impacts on distribution, while income taxes are usually progressive.

In cases where the recovery schemes are financed by industry, the companies that pay for the costs in the first place are usually able to shift a considerable part of the burden to upstream suppliers and especially to downstream users. Ultimately, consumer prices of many products are affected. As low income groups save less and thus spend a higher share of their income on consumption, increases in real consumer prices – with the exception of luxury goods - have a regressive effect on the distribution of real household income. The more difficult it is to substitute away from a company's products, the better are the chances for a company to pass on a substantial part of the burden to the demand side.[75] Many of the basic consumer goods exhibit such inelastic demand, which means that in these cases the largest part of the burden is not carried by the shareholders or labourers of the affected companies, but by the consumers. Therefore, in the case of industry-financed recovery schemes, it is likely that poorer people are more affected by additional costs for recycling than rich people, who spend a lower share of their income on packed goods.

[74] Regressive means that low-income groups lose a higher share of their income than high-icome groups. Progressive has the opposite meaning.

[75] The extent to which a company is able to shift the burden to others also depends on the shape of the cost curve and on the market structure, which the shape of the cost curve has a major influence on. In general, industries that exhibit substantial economies to scale – and as a consequence also a high degree of concentration – have better opportunities to compensate for a cost increase by decreasing production and raising output prices. VALPAK comments that in the UK price competition for essential grocery products is very intense.

1.11 COMPARE THE PACKAGING AND PACKAGING WASTE DIRECTIVE WITH TWO SCENARIOS

Now that we have identified and estimated all the relevant impacts (economic, environmental and social) of the Packaging Directive, the next step is to present them in a way that helps to judge it's effectiveness and utility.

The purpose of this section is to combine the financial costs with the environmental benefits of packaging recovery. In the tables on the following pages the specific cost is presented to obtain one unit of environmental benefit through packaging recovery (e.g. the cost of the reduction of CO_2 equivalent emission by of 1 tonne). We look first at the environmental costs and benefits of packaging recovery in general and after that to the proportion that can be attributed to the Packaging Directive.

It is, however, not the purpose of the study to give an evaluation whether this cost is "reasonable" or not (= efficiency).

1.11.1 Specific cost of environmental benefits through packaging recovery

The "net internal cost for society" is equal to the financing need for packaging recovery minus the saved disposal costs. Therefore we have considered the differences between scenario 3 (packaging directive) and scenario 1 (zero recovery). Both the differences in environmental impact and the difference in financing need between those two scenarios have been calculated. Further the ratio between surplus financing need and surplus environmental benefit has been calculated per impact category. The results are presented in Table 56. The results of this table should be interpreted as follows:

The cost of reducing the Global Warming Potential by 1 kg of CO_2-equivalents through packaging recovery was 1,2 Eurocents in 1997 and rose to 2,3 Eurocents in 2001. This rise is an illustration of the normal environmental-economics principle that the marginal cost for further reduction measures rises as the results already obtained get better. In the case of packaging recovery, this is the result of two effects, acting in the same direction:

1. The specific cost for packaging recovery has risen over the years as the recovery ratio was rising;
2. The incremental packaging fractions that are recovered to meet the rising recovery ratios seem to lead to lower marginal environmental benefits.

These figures should, however, be taken with care. Both the financing need and the alternative disposal costs are a dimension bigger than their difference which is used for these calculations. Therefore, already a variation of a few percent in either the financing need or the alternative disposal costs could mean that the costs for packaging recovery might actually turn into (financial) benefits or that costs per unit of environmental benefit will double or triple. These figures are also average figures of many materials and applications with very different cost and benefit patterns for recycling.

Furthermore, the reduction of greenhouse gas emissions is not the only environmental benefit of recycling. The unit costs given in tables 56 and 57 are however based on the assumption that all recycling costs are related to one impact only. In other words, if the cost of reducing one kg of CO_2 equivalent is 1.2 euro cent, the 1.2 euro cent will not only reduce 1 kg of CO_2 but at the same time save 10 kg of oil equivalent, 13 g SO_2 etc. Therefore the cost of recycling should be compared to all environmental benefits which occur simultaneously as a result of recycling.

It is outside of the scope of the study to give an evaluation whether this cost is efficiently spent. For this we would need to compare with the specific costs of environmental benefits (e.g. Global Warming Reduction) obtained trough other policies and measures.

Table 56 : Unit costs of environmental benefits : comparison between scenarios 3 and 1

Impact	*Unit*	*1997*	*1998*	*1999*	*2000*	*2001*
Total financing need difference	Mio Euros/y	271	263	415	491	610
Abiotic depletion	Euro/kg Oil equiv	$0,13\ 10^{-02}$	$0,12\ 10^{-02}$	$0,18\ 10^{-02}$	$0,18\ 10^{-02}$	$0,22\ 10^{-02}$
Energy	Euro/MJ	$2,0\ 10^{-03}$	$1,86\ 10^{-03}$	$2,7\ 10^{-03}$	$3,0\ 10^{-03}$	$3,7\ 10^{-03}$
Global Warming Potential	Euro/kg CO_2 equiv.	$1,2\ 10^{-02}$	$1,1\ 10^{-02}$	$1,6\ 10^{-02}$	$1,8\ 10^{-02}$	$2,3\ 10^{-02}$
Acidification	Euro/kg SO_2	1,29	1,16	1,67	1,88	2,32
Ecotoxicity	Euro/Aquatic m3	108	103	151	154	189
Human Toxicity	Euro/(kg/kg)	0,81	0,72	1,05	1,17	1,43
Nutrification	Euro/kg PO_4	20	17	25	28	35
Odour	Euro/kg NH_3	$3,6\ 10^{-02}$	$3,2\ 10^{-02}$	$4,75\ 10^{-02}$	$5,4\ 10^{-02}$	$6,7\ 10^{-02}$
Ozone depletion	Euro/kg CFC 11	$6,3\ 10^{+04}$	$5,4\ 10^{+04}$	$8,2\ 10^{+04}$	$8,8\ 10^{+04}$	$10,5\ 10^{+04}$
Summer Smog	Euro/kg ethylene	11,1	9,7	13,5	15,0	17,3

1.11.2 Specific cost of environmental benefits attributed to the Packaging Directive

Not all of the above environmental benefits can be attributed to the Packaging Directive. Part of the recycling and recovery rates and other national measures would have occurred anyway, even in the absence of the Directive. To judge the specific effect of the Packaging Directive, we must consider the difference between Scenario 3 (Packaging Directive) and Scenario 2 (the baseline scenario).

Again both the differences in environmental impact and the difference in financing need between those two scenarios have been calculated. Further the ratio between surplus financing need and surplus environmental benefit has been calculated per impact category. The results are presented in Table 57. The results of this table should be interpreted as follows:

The cost of reducing the Global Warming Potential by 1 kg of CO_2-equivalents that can be attributed to the Packaging Directive was 7,2 Eurocents in 1998.

The results are presented graphically in Figure 79.

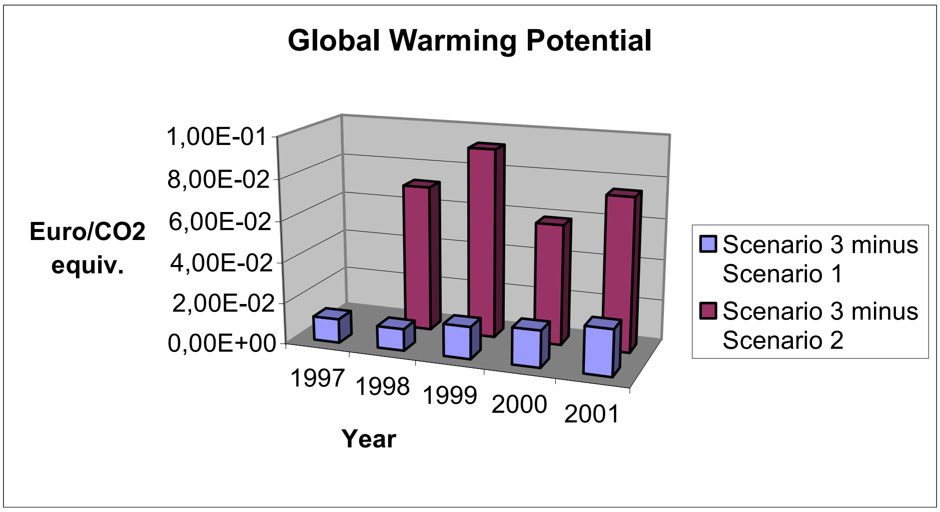

Figure 79 : Specific costs of Global Warming Potential reduction

Table 57 : Unit costs of environmental benefits : comparison between scenarios 3 and 2

Impact	*Unit*	*1997*	*1998*	*1999*	*2000*	*2001*
Total financing need difference	Mio Euros/y	50	46	176	185	227
abiotic depletion	Euro/kg Oil equiv		$1,3\ 10^{-02}$	$0,94\ 10^{-02}$	$0,42\ 10^{-02}$	$0,67\ 10^{-02}$
Energy	Euro/MJ		$9,9\ 10^{-03}$	$10,6\ 10^{-03}$	$7,0\ 10^{-03}$	$9,0\ 10^{-03}$
Global Warming Potential	Euro/kg CO2 equiv.		$7,2\ 10^{-02}$	$9,2\ 10^{-02}$	$5,9\ 10^{-02}$	$7,5\ 10^{-02}$
Acidification	Euro/kg SO2		6,3	10,6	7,3	8,6
Ecotoxicity	Euro/Aquatic m3		1.059	862	379	608
Human Toxicity	Euro/(kg/kg)		3,9	7,1	4,8	5,4
Nutrification	Euro/kg PO4		100	171	118	131
Odour	Euro/kg NH3		$20\ 10^{-02}$	$44\ 10^{-02}$	$27\ 10^{-02}$	$30\ 10^{-02}$
Ozone depletion	Euro/kg CFC 11		$2,7\ 10^{+05}$		$8,4\ 10^{+05}$	$6,8\ 10^{+05}$
Summer Smog	Euro/kg ethylene		38	50	42	43

For most environmental impacts, the specific cost of environmental benefits that can be attributed to the Packaging Directive is significantly higher than the specific cost of environmental benefits of packaging recovery in general, as illustrated in Figure 80.

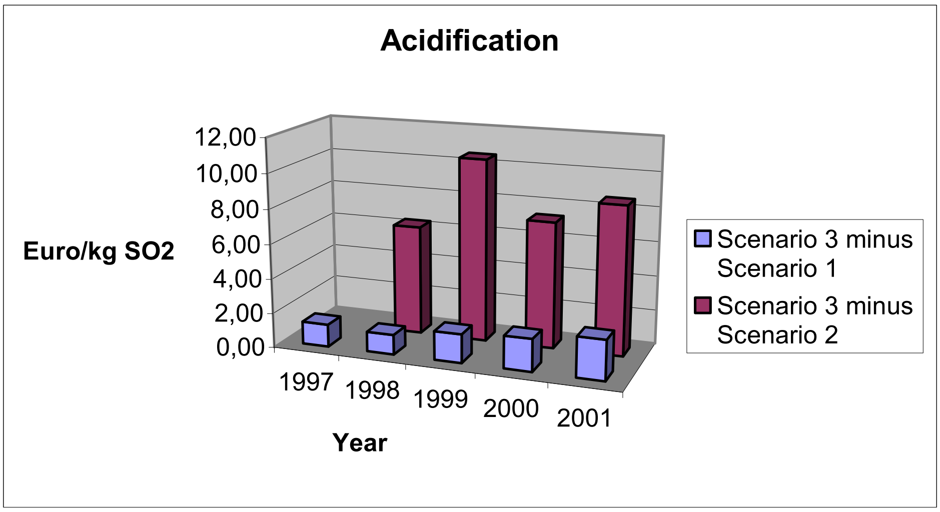

Figure 80 : Specific costs of Acidification reduction

1.11.2.1 Conclusion

As a conclusion the implementation of the Packaging Directive is assessed on the basis of its effectiveness and efficiency:

EFFECTIVENESS

Definition : judging whether and how far the observed effects (i.e. outcomes and impacts) meet up to the explicit objectives set for it and involves comparing intentions with performance.

In paragraph 1.4 it has been demonstrated that the packaging recycling and recovery targets of the PPWD have largely been met. In paragraph 1.7 it has been demonstrated that the PPWD has also met its objective to reduce the environmental impact of packaging and packaging waste.

As regards to the prevention of the production of packaging waste, which is a priority of the PPWD, the picture is more nuanced. The figures from paragraph 1.6 indicate that the packaging waste generation is almost following the growth in GDP. From 1997 to 2001 the packaging waste generation and the GDP had increased by 8,3% and 11% respectively.

EFFICIENCY

Definition : have the objectives been achieved at a reasonable cost compared to its estimated benefits?

The specific cost to obtain one unit of environmental benefit through packaging recovery has been calculated, both for packaging recovery in general and the proportion that can be attributed to the Packaging Directive.

The specific costs of environmental benefits obtained through packaging recovery have risen from 1997 to 2001.

It is outside of the scope of the study to give an evaluation whether this cost is efficiently spent.

For most environmental impacts, the specific cost of environmental benefits that can be attributed to the Packaging Directive is significantly higher than the specific cost of environmental benefits of packaging recovery in general.

There are many effects beyond those reflected in the above considerations on effectiveness and efficiency. For example, one stakeholder commented: "The Directive has enlarged the view of all stakeholders and assisted in bringing coherence to the systems in place or to be set up. This contributed significantly to improving the results achieved." Other positive aspects of the Directive include for example the awareness-raising effect of packaging recycling among consumers.

2. TASK 2.: PACKAGING PREVENTION

2.1 TASK 2.A: PACKAGING PREVENTION – INDICATORS FOR THE ENVIRONMENTAL PERFORMANCE OF PACKAGING

2.1.1 Definition and background

2.1.1.1 Introduction

The concept of a packaging environment indicator (PEI) was introduced during the revision of Directive 94/62/EC on Packaging and Packaging Waste. One of the outcomes of the revision was to further investigate the possible development of a PEI to help render packaging waste prevention simpler and more effective.

The concept of a PEI stems from the wish to be able to measure the environmental impact of packaging. The achievements of current policy measures to prevent environmental impact from packaging are considered difficult to verify. This is, for example, evident in the current application of the Essential Requirements. From this predicament has grown the idea of a PEI. The usefulness of a PEI will to a large extent depend on its accuracy in giving a correct environmental evaluation and its ease in application.

In order for a PEI to operate successfully a number of prerequisites must be met. These can be summarised as follows:

1. The PEI must effectively meet its objective of enabling the environmental performance of packaging to be measured with a useful degree of accuracy;
2. The PEI must enable comparisons to be made between different packaging options or different packaging systems performing the same function;
3. The PEI results must be meaningful while the methodology must offer a feasible degree of simplicity.

When assessing the possible use of a PEI in the context of packaging prevention it is therefore necessary to consider these prerequisites in detail. In the context of the evaluation of the Directive on Packaging and Packaging Waste and its implementation this assessment is split into several phases.

First, the legal context and the concept of the PEI is addressed (2.1.1.2)

- This is followed by a brief discussion of some of the issues to consider when establishing a PEI based on life cycle assessment and to be used for comparisons (2.1.3).

The evaluation of a PEI is addressed in two parts:

- Evaluation of the potential influence of data uncertainty on a packaging environment indicator (2.1.4);
- Stakeholder evaluation of a packaging environment indicator (2.1.5)

Based on the discussions and evaluation above, the use of an indicator for determining the environmental performance of packaging is assessed:

- From an economic and social perspective (2.1.6.1) ;
- From an environmental perspective.

2.1.1.2 Legal context

DIRECTIVE 2004/12/EC AMENDING DIRECTIVE 94/62/EC ON PACKAGING AND PACKAGING WASTE

The packaging environment indicator (PEI) is presented in Article 1 Paragraph 3 of Directive 2004/12/EC[76] amending Article 6 of Directive 94/62/EC on packaging and packaging waste.

> *Article 6*
> **Recovery and Recycling**
> …
> 8. The Commission shall, as soon as possible and no later than 30 June 2005, present a report to the European Parliament and the Council on the progress of the implementation of this Directive and its impact on the environment, as well as on the functioning of the internal market. The report shall take into account individual circumstances in each Member State. It shall cover the following:
>   (a) an evaluation of the effectiveness, implementation and enforcement of the essential requirements;
>   (b) additional prevention measures to reduce the environmental impact of packaging as far as possible without compromising its essential functions;
>   **(c) the possible development of a packaging environment indicator to render packaging waste prevention simpler and more effective;**
>   (d) packaging waste prevention plans;
>   (e) encouragement of reuse and, in particular, comparison of the costs and benefits of reuse and those of recycling;
>   (f) producer responsibility including its financial aspects;
>   (g) efforts to reduce further and, if appropriate, ultimately phase out heavy metals and other hazardous substances in packaging by 2010.
>
>   This report shall, as appropriate, be accompanied by proposals for revision of the related provisions of this Directive, unless such proposals have, by that time, been presented.
>   …

THE CONCEPT OF THE PACKAGING ENVIRONMENT INDICATOR (PEI)

The concept of a packaging environment indicator (PEI) was originally put forward by Dorette Corbey MEP, rapporteur to the European Parliament Environment Committee on the revision of Directive 94/62/EC. Dorette Corbey suggested that future EU packaging and packaging waste policies should be based on LCA-like analysis or an LCA-like approach and thinking[77]. The idea was based on the concept that recycling should not be encouraged as an end to itself; instead, environmental impact should be reduced.

Originally, Dorette Corbey proposed three parameters for a PEI: greenhouse gases, reduction of final waste and protection of natural resources. However, because of difficulties measuring impacts, this was

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[76] *Directive 2004/12/EC of the European Parliament and of the Council of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste*, Official Journal L047, 18/02/2004 p. 0026 – 0032.

[77] *Alternatives to Targets*, MEP Dorette Corbey's speaking notes from the conference Packaging Our Futures, arranged by European Voice, on 1st March 2004, Brussels, Belgium.

reduced to two parameters: greenhouse gases and final waste[78]. The aim was to convert the results of these two parameters into a single points figure. The accumulated figure would represent the PEI for the packaging being considered. Therefore the challenge would be to bring down the points, the philosophy being that the lower the PEI, the more environmentally preferable the packaging.

The PEI is intended as a tool to measure environmental impacts but not a prevention instrument as such. According to Mr Linher[79], DG Environment, the purpose of the PEI can be to inform the internal design and production processes in industry or to inform consumers. This information can in turn provide producers and consumers with an incentive to make decisions to reduce the environmental impact of packaging.

The PEI could in principle also be designed to support implementation of legislation. However, according to Mr Linher, the experience with the Essential Requirements has shown that it would be difficult to identify clear yes/no criteria of single figures to decide which packaging is more environmentally friendly or acceptable for the purpose of legislation.

2.1.2 Packaging indicator initiatives in Member States

A number of packaging indicator-type initiatives has already been initiated in several Member States. Although the measures might not be called indicators they still have similarities with a PEI in that they aggregate environmental impacts of packaging in some manner. Examples of such measures include:

- Eco-taxes on packaging, for example in Denmark: indicator-based measures on environmental impacts are used to calculate the tax to be put on each packaging material.
- Deposit schemes in Germany: in the UBA study weighting is applied to the environmental impacts, which allows for aggregation into an indicator-type measure.
- Packaging policy in the Netherlands: a packaging indicator for combining packaging and product policy is currently being investigated.

In the following the Dutch project on developing a packaging indicator, which is currently on-going, is described in more detail.

2.1.2.1 The Dutch packaging indicator

The Dutch initiative was instigated through the signing of the Packaging Covenant III by the Dutch government and Dutch industry (SVM.PACT) in late 2002. Article 14 of the Covenant states that research is to be initiated on the possibility of developing a packaging indicator thereby making it easier to ascertain eco-efficiency. The reason for the initiative was the notion that the current measure of assessing packaging according to recycling rate was inappropriate for achieving real progress with regards to environmental packaging and product policy[80]. It was accepted that without integrating environmental policies for products and packaging, maximum eco-efficiency would be difficult to achieve.

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[78] *Can you imagine an EU without targets?*, MEP Dorette Corbey's speaking notes from workshop Use of LCA in Policy Making in the Context of Directive 94/62/EC, co-hosted by EUROPEN and the Sustainable Resources Unit of DG Environment, 20 June 2002.

[79] *Study on the implementation of Directive 94/62/EC on Packaging and Packaging Waste and options to strengthen prevention and re-use of packaging – comments on the Interim Report dated 23 April 2004,* Otto Linher, DG Environment, Brussels, Belgium.

[80] Bergsma G., Vroonhof J. (2002) *CE and a packaging environment indicator,* CE Delft, the Netherlands.

The signatories to the Covenant therefore commissioned CE Delft and KPMG to research the possibility of introducing a packaging indicator based on carbon dioxide CO_2 (global warming) and waste disposal in consultation with industry. The research has two components:

1. Formulating a better environmental indicator for packaging; and
2. Integrating environmental policies for products and packaging.

The first component of the research has similarities with the PEI being discussed at EU level. However, the two indicator concepts do have definite differences. The Dutch indicator is not intended for communication to the consumer and not intended for regulatory purposes (such as introducing environmental taxes on packaging according to environmental preferability). Instead, the goal of the Dutch indicator is to make it possible to combine the environmental policies for products and packaging.

Although the project is still ongoing, one of the project partners[81] have provided preliminary conclusions for inclusion in this study:

- An indicator measuring the effect of greenhouse gases and the amount of final waste through the life-cycle of the packaging, while not without flaws, is a better indicator for the environmental impact of packaging than the recycling rates of different packaging materials.
- A more complex environmental indicator with more environmental impact categories is needed for products.
- The environmental impact of products is on average ten times larger than that of packaging, suggesting that product initiatives have greater potential to reduce environmental impact than packaging initiatives.
- It has proved very difficult to reach consensus on the exact environmental figures for packaging materials.

As part of the study, case studies are being conducted in co-operation with Philips, Unilever, Campina and the Greenery. One of the interesting findings of the case studies has been the product savings achieved for food products when integrating packaging and product environmental policies. An extreme example was a case study for paprika. By packing fresh paprika in plastic the environmental impact is increased by 2%, however at the same time the paprika's storage life is extended by 50-100%. Thereby less paprika is lost. By combining the product and packaging, this particular case study shows that extra packaging is beneficial to the environment.

2.1.3 Deliberations on a packaging environment indicator

The creation of a PEI is challenging for a number of reasons. A PEI would not only have to be functional, it would also have to be feasible. It would need to be simple enough that it could be applied to a vast number of packaging systems, but sophisticated enough to generate credible results, enabling the comparison of different packaging systems.

This section deliberates on some of the challenges to be overcome if developing a PEI.

2.1.3.1 Simplifying life cycle assessment

It is important to recognise that simplifying (or streamlining) an LCA is not a new approach to LCA. Instead, 'full-scale' LCA and very simplified LCA can be seen as the two extremes on a scale with most

[81] Geert Bergsma, CE Delft, *personal communication*.

LCA studies falling somewhere between the two[82]. Simplification of an LCA is in reality an important part of the goal and scope definition process. For example, when determining what is and is not to be included in the study the LCA practitioner is engaged in streamlining.

Simplified LCA methods or tools can be divided into two categories[83]:

- A matrix LCA using qualitative or semi-quantitative information; or
- A screening LCA using readily available quantitative data or semi-quantitative information.

Both methods are generally used in early product development stages or as a tool for increasing the use of LCA. The limited data requirements mean that the simplified tools are ideal in the early development stage when a number of ideas are being considered and for introducing smaller companies (e.g. SMEs) with limited resources for environmental improvement to LCA and life cycle thinking.

It should be noted that a very simplified LCA may have lost its life cycle distinction. This is the case for some matrix methods, which therefore are sometimes called environmental assessment methods rather than life cycle assessments.

The aim of simplifying LCA is to provide essentially the same results as a detailed LCA, but with a significant reduction in expenses and time used, thereby being perhaps more attractive to business in general. However, it is important to understand that the simplification of an LCA may affect the purpose to which the LCA can be used and the nature of the decisions that it can support. The key is therefore to ensure that the simplification is consistent with the study's goal, its anticipated use, and that it meets the needs of the user.

USING SIMPLIFIED LCA FOR COMPARISONS

Whether using simplified LCA for product development or as an introduction into LCA, the main goal is generally to identify where in the product life-cycle the most significant environmental impacts occur. For such purposes the simplified LCA may form a specific tool in cases where speed and cost may very well precede completeness and full accuracy. This is often the case in product development where today the time from conception to final product is getting ever shorter. Additionally, the simplified LCA may not be a replacement for a 'full' LCA. Instead, the simplified LCA may supplement a 'full' LCA as a first indication of areas for further investigation, which could subsequently be examined by a more detailed LCA.

When the purpose of the LCA is for comparisons of different products (or in this case packaging), it is important that the quality of the data used is sufficient to support such comparisons. The reason for this is that unless there are meaningful and evident differences between the LCA results of the products being compared, the comparison will be inconclusive.

LCA has revealed that for competing packaging systems the difference between the LCA results are often small. There are reasons for this. The main cost of packaging is not made up of indirectly related costs (such as the up-front R&D costs that can dominate the price of new pharmaceutical products, for example), rather the cost of packaging is closely related to the cost of energy and materials that make up the pack. Also, packaging manufacture is generally relatively straightforward in terms of inputs and outputs; unusual or highly polluting outputs seldom arise. This means that the environmental impact of

[82] J.A. Todd and M.A. Curran (ed.) Streamlined Life-Cycle Assessment: A Final Report from the SETAC North America Streamlined LCA Workgroup, Society of Environmental Toxicology and Chemistry (SETAC) and SETAC Foundation for Environmental Education, July 1999.

[83] Wenzel H. (1998) *Application dependency of LCA methodology: Key variables and their mode of influencing the method*, International Journal of LCA, volume 3, number 5, 1998.

packaging tends to be closely related to its energy use and material inputs. The result is that the cost of packaging is likely to be more closely related to its environmental impact than may be the case with many other products. Therefore, packaging systems that are competitive in terms of cost will often, but not necessarily always, be competitive in terms of environmental impact.

Therefore, in order to ensure that the conclusions drawn are valid it is important to include some kind of data quality assessment in a PEI. To assess data quality a number of methods are available. The ISO standards require that the techniques of completeness, sensitivity and consistency checks must be used for assessing the validity of the LCA results supplemented by uncertainty analysis and assessment of data quality.

The issue of data quality, and especially data uncertainty, is further evaluated in section 2.1.4.

USING SIMPLIFIED LCA FOR A PACKAGING ENVIRONMENT INDICATOR

As discussed above, using simplified LCA for a PEI is not the issue: the issue is to create a balance between simplicity of use, conformity with the international standards on LCA and scientific accuracy.

In order to arrive at a single indicator, as is the case for the PEI, the inventory results must go through the elements of life cycle impact assessment (LCIA) including weighting. LCIA, and especially weighting, has always been subject to controversy, partly due to the fact that the science of weighting is in the early stages of development and partly due to the inevitable presence of value judgements.

Although ISO 14040 states that "*there is no scientific basis for reducing LCA results to a single overall score or number*", weighting is still widely used because of the advantages it provides. The purpose of LCIA is to determine the relative importance of each inventory result and to aggregate characterised LCI results to a small set of indicators. This is done in order to identify those processes or materials that contribute most to the overall result, or to compare products. Weighting simplifies this process even further by allowing for the aggregation to a single indicator.

There is no unique, best method for conducting an impact assessment[84]. This will therefore make it challenging to determine which impact assessment method, impact categories and weighting method to use for a PEI. Again this is where a necessary trade-off between certainty and feasibility is required for a PEI to be developed.

2.1.3.2 Packaging alone or packaging in context with the product

A number of arguments exist for including the product as part of a PEI. The main argument being that on its own packaging is of little use; it only has a function in connection with a product. LCAs have shown that products tend to have much higher environmental impact than packaging, so ignoring the product risks missing the most significant aspect of the system. However, although packaging in many cases accounts for a small part of the environmental impact of packaged goods along their life cycle, it must be kept in mind that the purpose of a PEI has been described as being to "*render packaging waste prevention simpler and more effective*" and not to assess the environmental impact of packaged goods.

Conversely, the requirements of the packaged good should not be disregarded completely in the PEI approach. Instead the function, functional unit and reference flow of the packaging under study should include such requirements. For example, the percentage of product loss through the supply chain due to packaging failure should be incorporated into the functional unit and reference flow. To illustrate this,

[84] Work is currently undergoing in the UNEP/SETAC Life Cycle Initiative to develop best available practice in life cycle impact assessment.

one could imagine the functional unit being quantified as the delivery of 1000 units of packaged goods to the end-user. If, for example, a failure rate of 3% is found to occur, the reference flow should be 1030 items of packaging (assuming the packaging is non-reusable). It is therefore important that the functional unit is not the amount of packaging produced, but rather the amount of packaging required to successfully deliver a certain quantity of goods.

The PEI approach should ensure that only PEIs for packaging providing the same function can be compared. For example, only packaging containing the same or very similar products should be compared (e.g. packaging containing carbonated drinks should not be compared to packaging containing still drinks as these stipulate different requirements as to the strength of the packaging). As a consequence, the function of the packaging and the functional unit dictate which packaging can be compared. The definition of the function and functional unit under the PEI system is therefore of great importance in ensuring comparability.

It is recognised that even with a well-defined functional unit all functions of the packaging are unlikely to be included. This may be because they are difficult to measure (such as tamper evidence, openability or convenience) or difficult to define in LCA terms (such as marketing issues, aesthetic appeal or sales enhancement).

2.1.3.3 Requirements of a PEI system

Although Type III declarations[85] and the PEI serve different purposes they are both 'intended for comparison by a third party' (where the PEI is being considered for use either as a regulatory aid or for consumers to differentiate between packaging). They therefore have a number of similarities, including:

- *Standardised* – the calculation is based on specific guidelines;
- *Objective* – information is without emotional statements;
- *Comparable* – data is collected and calculated based on the same methods with to enable comparison;
- *Credible* – results are based on international guidelines and consensus amongst stakeholders, and may include verification/certification.

The systems operating the two methods can be said to have the same requirements in the form of specific procedures and requirements, monitoring and verification. The procedure for developing a Type III declaration (also called environmental product declaration, EPD) consists of guidelines and controls as well as product specific requirements developed for each product group based on which a draft EPD is prepared. This is then checked and verified/certified before the declaration can be published. This is depicted in Figure 81 below.

[85] A Type III Declaration is intended to be a standardised four-page document summarising the results of an LCA of a product. See the draft ISO standard 'ISO/TR 14025:2000 Environmental labelling and declarations – Type III environmental declarations – Principles and procedures'

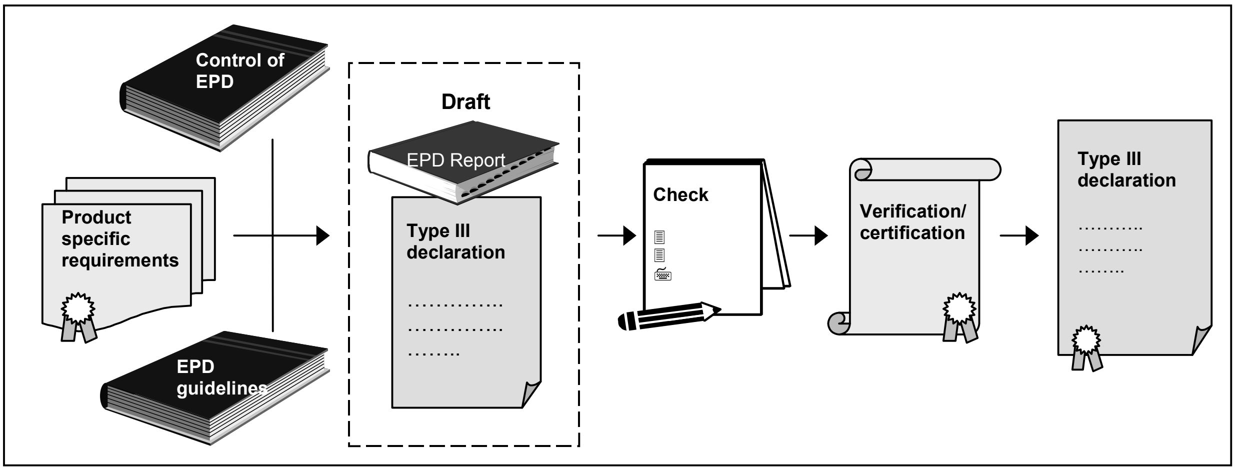

Figure 81 : Method of developing an EPD[86]

A similar structure for a PEI system can be envisaged. A draft PEI would be calculated based on specific PEI guidelines (based on the ISO 14040 series of standards) and possibly packaging specific requirements. The accuracy of the information behind the calculation of the indicator would be checked and verified (or certified) after which the PEI could be published.

Such a system has the potential to provide the necessary framework for a credible system for the comparison of PEIs.

2.1.4 Evaluation of the potential influence of data uncertainty on a PEI

The specific issue of data uncertainty is evaluated in this sub-section. Data uncertainty can be divided into data inaccuracy and lack of data. Furthermore, lack of data can be further specified as a complete lack of data (data gaps) and a lack of representative data[87]. In this sub-section the influence of the lack of representative data and data inaccuracy are discussed.

This evaluation is only an indication of the data inaccuracy considerations that apply to a PEI. Further investigation into these issues is required for a working PEI to be developed.

2.1.4.1 Methodology

Anecdotal evidence is used for this evaluation. Reports were identified based on recommendations by stakeholders and through a literature review exercise by the project team. From these a small selection of reports was chosen based on their relevance for the purposes of this sub-section. The reports are:

- LCA sensitivity and eco-efficiency analyses of beverage packaging systems by TNO Environment, Energy and Process Innovation (TNO-MEP)[88].

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[86] Danish Environmental Product Declaration Scheme, www.mvd.dk

[87] de Beaufort-Langeveld A.S.H., Bretz R., van Hoof G., Hischier R., Jean P., Tanner T., Huijbregts M. (ed.) (2003) *Code of Life-Cycle Inventory Practice*, Society of Environmental Toxicology and Chemistry (SETAC), USA.

[88] Ansems A.M.M., Ligthart T.N. (May 2002) *LCA sensitivity and eco-efficiency analyses of beverage packaging systems*, TNO-report R 2002/179, TNO Environment, Energy and Process Innovation (TNO-MEP).

- Choice of electricity-mix for different LCA applications by Dones, Ménard and Gantner[89].
- Code of Life-Cycle Inventory Practice by the SETAC Workgroup on Data Availability and Quality[90].

The discussions and findings of the reports have been used to provide input to this sub-section.

2.1.4.2 Data inaccuracy – with a packaging LCA study as an example

One of the stakeholder arguments against a packaging environment indicator has been that a one number indicator without any further detail will strongly overestimate the LCA results behind the indicator and may therefore mislead the user of the PEI. Where the PEI is intended for comparisons, this could have serious consequences for industries.

Data inaccuracy can occur for a number of reasons, for example due to imprecise measurement methods, estimations and assumptions, use of measurements from a small number of sites, and inadequate time periods of measurements pertinent to the processes involved. Various methods have been proposed to deal with data inaccuracy in LCAs, such as analytical uncertainty propagation methods, calculation with intervals and fuzzy logic, and stochastic modelling[91]. The method of stochastic modelling, which can be performed by Monte Carlo simulation, is widely recognised as a valid technique and the level of mathematics required is quite basic. This method varies all parameters at random with the variation being restricted by a given uncertainty distribution for each parameter. The randomly selected values from all the parameter uncertainty distributions are inserted in the output equation. Repeated calculations produce a distribution of the predicted output values, reflecting the combined parameter uncertainties.

Monte Carlo simulation is used in the TNO report *LCA sensitivity and eco-efficiency of beverage packaging systems*. The report, commissioned by APEAL, uses the systems of the UBA II study[92] on beverage packaging as a reference for a sensitivity analysis with the objective of showing "*that regulators have to be cautious when they intend to apply the results of LCA calculations of different packaging systems as a basis for discriminating several systems and related materials*".

The following beverage packaging systems were investigated in the TNO report:

Type of system	Packaging system	Content
One-way	Steel can (SteelCan33)	0.33 l
	Aluminium can (AluCan33)	0.33 l
	Glass bottle (GlassEW33)	0.33 l
	PET bottle (PETEW33)	0.33 l *
	Beverage carton (Carton33)	0.33 l ***
Refillable	Glass bottle (GlassMW33)	0.33 l

[89] Dones R., Ménard M., Gantner U. (1998) *Choice of electicity-mix for different LCA applications*, Paul Scherrer Institute (PSI), article presented at the 6th LCA Case Studies Symposium SETAC Europe.

[90] de Beaufort-Langeveld A.S.H., Bretz R., van Hoof G., Hischier R., Jean P., Tanner T., Huijbregts M. (ed.) (2003) *Code of Life-Cycle Inventory Practice*, Society of Environmental Toxicology and Chemistry (SETAC), USA.

[91] de Beaufort-Langeveld A.S.H., Bretz R., van Hoof G., Hischier R., Jean P., Tanner T., Huijbregts M. (ed.) (2003) *Code of Life-Cycle Inventory Practice*, Society of Environmental Toxicology and Chemistry (SETAC), USA.

[92] Plincke E. *et al* (2000) *Ökobilanz für Getränkeverpackungen II – Endbericht zu Phase I*, Umweltbundesamt, Berlin, Germany.

	PET bottle (PETMW33)	0.33 l **

* Based on data measured by TNO of 0.33 l PET bottle for fruit drinks.
** Based on one-way and refillable glass bottle of 0.33 l, 1.0 l PET bottle from the UBA II study and measurements by TNO on a 0.33 l one-way PET bottle.
*** Based on the 1 l beverage carton for non-carbonated beverages and measurements on two types of 0.25 l beverage cartons.

Although the uncertainty distribution was set at an arbitrary ±50% and the parameters investigated were limited, the report shows that when taking into account data uncertainties the results of an LCA may show less significant differences between individual packaging types, and that results may be misleading without an evaluation of data uncertainty.

To illustrate this, the results for global warming potential (GWP) are reproduced here (see Figure82):

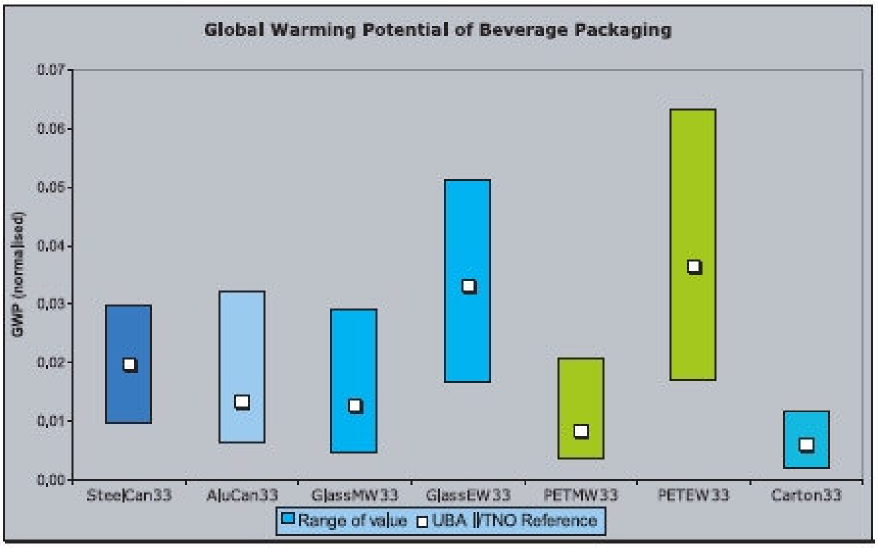

Figure 82 : Variation in global warming potential, GWP (TNO[93])

The results show that the packaging systems can be divided into two groups, one with relatively high scores (one-way glass and PET bottles), and one with relatively low scores (cans, cartons and reusable bottles). Without uncertainty distribution it is likely that it would have been concluded that, for example, the aluminium can contributes less to GWP than the steel can. However, when including the uncertainty distribution it is not possible to conclude that the aluminium can contributes less to GWP than the steel can without further analysis.

2.1.4.3 Lack of representative data – with electricity as an example

The discussions with regards to electricity data and a PEI have centred on what constitutes the most appropriate geographical area for the electricity mix used.

The electricity mix is a proportional combination of electricity generation technologies and primary fuels used for a specific region. Electricity mixes used in LCA can be based on temporal, geographic, base/peak load, or marginal issues. For geographical electricity mixes the scales can be divided into:

- Local or site-specific (including company specific);

[93] Ansems A.M.M., Ligthart T.N. (May 2002) *LCA sensitivity and eco-efficiency analyses of beverage packaging systems*, TNO-report R 2002/179, TNO Environment, Energy and Process Innovation (TNO-MEP).

- Regional;
- Country specific; or
- European.

The article by Dones, Ménard and Gantner describes their report *Strommix in Ökobilanzen*[94] which aims at analysing the methodological issues associated with the definition of electricity mixes and discussing the consequences of the choice of specific electricity mixes. Although primarily aimed at conditions in Switzerland, the main concepts, the modelling and parts of the information can also be applied to other European countries. In the report different models for the Swiss yearly average electricity mix are assessed which shows how different assumptions affect the results. As an example, CO_2 emissions calculated for the model assuming an average electricity mix based on Swiss own production were 21 g/kWh, whereas for the model assuming an average electricity mix based on Swiss own production plus imports minus exports the CO_2 emissions were almost seven times higher at 140 g/kWh. If assuming that the average electricity mix was based on average UCPTE data the CO_2 emissions were over three times higher again at 500 g/kWh. This shows that the broader the assumptions the more likely it is that the results are significantly different from the actual market situation. It also shows that averages can be highly debatable, whether they are national, regional, or EU-wide averages. In a discussion about marginal production technologies, Weidema[95] contended that possible arguments for preferring one average over the other are often market-based.

The electricity mix is often described by the percentage of different fuels used. However, the environmental impact of electricity production is determined not only by the fuels used, but also their origin and how they are processed, as well as the conversion and emission control technologies for the energy production phase. To illustrate the influence of data sources and technologies, the SETAC Workgroup on Data Availability and Quality did a brief comparison of three energy LCA studies, a European[96], a Swedish[97] and a Finnish[98] study. The findings were summarised as follows:

- *Energy efficiency* varies according to the conversion technology. The lowest value for energy efficiency of the condensing power plant is about 35% for coal, and the highest value is about 52% for gas. Combined Heat and Power (CHP) plants have higher energy efficiencies than condensing power plants, which can have energy efficiencies as high as 93%. The energy efficiency of oil-fired district CHP plants is about 85%. It is necessary to define the efficiency, that is, produced electricity (kWh) in the form of electricity and heat, compared with input fuel energy content (kWh), and carefully describe the technologies. The different efficiencies are not directly comparable.
- *CO_2 emissions* (kg/MWh) vary greatly depending on the energy source and energy conversion technology. For example, gas power plants vary from 210 to 620 kg/MWh. The highest value is 960 kg/MWh for a coal condensing power plant.

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[94] Ménard M., Donnes R., Gantner U. (1998) *Strommix in Ökobilanzen – Auswirkungen der Strommodellwahl für Produkt- und Betriebs-Ökobilanzen*, PSI Report 98-17, Paul Scherrer Institute, Switzerland.

[95] Weidema B.P. (1999) *A reply to the aluminium industry: Each market has its own marginal*, International Journal of LCA, Volume 4, Issue 6, 1999.

[96] Frischknecht R., Hofstetter P., Knoepfel I., Dones R., Zollinger E. (1994) *Ökoinventare für Energiesysteme*, ETH-Zurich, Switzerland.

[97] Brännström-Norberg B.M., Dethlefsen U., Johansson R., Setterwall C., Tunbrant S. (1996) *Life-cycle assessment for Vattenfall's electricity generation – Summary Report*, Vattenfall AB, Sweden.

[98] Rissanen H., Siitonen S., Sarin S., Gustafsson R., Kosonen M., Lappalainen R. (1997) *Polttoaineketjujen paikalliset ympäristövaikutukset*, Energia-Ekono Oy, Finland.

- *SO_X emissions* (kg/MWh) depend mainly on the sulphur content of the fuel and vary from 0.004 to 7.3 kg/MWh according to the different energy studies.
- *NO_X emissions* (kg/MWh) depend greatly on the conversion technology and vary from 0.2 to 1.2 kg/MWh according to the different energy studies.
- *Particulates* (kg/MWh) depend on the type of fuel and the technology used and vary from 0.009 to 0.25 kg/MWh according to the different energy studies.

The comparison shows the variability in energy production data according to the fuel source and technology. It is therefore important to understand that, not only the electricity mix, but also the energy data and assumptions used can have a decisive effect on the overall results and conclusions of an LCA. The electricity data used should therefore be chosen with careful consideration of the goal of the study.

This is a particularly significant issue for packaging LCAs since the environmental impact of electricity production frequently accounts for a significant share of the total environmental impact of packaging. The debate about the electricity mix when discussing a PEI is therefore an important one.

It is important to point out that structural changes to the electricity supply system may mean that a 'simple' average electricity mix as an input to a process might be less appropriate in the future. The liberalisation of electricity markets and new policy measures (CO_2 trading, CO_2 caps, etc.) are likely to mean that ecological considerations will play an increasingly important role for companies considering electricity suppliers in future.

To address these issues a SETAC Europe Working Group on LCA and Electricity Markets[99] was launched in 2003 with the objective of elaborating on how these new electricity market instruments work and how current LCA methodology is affected. The expected output of the Working Group is methodological guidance on how to address electricity in future LCA studies.

2.1.4.4 Discussion

Without a clear definition of the purpose of the PEI it is not possible to recommend a solution to the debate about data uncertainty in PEIs. Instead data uncertainty issues are briefly discussed in the following for two possible PEI purposes:

- *Purpose: for industry to inform internal design and production processes*

  As this PEI is for internal use within industry, decisions with regards to accuracy of data would ultimately lie with the individual companies. The same recommendations apply to the PEI as would for any other LCA, namely that dealing with data uncertainty should be an integral part of any LCA and that the goal of the study should reflect the degree of data uncertainty. Analysis of data uncertainty may provide vital information with regards to the accuracy of the LCA results, which could have significant impact on the decision-making process whether it be for product comparison, product improvement, marketing purposes and so on.
- *Purpose: for consumers to make a choice between packaged products*

  As this PEI is for comparisons intended for public use, it is important that the scope of the different systems enables comparisons. This means, for example, that the system boundaries, data quality, allocations and any assumptions must be compatible for all the systems. However, this does not alter the fact that the same recommendations with regards to data uncertainty apply as above. It is therefore important that requirements are established and communicated to all "calculators" of a PEI. When setting the requirements it is important to investigate that any

[99] SETAC Europe Working Group on LCA and Electricity Markets (LCA-EM), http://www2.dlr.de/TT/system/projects/network/SETAC_WG_LCA-EM

data inaccuracy does not favour one type of packaging or packaging manufacturing process over another.

2.1.5 Stakeholder evaluation of the packaging environment indicator

Stakeholder involvement and participation forms the basis for the assessment of the packaging environment indicator (PEI) in this project. The significant expertise and experience of stakeholders with regards to application of environmental tools in industry, life cycle assessment of packaging and life cycle thinking in general has placed emphasis on obtaining stakeholder opinions and stimulating discussion, rather than producing a pure consultants' report.

2.1.5.1 Methodology

Information from the stakeholders was obtained via a one-day workshop held in Brussels for key stakeholders, followed by questionnaire-based consultation on the testing of an actual conceptual PEI tool, and feedback in response to the Interim Report. This information, and subsequent compilation and analysis by the consultants, was used to complete this sub-section.

WORKSHOP CONSULTATION

In order to build on the Interim Report and promote dialogue, a workshop was held on the 26th May 2004 at the European Commission offices in Brussels. The workshop was attended by 19 external delegates, one DG Environment representative, and six members of the project team (see Table 58 : PEI testing by stakeholder categories). Delegates were invited on the basis of their application to an invitation published by DG Environment on the internet.

QUESTIONNAIRE CONSULTATION ON THE TESTING OF A CONCEPTUAL PEI TOOL

The questionnaire consultation was based on the testing of a conceptual PEI tool developed for the purposes of this project. The consultation pack comprised the questionnaire, the PEI tool software and a guidance document setting out the reasons for conducting the consultation and additional explanatory information, all contained on a CD-ROM. The CD-ROM was distributed via the delegates attending the workshop. It was explained that the intention was to open testing to:

- as wide a range of businesses as possible;
- involved in a wide range of packaging activities; and
- including a mix of large corporations and small and medium-sized enterprises[100] (SMEs);
- with knowledge of life cycle assessment and thinking varying from none to good.

A total of seven stakeholders from five countries completed or partly completed the questionnaire (see the table below). Two stakeholders did not test the tool and therefore did not complete the second half of the questionnaire. None of the respondents are SMEs and all have good knowledge of life cycle assessment and life cycle thinking.

Table 58 : PEI testing by stakeholder categories

Stakeholder category	No. of stakeholders	Member State*
Raw material producer	4	Germany, Luxembourg, Switzerland

[100] A SME is classified as having less than 250 employees.

Converter	2	Germany, Sweden
Packer/filler	2	Germany, the Netherlands
Brand owner		
Other		

*Note: Several of the respondents were multi-national organisations and the Member State from which the response was sent is not necessarily indicative of the field of operation of the company. Also, the business operations of one of the stakeholders expanded over more than one stakeholder category.

FEEDBACK IN RESPONSE TO THE INTERIM REPORT AND PEI IN GENERAL

In addition to the questionnaire consultation, a further 20 stakeholders provided general comments on the PEI section of the Interim Report and on PEI in general. These can be categorised as:

- 12 industry associations;
- four companies (none of them SMEs) – of which one also took part in the questionnaire consultation;
- two regulators;
- one compliance scheme provider;
- one environmental non-governmental organisation (ENGO); and
- one consultancy.

2.1.5.2 The purpose of a packaging environment indicator

The stakeholders expressed uncertainty as to the purpose of a PEI. Directive 2004/12/EC[101] states that the objective of a PEI is "*to render packaging waste prevention simpler and more effective*" and generally to help reduce the environmental impact of packaging. However, more specific issues with regards to its aims and objectives, such as who will be using the PEI, how it will be used, and how it will be regulated, have yet to be addressed.

As a consequence, many stakeholders found it premature and inappropriate to provide detailed and specific comments to a number of issues with regards to a PEI without a proper definition of the aims and objectives of the PEI. However, they questioned the need for, and the added value of, a PEI. Many of them find that packaging prevention is already adequately addressed through the Essential Requirements and thus a PEI is unnecessary. One consultee[102] noted, *"there is a tool in place that has legal binding power for assessing the conformity of packaging to the Directive (CEN standard EN 13428 Prevention)[103]"*.

AIMS AND OBJECTIVES OF PEI

Through the questionnaire-based consultation stakeholders were asked to indicate from a list what in their opinion were the aims and objectives of a PEI. The list of suggested aims and objectives is shown

[101] Directive 2004/12/EC of the European Parliament and of the Council of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste - Statement by the Council, the Commission and the European Parliament, *Official Journal L 047, 18/02/2004, pg. 0026 – 0032.*

[102] APME.

[103] CEN EN 13428 Packaging - Requirements specific to manufacturing and composition - Prevention by source reduction.

in the text box below. The responses confirm that there is no clear understanding amongst stakeholders of the aims and objectives of the PEI , as each of the suggestions A, B, C, D, F and G were awarded one vote each, and suggestion E was awarded two votes. One respondent suggested an alternative objective, to "*enable end users to* differentiate *between packaging options on the basis of fitness for use, cost* and *environmental performance*".

List of aims and objectives suggested by the consultants in the questionnaire:

A. Render packaging waste prevention *simpler* and more *effective.*
B. Enable end users to *differentiate* between packaging options on the basis of environmental performance.
C. Raise *general* environmental awareness (through using/working with the PEI).
D. Raise awareness of different packaging options' *specific* environmental performance.
E. Identify *life cycle impacts* of packaging formats, thus facilitating improvements in environmental performance.
F. Provide an indication of *best practice.*
G. Contribute to responsible *company / brand image.*
H. "*Reward*" producers for improvements in packaging environmental performance.
I. "*Shame*" producers into improving packaging environmental performance.
J. Other (please specify).

Questionnaire respondents were also asked to indicate who will be producing/calculating the PEI and who will be using the PEI. Again, the answers show uncertainty to the aims and objectives of a PEI. Many respondents replied that before answering these questions the aims and objectives of a PEI must be determined more clearly. One respondent[104] commented that "*all parts of the value chain could provide or receive information necessary to calculate a PEI but this depends upon the objectives of the PEI and the intended user, the scope of the model and the data requirements. Other stakeholders (e.g. consumer groups) may need to be included and the waste management sector may also need to be considered as they ultimately determine the disposal route/options for the packaging material".*

Only two questionnaire respondents indicated who in their opinion will be producing/calculating the PEI, and two respondents indicated who in their opinion will be using the PEI. Their replies did not correspond, however overall their responses indicate that in their opinion stakeholders upstream in the supply chain will be calculating the PEI, and that packaging users (brand owners, retailers, etc.), consumers and regulators will be using the PEI results.

Another stakeholder[105] comments that if "*the intention in generating a single number is that it could be used in a simplistic system…for consumers to judge "environmental friendliness"…then we consider that this approach would be fundamentally misleading, subject to endless challenges and would contribute nothing either to the reduction of environmental burdens or to environmental improvement*".

In conclusion, questionnaire respondents were asked to rate the PEI's ability to achieve packaging prevention. Five rated a PEI as *Not Appropriate* as a measure for packaging prevention (lowest score out of a maximum of five), one rated a PEI as *Appropriate to Some Extent* (second lowest score out of five), and one did not respond to the question.

[104] Unilever.

[105] FEFCO

2.1.5.3 Key parameters affecting the implementation of a PEI

For the questionnaire-based consultation, key parameters representing potential barriers to the use of a packaging environment indicator (PEI) were identified by the consultants:

Key parameters affecting producers
1. **Issues surrounding using simplified LCA for comparisons** including - Functional unit - System boundary - Allocation - LCI data availability 2. **Costs** including - Time, expertise requirements - Potential verification / certification costs
Key parameters affecting purchasers
3. **Understanding** including - The indicator result - The wider functionality of the packaging 4. **Perceived credibility** including - Data quality - Management, monitoring and potential verification / certification
Key parameters affecting regulator use of PEI as a policy tool
5. **Understanding** including - The complexity of the packaging industry - The limitations of an indicator 6. **Effectiveness of achieving the goal**, i.e. render packaging waste prevention simpler and more effective 7. **Monitoring** including - Ensuring data conformity - Avoiding free-riders

Questionnaire consultees were asked to identify the strengths and weaknesses of a packaging environment indicator according to these parameters.

Where feedback from stakeholders with regards to the Interim Report or PEI in general include comments on parameters representing barriers to use, these have also been included in this section.

KEY PARAMETERS AFFECTING PRODUCERS

<u>Parameter 1: Issues surrounding using simplified LCA for comparisons</u>

Why is this a potential barrier to use? What are the implications?

- The simplification of an LCA may affect the purpose to which the LCA can be used and the nature of the decisions that it can support. A number of stakeholders expressed concern that, depending on the level of simplification, the indicator may not be accurate enough to be communicated to an external user and form the basis for comparisons. A PEI based on simplified LCA *"could only be* *considered a tool to gain first impressions and is thus not suitable for external communications*".[106]

- The international standards on LCA[107] set specific requirements to comparative assertions disclosed to the public. The standards describe consensus amongst international LCA experts on the principles and framework for conducting and reporting LCA studies, and the stakeholders were adamant that the standards as a minimum should form the basis for a PEI. The standards require that for comparative studies, the equivalence of the systems being compared are evaluated before interpretation, and that for comparative assertions disclosed to the public, this evaluation is conducted in accordance with the critical review process set out in the standard. Additionally, the standards say that there is no scientific basis for reducing LCA results to a single overall score or number.

What influences this potential barrier?

- The user's knowledge and understanding of the limitations of LCA and simplified LCAs in particular.
- The degree of simplification applied to the PEI and whether this complies with the aims and objectives of the indicator.

How could this potential barrier be overcome?

- "Don't use simplified LCAs for comparisons".[108]
- "Avoid any kind of PEI, and go back to the CEN standard on prevention".[109]
- Due to previous experience with LCAs being used (or some industry stakeholders would say abused) for policy making (for example, packaging taxes in Denmark, the refill quotas and the deposits on one-way beverage containers in Germany, and the eco-boni system in Belgium), industry is very cautious whenever LCA is discussed at regulatory level. One respondent[110] therefore suggests that demonstrated examples are the way to overcome the barriers between the viewpoints of the supporters and opponents of a PEI.

Parameter 2: Costs

Why is this a potential barrier to use? What are the implications?

- A balance must be struck between the benefits and costs of introducing a PEI. To organisations who all have significant LCA knowledge and already use LCA (like the respondents to the questionnaire-based consultation) there is, in their opinion, little or no environmental benefit to introducing a PEI. Though several do state that this is hard to determine without the aims and objectives being specified in more details. For organisations who do not have LCA knowledge and experience there will probably be some benefits. However, the respondents are concerned that there might not be a balance between the costs involved and the benefits achieved.
- Costs will mainly be incurred for implementing appropriate information handling and management systems; data collection within a company and along the supply chain; and validation and/or

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[106] SIG Combibloc Systems GmbH.

[107] ISO 14040ff series, Environmental management – Life cycle assessment.

[108] AB Tetra Pak.

[109] The Dow Chemical Company.

[110] Exxonmobil Chemical Films Europe.

verification of the results. Experience from comparative LCA studies disclosed to the public show that such costs can be significant, and several questionnaire respondents question the validity of such costs – in particular to SMEs.

What influences this potential barrier?

- The degree of simplification of the system under study. The simpler the system and data requirements, the less time is spent on data collection.
- Availability of data.
- The level of LCA expertise and product and supply chain knowledge of the person who will be calculating the PEI.

How could this potential barrier be overcome?

- "Extremely difficult if the model is to be useful given the current data available".[111]
- "If the calculation of the PEI will be made mandatory, I do not see any way of overcoming this barrier".[112]
- "Learn from existing LCAs, focus on relevant questions regarding packaging not yet resolved".[113]
- "Demonstrations, examples".[114]

KEY PARAMETERS AFFECTING PURCHASERS

Parameter 3: Understanding

Why is this a potential barrier to use? What are the implications?

- Although a one number indicator is easy to understand, it has lost transparency into the method applied and any assumptions and estimates that may have been made for the packaging system being assessed. Through a one number indicator, the user of the PEI has been deprived the opportunity to critically assess for themselves the scope of the assessment.
- Environmental impact is only one of a number of criteria that packaging needs to fulfil. Other criteria may include material properties, filling line performance, stackability, shelf-life requirements, supply chain hazards, handling, sales impact, tamper evidence, product preservation, openability, reclosability, dispensing, information, recyclability, value for money, etc. Focusing solely on one criteria may have significant impact on other criteria. Hence, understanding all criteria and considering the impact that the improvement of one criteria may have on the others is of great importance when developing and choosing packaging. Ignore this and the consequence may be that the packaging does not fulfil its function.
- Packaging's main function, to contain and protect the product inside, is not included in the PEI. As one stakeholder[115] put it, "*in theory, of course, the best (i.e. lowest PEI score) package would be zero, but the product damage and wastage would be huge*". Several studies have shown that excluding the consequences of the product from a packaging LCA study may have significant

[111] Unilever.

[112] The Dow Chemical Company.

[113] Bayer AG.

[114] Exxonmobil Chemical Films Europe.

[115] Valpak.

impact on the results. For example, "*the Packforsk report*[116] *has clearly shown, as did other studies too, that decreasing packaging under a certain limit leads to product losses the impact of which…is much more important than e.g. a 5% excess of packaging. This means that better PEI (less solid waste, less GHG from packaging) would in such cases increase the environmental impact, even if not apparent in the assessment of packaging itself".*[117]

What influences this potential barrier?

- The user's knowledge of PEI and the underlying assumptions, data quality, limitations and uncertainties.
- The user's understanding of the functions that packaging fulfil.

How could this potential barrier be overcome?

- "At least two months training for each user"[118]
- "Don't supply indicators but advice on best practise for managing environmental impact of packaging (management approach)".[119]
- "By taking a more integrated approach to policy making and implementation and not focusing on packaging as a single issue".[120]
- "Constructing a database of cases".[121]

Parameter 4: Perceived credibility

Why is this a potential barrier to use? What are the implications?

- The worst case scenario, for a PEI that is perceived not to be credible, is that it may not be used.
- A PEI that is perceived not to be credible, may receive little preference over other criteria such as packaging functionality, even other environmental criteria.

What influences this potential barrier?

- Acceptance of the PEI "*by all relevant stakeholders*". Their involvement in the PEI development process is therefore of great significance.
- Preconceived opinions about the environmental impact of packaging may influence how the user perceives the credibility of a PEI. Without any further detail than the one number indicator, the user may dismiss the PEI and go with 'gut instinct' instead.

How could this potential barrier be overcome?

- "Communicate PEI as being dependent on specific parameters, not as "true figures". Involve affected stakeholders, peer review, etc."[119]
- "Don't use it as an instrument for policy making and packaging evaluations."[122]

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[116] Erlov L., Lofgren C., Soras A. (2000) *Packaging – a tool for the prevention of environmental impact*, Packforsk, Sweden.

[117] APME.

[118] BASF AG.

[119] Bayer AG.

[120] Unilever.

[121] Exxonmobil Chemical Films Europe.

KEY PARAMETERS AFFECTING REGULATOR USE OF PEI AS A POLICY TOOL

Parameter 5: Understanding

Why is this a potential barrier to use? What are the implications?

- There is great concern amongst stakeholders that regulators will use a PEI as basis for policy decisions, which the PEI, because of its limitations, may not be capable of supporting. One respondent[123] states that "*environmental impact differences between packaging types are small whilst any attempt to discriminate between packaging would have major economic consequences to industry*".
- The PEI considers only the environmental impact of packaging, not the many other criteria that the packaging must fulfil in order to provide the desired function. Without taking these other criteria into consideration, policy decisions may be based on incomplete information. To this extent, and in reference to already existing legislative measures in Member States, several stakeholders[124] [125] commented that the tool should not be used by regulators in order to differentiate between "good" and "bad" packaging as it was felt to be misleading for such a purpose.

What influences this potential barrier?

- Regulators "knowledge of the specifics of packaging requirements, packaging technology, etc."[126]
- Regulators understanding of PEI and the underlying assumptions, data availability, limitations and uncertainties.

How could this potential barrier be overcome?

- "Using complete eco-efficiency studies which include fitness of use of the packaging, the whole life cycle, costs."[127]
- "…a more integrated approach to policy making supported by life cycle thinking and management not more LCAs focused on a single aspect such as packaging." [123]
- "By going back to CEN standards, the best tool for prevention. This is demonstrated by the records of the packaging industry, which show that the ratio weight of packaging/weight of packaged goods has significantly decreased (see examples in "Packaging Reduction – Doing More with Less", INCPEN), without any need of the PEI".[128]

Parameter 6: Effectiveness of achieving the goal

Why is this a potential barrier to use? What are the implications?

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[122] SIG Combibloc Systems GmbH.

[123] Unilever.

[124] EUROPEN

[125] P&G.

[126] Bayer AG.

[127] BASF AG.

[128] The Dow Chemical Company.

- Due to the aims and objectives of a PEI not having been defined in detail, a number of stakeholders found it difficult to answer this question. Based on the comments received, there seems to be agreement that it essentially comes down to striking a balance between costs and benefits and developing a credible PEI.
- The PEI, as it is currently described, does not encourage continuous improvement in itself. Instead, only by becoming a competitive factor between packaging manufacturers will it encourage environmental improvement. Therefore, its successful integration into public procurement, packaging user purchasing decisions, and consumer shopping habits (depending on who the user is) will be the prerequisites of the PEI's effectiveness.
- Several stakeholders stress that a PEI in order to be successful must convey relevant and correct information on which the user can act. "*Providing environmental information about the packaging whilst ignoring that of the product is potentially misleading and likely to confuse end users, particularly since the environmental impact of the product usually far outweighs the impact of the packaging alone*" [129]. In this stakeholder's opinion, "*environmental information should be conveyed as part of a packaging of information about the full product offering*".

What influences this potential barrier?

- The methodology of the PEI, and its effectiveness in providing "correct" indicators.
- The perceived credibility of a PEI.

How could this potential barrier be overcome?

- "By going back to CEN standards, the best tool for prevention."[130]
- "Do a credible piece of work within a credible process"[131]

Parameter 7: Monitoring

Why is this a potential barrier to use? What are the implications?

- Significant cost and resources will be required to administer a PEI programme, ensure compliance and monitor progress. This cost is most likely to be borne by industry and, ultimately, the consumer. Only when issues such as a balance between costs and environmental benefits, credibility and effectiveness at achieving its goal are met, will the cost of monitoring be acceptable to industry.

What influences this potential barrier?

- The costs of monitoring and the associated requirements this put on industry.

How could this potential barrier be overcome?

- The PEI "should be on voluntary and promotional base".[132]
- "Apply the existing management standards in a cost effective way".[133]

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[129] Unilever.

[130] The Dow Chemical Company.

[131] AB Tetra Pak.

[132] Exxonmobil Chemical Films Europe.

[133] The Dow Chemical Company.

2.1.5.4 Testing of the conceptual PEI tool

For the practical testing of the conceptual packaging environment indicator (PEI), a trial indicator was specified and modelled. A simple tool was developed containing three conceptual PEI models of varying levels of complexity. Due to the scope of the project, the PEI tool is merely a conceptual model and should not be mistaken for a possible future PEI tool. Achieving consensus on such issues as methodology, application and so on amongst all stakeholders and developing such a tool would be a considerable project in itself.

Therefore, a number of methodological issues such as system boundaries, assumptions, cut-off criteria, allocation etc. were not described in the guidance document to the tool as such issues were considered premature for discussion at this early stage of discussions on a PEI. In developing the tool, the consultants had, of course, applied such methodological decisions, however the choices made by the consultants were not the focus of the testing exercise. Additionally, including such issues would just add confusion for organisations with little or no prior LCA knowledge.

The main reasons for developing a conceptual PEI tool for this project was firstly to give stakeholders with little or no LCA knowledge the opportunity to take part in the consultation process, and secondly to show how such a tool can perform and where its limitations lie.

THE THREE CONCEPTUAL PEI MODELS

PEI model 1

PEI model 1 is a very simple model with only one parameter. This parameter is the energy requirement, measured in MJ, to produce the packaging. This model therefore does not consider the whole life cycle of the product.

Reason for choosing model: A very simple model like PEI model 1 was chosen as this would eliminate a number of potentially sensitive LCA methodology issues. These methodology issues include the choice of life cycle impact assessment and weighting methods used. Additionally, for this very simple tool it was decided to only focus on the raw materials and production phases, thereby excluding the use and waste management phases of the life cycle of the packaging. This is done to investigate whether it is necessity to include the whole life cycle for the purposes of a PEI. The advantage of this model is simplicity of use and clarity of methodology and assumptions. The disadvantage is that environmental impact is hugely simplified.

PEI model 2

PEI Model 2 is more complex than PEI Model 1 in that it includes the whole life cycle of the packaging. It includes impact assessment and weighting and it models two parameters; global warming and final waste (to disposal).

Reason for choosing model: PEI Model 2 is based on the PEI proposed by MEP Dorette Corbey. It aligns with the objective of the PEI to improve packaging prevention in that it encompasses the whole life cycle of the packaging system including both the raw material phase (included in the global warming modelling) and final waste.

PEI model 3

PEI Model 3 is similar to model 2 except that it takes into account more environmental impacts. Apart from global warming and final waste for disposal, these are acidification and respiratory effects from particulates (PM10).

Reason for choosing model: PEI Model 3 is an alternative to model 2 and is based on a proposed alternative from the Dutch consultancy CE[134]*. The proposed model is a simple LCA based on two to four environmental impacts; global warming, final waste, acidification and possibly toxicity. It is said that stakeholders in the Netherlands had hoped that such an indicator might be precise enough to make a clear and fair distinction between different packaging solutions. PEI Model 3 is loosely based on the CE model, modified to include the effects of PM10 and disamenity.*

STAKEHOLDER FEEDBACK FROM THE TESTING OF THE CONCEPTUAL PEI MODELS

The following summarises the comments provided on the conceptual PEI models through the questionnaire-based consultation.

Testing

The five organisations that tested the tool did so on a variety of packaging formats for fast moving consumer goods (FMCG) such as beverages and snacks.

In general, they found it took them between two and eight hours to calculate the PEI, however this was to some extent based on readily available data and thereby eliminating the data collection process which in most cases is the most time consuming part of an LCA. Two out of four respondents found that the time required varied depending on the packaging being assessed.

Four out of five found the tool easy to use.

Understanding, appropriateness and benefits

The majority of questionnaire respondents did not find the tool appropriate at creating further understanding within their company of the life cycle of the packaging assessed. Neither did they find the tool appropriate at creating further understanding within the packaging industry of the environmental impacts throughout the life cycle of packaging. Only one respondent found PEI model 1 or 2 to be acceptable for use.

It must be pointed out that all the organisations responding to the questionnaire consultation had good knowledge of the principles of life cycle thinking and had conducted LCA studies of their products. A simplified LCA tool might therefore not be considered to bring any benefits to procedures already implemented in their organisations.

When asked to estimate the percentage of the packaging industry that would actively use the PEI to improve the environmental impact of their packaging, three of the respondents thought that 0% of the industry would use the tool, although one respondent estimated that 2% of the industry would use something similar to PEI Model 3. A fourth respondent estimated that less than 30% of the industry

[134] *CE and a Packaging Environment Indicator*, G. Bergsma and J. Vroonhof, CE, Delft, the Netherlands, 18 November 2002.

would use a Model 1 type of PEI, and less than 10% of the industry would use a Model 2 or 3 type of PEI. These estimates of course rely on a PEI being implemented on a voluntary basis.

Due to the low estimated uptake within industry, the same four respondents estimated that there would be no environmental improvement of packaging on the market if a PEI was introduced. The fifth respondent estimated that there would be a 20% improvement for a Model 1 type of PEI and a 10% improvement for a Model 2 or 3 type of PEI.

Finally, the consultees were asked to consider which of the models would be most appropriate as a PEI. Two responded that a Model 3 type PEI would be most appropriate as this was "*less worse than the others*", one respondent preferred Model 1, and two respondents said that none of the models were appropriate due to their "*fast screening tool*" nature.

Cost

Consultees found it difficult to estimate the costs involved in setting up the management procedures for collecting data and calculating the PEI due to the limited information available. One respondent commented that "*this would require a massive revision and upgrade of our existing IS/IT infrastructure just to provide the necessary input data, and in addition would require the creation of a new database for handling the PEI info for 1000s of specifications*".

In response to the question of the estimated cost to their company of introducing a management structure to calculate the PEI of all their packaging types, only two consultees found it possible to estimate a cost. One respondent, who handles approximately 16,000 packaging types annually, estimated the cost to be approximately €5 million with an annual running cost of €10 million. This amounts to an estimated set up cost of €312.50 and a running cost of €625 per packaging type. Another respondent, who handles approximately 250 packaging types annually, estimated the start up cost to be €10-20,000 depending on PEI model with an annual running cost of €1-2,000. The estimated set up cost is €40-80 and the running cost is €4-8 per packaging type.

Another two consultees estimated the personnel required if a PEI was introduced. One respondent, who handles several hundreds of packaging types annually, estimated that this would require more than one full time person. Another respondent, who handles thousands of packaging types annually, estimated that this would require at least three full time personnel.

The above shows that it is difficult to estimate the costs involved with the introduction of a PEI. However, in general the stakeholders felt that the costs associated with the time and resources required for collecting the necessary data and calculating the indicator for every piece of packaging going onto the market would be disproportionate to the environmental benefits achieved.

2.1.5.5 Conclusions on stakeholder consultation

Stakeholders are united in their reservations regarding a PEI. Whilst supporting continuous environmental improvement and life cycle thinking, they do not support the concept of PEI as a means of enhancing the environmental performance of packaging. Their arguments can be summarised as follows:

- The PEI considers the environmental impact of packaging in isolation of the product that it contains and takes no account of the broader prevention role played by packaging (e.g. reducing product wastage);
- The PEI does not consider the functional requirements or consumer acceptance of the packaging;
- The PEI reduces environmental impact to a one number indicator, despite the ISO standards on LCA stating that there is no scientific basis for reducing LCA results to a single overall score or number.

- A PEI for each type and size of packaging put on the market will require enormous time and resources for collecting the necessary data and calculating the indicator meaning that the associated costs would be disproportionate to the environmental benefits achieved.
- The availability and quality of the data used for the calculation of a PEI in combination with the simplified LCA means that any such indicator will have a significant degree of variance and hence not be suitable for meaningful comparisons of different packaging options.

Stakeholders are questioning the added value of a PEI, when measures for prevention and minimisation in the form of the Essential Requirements exist. A more appropriate way of enhancing prevention is, according to the stakeholders, the greater implementation and enforcement of the Essential Requirements. According to the stakeholders the Essential Requirements should "*ensure that the political objectives of prevention (amount, hazardous nature of packaging, etc.) and recovery of used packaging are addressed*."

"*Proper enforcement of [Essential Requirements] legislation by Member States and unequivocal use by Industry of the CEN standards would ensure that a process of continuous environmental improvement is undertaken by companies*." [135]

Whilst being against a PEI, the stakeholders do support the use of life cycle thinking for continuous environmental improvements. They advocate its voluntary use and its use in the context of full product systems. Several stakeholders highlight the ideas outlined in the EU Commission communications on IPP[136] and the thematic strategies on the prevention and recycling of waste[137] and the sustainable use of natural resources[138] for providing a framework for a more holistic approach to packaging environmental improvement.

2.1.6 Assessment of a packaging environment indicator

This chapter presents the consultants' assessment of the pertinence of indicators to measure the environmental performance of packaging. It includes conclusions drawn from the evaluation of the potential influence of data uncertainty and the stakeholder evaluation.

2.1.6.1 Assessment of PEI from an economic and social perspective

As discussed in section 2.1.4, the level of data certainty as well as transparency and documentation must reflect the purpose of the PEI as these are all elements of the underlying LCA approach that deals with credibility. In other words the need to verify and justify the validity of the PEI should be supported by uncertainty assessment, transparency in the methodology and choices made, and documentation of this. Is the PEI to be used by consumers or regulators, this could be ensured through a system in many ways similar to that of the Type III Environmental Declaration system as described in section 2.1.3.3.

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[135] Unilever.

[136] Green Paper on Integrated Product Policy, COM(2001)68 final, and Communication from the Commission to the Council and the European Parliament – Integrated Product Policy. Building on Environmental Life-Cycle Thinking, COM(2003) 302 final.

[137] Communication from the Commission – Towards a thematic strategy on the prevention and recycling of waste, COM(2003) 0301 final.

[138] Communication from the Commission to the Council and the European Parliament – Towards a thematic strategy on the sustainable use of natural resources, COM(2003) 572 final.

The level of detail put into the elements of the PEI is in practice highly dependent on the social and economic importance of the use of the PEI. Wenzel[139] illustrated this point (see Figure 83) by giving examples of applications with different requirements of certainty, transparency and documentation. Depending on the three possible uses for the PEI, the PEI can be almost anywhere on the graph. For example, if the PEI is used as a product development tool within industry it will be towards the bottom left of the graph. On the other hand, if the PEI is used for regulatory purposes or as an indicator for consumers to differentiate between packaging it will be towards the top right of the graph.

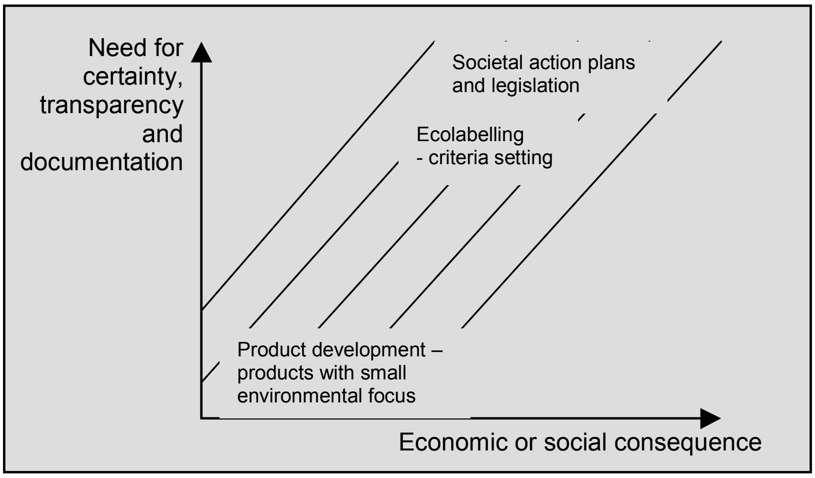

Figure 83 : Examples of LCA applications with different needs for certainty, transparency and documentation caused by differences in economic or social consequences of the decision to be supported (Wenzel[140])

It must be noted that the different applications are not points on the graph but instead areas, as within each application decisions with both large and small economic and social consequences may be found. Wenzel points out that for products receiving a lot of environmental focus, which is the case for packaging, the economic and social consequences will be higher and will therefore lie in the upper part of that application area.

Without a clear definition of the aims and objectives of a PEI it is therefore difficult to estimate economic and social impacts. This is also illustrated in the stakeholder evaluation where the lack of feedback and the variable cost estimates provided has prevented the development of quantitative estimates of the costs and social benefits of a PEI system. Instead, in the following the costs and social benefits of a PEI system are considered qualitatively.

ECONOMIC IMPACTS

When considering the introduction of a PEI, it is necessary to also consider the costs and benefits of such a measure. The organisations participating in the stakeholder evaluation as part of this study were more

139 Wenzel H. (1998) *Application dependency of LCA methodology: Key Variables and their mode of influencing the method*, International Journal of LCA, Volume 3, Number 5, 1998.

140 Wenzel H. (1998) *Application dependency of LCA methodology: Key Variables and their mode of influencing the method*, International Journal of LCA, Volume 3, Number 5, 1998.

or less unanimous in their opinion. They considered that the costs associated with the time and resources required for collecting the necessary data and calculating the indicator for each type and size of packaging put on the market would be disproportionate to the environmental benefits achieved. The economic burden that the introduction of a PEI would put on organisations, especially SMEs, was considered unacceptable.

The costs very much depend on the aims and objectives of the PEI and how these are applied. As discussed above, if the PEI is used for regulatory purposes or as an indicator for consumers, transparency and documentation requirements are high and so are the economic consequences of the PEI as illustrated in Figure 83. The cost to the companies calculating the PEI will as a consequence be high. If the PEI is used as a product development tool within industry, the cost is likely to be lower mainly due to the need for certainty, transparency and documentation being lower and the economic consequences being lower as well.

Without further consultation with a wider stakeholder group and possibly actual in-company trials, the cost to companies is hard to determine. However, if the PEI is used for regulatory purposes or as an indicator for consumers to differentiate between packaging, and taking into account that the PEI will apply to every single packaging type and size put on the market, the cost does seem to be unacceptable high. This of course depends to a large extend on the structure of a PEI system and the support it offers in the form of guidelines.

Several stakeholders[141] also asked how the complexity of environmental impacts potentially generated by systems running under widely differing local conditions could be reflected in a single score of a simple tool without distorting the functioning of the internal market. Such a question is difficult to answer without a clear definition of the aims and objectives of the PEI. For a PEI for product development purposes the tool would be used internally within companies for optimising products and possibly for marketing purposes. This would imitate, but expand, the current use of LCA within product development and no internal market distortion issues seem to be obvious. For a PEI used for regulatory purposes or as an indicator for consumers to differentiate between packaging the question of internal market distortion may very well be relevant. However, this depends on the tool's ability to accurately calculate the environmental impact of the packaging and to a large extent also stakeholder acceptance of the indicator and its credibility.

SOCIAL IMPACTS

Social benefits achieved through the introduction of a PEI may include an increased number of people in employment. If considering that the calculation of a PEI takes between one and ten person-days (depending on the complexity of the PEI tool) and with the diversity of packaging on the market, the number of additional people in employment may be significant. In practice, the number is likely to be less than can be theoretically calculated, as many organisations will instead prioritise the calculation of a PEI over other (possibly environmental) tasks within their organisation. This also represents an environmental risk if companies cut down on other environmental initiatives in order to devote staff time to PEIs.

A risk factor in introducing a PEI could be that some organisations will lose their competitiveness and may be squeezed out of the market. These would be likely to be SMEs who often have difficulties raising funding and allocate this to environmental purposes. They are likely not to have available resources in-house and will have to rely on external sources for calculating the PEI of their packaging products, which could be an expensive option.

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[141] APME and Feve.

However, before considering the social impacts of a packaging environment indicator the social need for such a tool should be established. This has not been done. For a PEI to achieve its goal the intended user must make use of it. This is in fact the most crucial element to the success of a PEI as without it being used by the intended user its credibility and feasibility is of no use. The intended user has as yet not been clearly defined, however three candidates exist: regulators, consumers or industry.

When considering regulators, a worst case scenario could be a comparison with the uptake of the Essential Requirements. Of the EU15, only France and the UK have a market surveillance system in place to ensure compliance with the regulations. Therefore, one could ask what would make regulators enforce a PEI when already existing prevention tools such as the Essential Requirements are only being enforced by a small number of Member States?

When considering consumers, comparisons could be drawn with consumers' use of eco-labels such as the EU Flower. Although eco-labels refer to products, consumers would still encounter a possible PEI in the same way as eco-labels, as labels on packaged products. The advantage of eco-labels is that they can be considered to be more convenient than the PEI in that the comparison has already been done and the consumer only needs to pick an eco-labelled product, whereas for the PEI the consumer must make an in-store comparison and assessment. Moreover, the EU ecolabel scheme has had a slow and difficult start and one of the criticisms by MEPs was that the ecolabel had a "*limited or non-existent visibility*" in the eyes of the public. A PEI is likely to encounter similar difficulties.

When considering industry, the uptake will depend on whether the PEI will be a mandatory or a voluntary tool. If mandatory, and enforced, the tool can be expected to be applied by all organisations. If voluntary, stakeholder comments have shown that organisations that already apply LCA in their product development consider a PEI not to add value to existing efforts within their organisations. It can therefore be assumed that they will continue to use their current LCA approaches and not utilise the PEI option. Whether SMEs will make use of the PEI is unclear, however considering the lack of SME participation in the consultation process for this report (whether due to time constraints or lack of interest) one may assume that this will be limited.

In considering developing a PEI, it is therefore not only important to consider the potential environmental improvement that can be achieved through the application of such a tool but also to consider the likely degree of use i.e. the likely environmental improvement. If the user of the PEI considers other criteria more important than an environmental indicator, its overall impact may not be as high as initially expected.

2.1.6.2 Assessment of PEI from an environmental perspective

Initially, the main priority for discussion when considering a PEI is the need for such an indicator. Measures already exist for the environmental assessment of packaging in the form of the Essential Requirements and a relevant question, as stated by a number of stakeholders, is therefore whether a PEI would provide any further environmental improvement than if the Essential Requirements were enforced across the EU. This is linked both to the usefulness of the tool at accurately determining the environmental impact of packaging and the uptake of the indicator by the intended user (as discussed in section 2.1.6.1).

Whether a PEI will be able to accurately determine the environmental impact of packaging, is an issue that is very much at the forefront of stakeholder comments received. In their opinion it can not due to the simplification of the life cycle assessment underlying the PEI and issues such as data inaccuracy and lack of representative data. This may be contested, however the issue cannot be resolved without considering the development of an actual PEI in more detail. As discussed in section 2.1.3, simplification (or streamlining) of the LCA is generally practised and is an important part of the goal and scope definition of an LCA. However, it is important to point out that simplification of an LCA may affect the purpose to which the LCA can be used and the nature of the decisions that it can support. The question is therefore how simplified can an LCA be for the uses discussed for a PEI? It may be that, when considering a PEI in more detail, the conclusion is that a simple PEI is too simple for any other application than as a product development tool within industry. The final conclusions from the Dutch packaging indicator initiative (see section 2.1.2.1) may give some indication to this.

Stakeholders are also concerned that the PEI, in its current form, considers the environmental impact of packaging in isolation from the product it contains. As rightly pointed out, the broader prevention role played by packaging (i.e. reducing product wastage) is not considered. As discussed in section 2.1.3.2, product wastage can in fact be considered by incorporating it into the functional unit, however wider issues such as the environmental impact of the damaged product (e.g. spillage of a hazardous liquid) will not be considered in a PEI that only includes the packaging. Additionally, without considering product and packaging in context, the environmental benefits of introducing additional packaging, as in the case of the fresh paprika example described in section 2.1.2.1, may not be realised.

Finally, a possible consequence of implementing a PEI may be to inadvertently reinforce consumer perception that packaging provides little benefit and contributes significantly to the waste stream. By reinforcing this perception, consumer attention may be redirected away from where in their daily life they can make the most significant environmental improvements (such as through their choice of transport modes and improving the energy efficiency of their homes).

2.2 TASK 2.B: PACKAGING PREVENTION – PACKAGING PREVENTION PLANS (PPRP'S)

2.2.1 Definition and background

Art. 4 of the Packaging Directive 94/62/EC postulates on prevention that:

1. Member States shall ensure that, in addition to the measures to prevent the formation of packaging waste taken in accordance with Article 9, other preventive measures are implemented. Such other measures may consist of national programmes or similar actions adopted, if appropriate in consultation with economic operators, and designed to collect and take advantage of the many initiatives taken within Member States as regards prevention. They shall comply with the objectives of this Directive as defined in Article 1 (1).
2. The Commission shall help to promote prevention by encouraging the development of suitable European standards, in accordance with Article 10.

2.2.2 Implementation of this prevention option in the member states

Packaging prevention plans (PPrP's) are required for certain businesses in Belgium, Italy, Slovakia, Spain and in the Netherlands.

In **Belgium** the Interregional Co-operation Agreement on the prevention and management of packaging waste of May 30 1996 states that:

Art. 4. § 1. Every three years and for the first time one year after the coming into force of the present co-operation agreement, all parties responsible for packaging waste as referred to in article 2, 19, a) who have packaged or caused to be packaged products with at least ten tonnes of packaging per year are obliged to present a general prevention plan to the Interregional Packaging Commission[142].

In **Italy**, the programme of prevention and management of packaging waste includes all information necessary for the achievement of the recovery and recycling targets (both in total and according to material) within both the long-term and intermediate periods. It sets out, among others, the initiatives currently underway and those in preparation designed to prevent the increase of packaging waste arising, as well as those designed to increase the amount of recyclable and recoverable packaging.

The concept of packaging prevention plans has been developed and implemented in **Slovakia**. For the purposes of prevention, obliged persons with annual production exceeding ten tons of packaged products shall draw a prevention programme, for the period of four years, including: a) quantitative objectives for prevention, b) measures to achieve objectives, c) supervisory mechanism to check fulfilment of objectives. (Act No.529/2002, §7).

In **Spain** the Royal Decree 782/1998 imposes to packers which, during one calendar year, place on the market a quantity of packaged products, and if applicable, industrial or commercial packaging, which may generate packaging waste exceeding certain thresholds per material shall be required to prepare a managerial (or entrepreneurial) plan for prevention.

[142] Art. 22. § 1. states that the regions shall establish the Interregional Packaging Commission as a common institution as defined in article 92bis of the Special Act of 8 August 1980 on institutional reforms. The IRPC has a corporate personality. The IRPC is composed of a decision-making body and a permanent secretariat, whose role is to assist the decision-making body.

According to the Dutch Packaging and Packaging Waste Decree (DPPWD) in **The Netherlands**, the producer or importer must ensure that, of the amount of packaging he places on the market each year, he achieves the defined recycling and recovery target: via a Covenant; via individual obligations or via joint notification by producers and importers.

Companies having more than 4 employees and which place more than 50,000 kg of packaging material on the Dutch market, must submit an annual report, via a cluster[143] or otherwise, on the progress of their prevention strategies. This report should, if possible, provide quantitative information, explanation and examples (Packaging Covenant III).

2.2.3 Evaluation

2.2.3.1 Strenghts

THE QUALITY OF PACKAGING PREVENTION PLANS INCREASES OVER THE YEARS

In **Belgium**, 93% of the individual PPrP's and 96% of the sector PPrP's 2001 were approved in their first draft. All the adjusted prevention plans were of noticeably better quality than the original version and were approved by the IRPC. In the end all packaging prevention plans were approved and furthermore it was found that almost 20% to 23% of the individual respectively sector prevention plans 2001 were of very high quality. In comparison to the prevention plans of 1998, of which the IRPC hardly approved 42%, there's a big improvement.

THE % OF PACKAGING PREVENTION PLANS THAT ARE IMPLEMENTED AS PLANNED INCREASES OVER THE YEARS

In **Belgium** the assessment of the execution of the general prevention plan by the party responsible for packaging is a yearly obligation imposed by article 17, §4 of the co-operation agreement:

In total over 90% of the parties responsible for packaging submitting a general individual prevention plan 2001, submitted in 2002 and 2003 an assessment report of the execution of the prevention plan. In Table 59 a global state of affairs is given.

[143] The number of businesses required by the DPPWD to achieve the prevention objectives is about 450.000. These businesses are mainly retail and whole sale trade industries. More than 98% are small and medium-sized enterprises (DPPWD, explanatory notes 5.1).

Table 59: Implementation of the individual and sector prevention plans 2001

	Percentage of companies			
	Implementation of the individual packaging prevention plans 2001		*Implementation of the sector prevention plans 2001*	
	Evaluation 2002	*Evaluation 2003*	*Evaluation 2002*	*Evaluation 2003*
Develops as planned	32%	24%	30%	18%
Develops partially as planned	34%	46%	48%	74%
Develops not at all as planned	8%	5%	4%	4%
Indistinct state of affairs	3%	2%	8%	4%

In global a certain progress is observed in the number of individual prevention plans of which the implementation develops at least partially as planned and the number of individual prevention plans of which the implementation develops not at all as planned.

As a sector prevention plan generally contains a greater number of planned measures in comparison to an individual prevention plan, the possibility of something going wrong with at least one of these measures is much higher. This is reflected in Table 59 in the fact that the percentage of prevention plans developing as planned is lower than in the case of individual prevention plans; and the percentage of prevention plans developing only partially as planned is higher than in the case of individual prevention plans. Besides this remark the trend is the same as for the individual prevention plans: the number of plans developing as planned diminishes, but the number of prevention plans at least partially developing as planned augments stronger in comparison. So also for the sector packaging prevention plans a certain progress in relation to 2002 is made.

PACKAGING PREVENTION PLANS ARE AN IMPORTANT SOURCE OF INFORMATION FOR THE AUTHORITIES.

The figures below for **Belgium** represent only the information obtained from the 398 individual packaging prevention plans 2001[144].

In **Spain** the Integrated Management Systems (IMS) which draw up the sector PPrP's check indicators and inform yearly the obtained results in the Annual Control Report. To prepare this report it is necessary to compile information about packaging placed on the market (Declaration of packaging) and about prevention measures taken and foreseen for the time period the PPrP is in force (Declaration of prevention measures) (ISR-CER, 2004).

In **Slovakia**, according to Section 4 of the Decree 5/2003 Coll. SR, the Liable Person also maintains the records of packaging based on type of materials, quantities of re-applicable packaging and quantities of "improved" waste of packaging and recycled waste of packaging according to specimen stated in the annex to the Decree. The Liable Person keeps the records continuously in electronic or written form. The Liable Person also announces the following information from the Register to the Ministry: data on the

[144] Pro Europe remarks that these individual packaging prevention plans represent less than 20% of the packaging.

volume of production, import and export of packaging, as well as information on volume of re-applicable packaging and improved waste of packaging and recycled waste of packaging

- Information on products sold without packaging:

More than 20% of the parties responsible for packaging informed the Interregional Packaging Commission that they put products without packaging on the **Belgian** market. The share of those unpacked products varies from 1% to 97% of the total company sales realised on the Belgian market. Especially in the sector of fuels and lubricants a large amount of products are sold without packaging (50% of the companies from this sector put unpacked products on the market and the share of the total sales that these products represent is almost 70%).

- Information on the use of reusable packaging:

More than 60% of the parties responsible for packaging informed the Interregional Packaging Commission that they use reusable packaging for the products sold on the **Belgian** market. Table 60 shows that the use of reusable packaging varies strongly between sectors:

Table 60: Use of reusable packaging in Belgium

Sector	*% companies with reusable packaging*	*Average % reusable packaging*[145]
Food industry (without drinks, 63 companies)	65%	37%
Food industry (only drinks, 7 companies)	86%	91%
Textile sector (textile, clothing, shoes)l	41%	59%
Plastic industry	75%	52%
Paints/Varnishes/Printing inks	67%	26%
Fuels and lubricants	33%	9%
Pharmaceutical industry	100%	29%
Cosmetics/ wash and cleaning products	60%	50%
Building industry	52%	64%
Metal industry	51%	53%
Wood industry (including furniture)	33%	21%

In **Spain** the indicator 'Increase of the percentage of re-use' has since 1999 a tendency to increase, which means that the number of reusable packaging has risen.

- Information on which types of reusable packaging are used:

Apparently the use of reusable pallets is to a large extent responsible for the high reuse percentage reported in some sectors. Table 61 gives an overview of which types of reusable packaging are applied by companies using reusable packaging.

[145] The averages % reusable packaging refer only to the companies with some reusable packaging. So these are not overall average tonnages.

Table 61: Used types of reusable packaging in Belgium

Sector	*Types of reusable packaging used*				
	pallets	*crates*	*containers*	*barrels*	*bottles*
Food industry	50%	28%	3%	0%	9%
Textile sector (textile, clothing, shoes)	36%	5%	12%	0%	0%
Plastic industry	74%	0%	7%	4%	0%
Paints/Varnishes/Printing inks	62%	0%	14%	29%	0%
Fuels and lubricants	20%	0%	20%	0%	0%
Pharmaceutical industry	100%	0%	0%	0%	0%
Cosmetics/ wash & cleaning products	60%	0%	0%	0%	20%
Building industry	52%	0%	4%	0%	0%
Metal industry	51%	6%	9%	3%	0%
Wood industry (including furniture)	22%	0%	0%	0%	0%

- Information on use of packaging consisting of recycled materials:

Almost 50% of the parties responsible for packaging mentioned that they use packaging made of recycled materials in order to set their products on the **Belgian** market. From this group more than 90% uses packaging made of paper or cardboard consisting for 50% or more of recycled paper and cardboard. The average % recycled paper and cardboard in those packages is about 70%. For the other materials these % are generally much lower.

In **Slovakia**, ENVI-PAK, a.s. collects data from obliged persons on the volume of packaging placed onto the Slovak market within a calendar year, in compliance with legal and contractual provisions. Further, it collects data on the use of packaging waste by obliged persons themselves (possibly retail) and municipalities operating collection and separation systems supported by ENVI-PAK, a.s. Comparison of the total volume (in kg) of packaging placed onto market by ENVI-PAK, a.s. system members and the total volume (in kg) of used packaging will result in the rate of use, which should gradually reach the defined reuse and recycling targets according to SR Governmental Edict No. 22/2003, which defines binding limits for packaging waste reuse and recycling in relation to total weight of packaging waste.

2.2.3.2 Practical consequences

WHEN OFFERED THE CHOICE MOST COMPANIES PREFER TO USE A STANDARD FORMAT TO PREPARE A PACKAGING PREVENTION PLAN.

In **Belgium**, 80% of the individual packaging prevention plans were based upon the standard format, resulting in a higher quality of the packaging prevention plans. The use of standard forms makes reporting and evaluation of the global amount of packaging prevention plans easier, as well as the comparison between two or more packaging prevention plan-years[146].

[146] The preference to use a standard format to prepare a packaging prevention plan is only true with regard to individual prevention plans (not for sector prevention plans).

According to the **Belgian** Packaging Institute the redaction of a standard format for the packaging prevention plans for a whole sector is much more complex regarding the big differences between the various industries/companies. Experience from **the Czech Republic** indicates that a framework standard format could be developed as the general conditions are given by law, even though it is a fact that each company has its particular conditions.

RESPECT OF THE "STAND STILL PRINCIPLE[147]" (FOR PRIMARY PACKAGING)

In conjunction with packaging prevention plans, several Member States introduced a stand-still principle or reduction targets, meaning that the ratio between the weight of the packaging and the weight of the product placed on the market shall not increase, respectively shall decrease.

Packaging prevention plans make the firms evaluate and re-evaluate their packaging (**Belgian Packaging Institute**). Although a standstill principle (for the whole packaging system in Belgium) is introduced, some exceptions on this rule must be allowed (e.g. if it is necessary for means of hygiene, safety or conservation; if the increase is compensated at the same time by a decrease in another part of the packaging system (primary, secondary, tertiary packaging) where the packaging is part of; …).

In the Belgian law on Product Standard the stand-still principle is, beside the Essential Requirements, officially introduced: *"any person who places on the market packaged products in non-reusable packaging shall be required to ensure that, for the same packaging material, the ratio between the weight of the packaging and the weight of the product placed on the market in this packaging shall not increase compared with the ratio when this law enters into force." (art. 11.2)*

In the standard format of the packaging prevention plans 2001 there was evaluated if the stand-still principle was respected for the period 1998-2001. Over 70% of the parties responsible for packaging mentioned they had respected this principle.

In **Spain** the so far applied prevention measures (of the sector PPrP's) in companies fix their attention to the reduction of the weight of the packaging. In fact, even though the evolution of the consumption habits implies that a part of the packaging will go to smaller, more sophisticated, more secure formats (characteristics which normally degrade the relation Kr/Kp[148]) it is tried to compensate that tendency thanks to the reduction of the weight of packaging, while optimising the quantity of packaging placed on the market to commercialise a fixed quantity of product (ISR-CER, 2004).

The indicator 'Decrease of the weight of the packaging' measures the quantified objective of 10% reduction of packaging waste to be reached in 2001, compared to 1997, and is analysed in most detail by the different IMS. Ecoembes has obtained a reduction of 14% during the period 1990-2002 of the packaging considered in the PPrP's of Ecoembes, of which 12% corresponds to the period 1990-1998, during which it wasn't obligatory to draw up PPrP's, and the remaining 2% relates to 1998-2002. This reduction tatrget (of 14%) is the outcome of the improvement achieved by companies participating in the Ecoembes sectoral prevention plans, corresponding to household, commercial and industrial packaging. The scope of packaging prevention plans is, according to Spanish law, not only household packaging (those packaging under the scope of Ecoembes) but all packaging placed on the market by the licensed companies participating in Ecoembes prevention plans. On the other hand, the Law (published in 1997) allows to take into account in the prevention plans the prevention measures implemented prior to

[147] The stand still principle for primary packaging means that the weight ratio between the primary packaging (this is the sales packaging) and the product may not increase.

[148] Total weight quantity of packaging waste generated per year/Total quantity of packed products per year *100

1997. Ecoembes thus points out that not all household packaging licensed to Ecoembes participates in the sectoral prevention plans.
Although we do not have the figure of 1997, it doesn't seem that the 10% target has been met.
The decrease of packaging weight is measured by the proportion Kr/Kp. As the data declared on Non IMS materials contain errors, the results are separated between packaging of materials adhered to an IMS (Table 62) and packaging of materials IMS + Non IMS (these are materials adhered to a PPrP which is not adhered to Ecoembes as they are not considered to be household packaging) (Table 63). In certain cases little logical variations in these results are observed which have several causes, among which the variation in the number of companies participating in the PPrP or problems of the quality of the data which are delivered by the companies (ISR-CER, 2004).

Table 62: Reduction of packaging weight in Spain[149]. IMS Materials (Source: Ecoembes in ISR-CER, 2004)

Sector	*Kr/kp*			
	1999	*2000*	*2001*	*2002*
Alimentation and tobacco	8,16	7,99	8,14	8,06
Optical	47,75	28,68	38,16	33,95
Household	9,26	8,62	7,69	7,49
Edition and publishing industry	11,63	7,88	9,55	9,18
Fur industries	24,71	16,47	14,57	15,22
Personal and household care	9,55	11,13	9,78	9,90
Pharmacy	13,77	8,89	9,05	20,27
Leisure and open air	5,01	5,09	5,05	8,59
Textile	11,68	11,46	9,24	5,60
Motor	7,63	6,89	6,36	6,48
Sound	24,72	28,86	26,18	27,08
Other	40,96	N/D	N/D	N/D
TOTAL	**8,44**	**8,33**	**8,31**	**8,26**

Table 63: Reduction of packaging weight in Spain. IMS + Non IMS Materials (Source: Ecoembes in ISR-CER, 2004)

Sector	*Kr/kp*			
	1999	*2000*	*2001*	*2002*
Alimentation and tobacco	9,34	9,97	13,11	5,88
Optical	42,27	30,21	34,45	33,90
Household	6,39	10,09	5,97	12,55
Edition and publishing industry	16,26	8,12	17,07	27,51
Fur industries	21,06	16,02	16,32	7,58
Personal and household care	12,28	10,19	13,83	6,16
Pharmacy	17,12	11,37	9,79	4,49
Leisure and open air	5,27	5,37	3,73	5,33
Textile	18,76	21,66	21,21	9,67
Motor	7,55	6,54	6,56	6,52

149 Ecoembes points out that the data in Table 62 and 63 refer to the reduction of packaging weight of the packaging covered by the sectoral plans of Ecoembes and not to the total packaging weight reduction in Spain.

Sound	24,64	25,44	22,73	20,69
Other	53,64	N/D	N/D	N/D
TOTAL	**9,55**	**10,00**	**11,98**	**6,41**

In **Spain** there are very few individual PPrP's presented and authorised by the Autonomous Communities. The majority of companies have chosen to present their PPrP by the Integrated Management System (IMS) where they're affiliated to. Only 19 individual PPrP's have been authorised by the Competent Body of the Autonomous Communities (Ministery of Environment in ISR-CER, 2004). From the analysis of these very few authorised individual PPrP's the following conclusions were drawn (ISR-CER, 2004):

- The majority of enterprises which presented an individual PPrP and which has been authorised, are companies placing industrial or commercial packaging on the market. So the majority of companies placing household packaging on the market have chosen to present a sector PPrP by the IMS to which they belong to.
- Likewise, the majority of them have paid attention to the successful outcome of the objective to reduce the Kr/Kp coefficient, considered being the main indicator for prevention, and thus the reduction of the weight of the packaging.
- In general, the Kr/Kp coefficient has increased since 1999, the moment when the first PPrP's were presented. The majority of companies has reached or is close to reaching the goal of a 10% reduction of the generation of packaging and packaging waste[150].

In **The Netherlands** Art. 5 of Law 11/1997 provides that before 30th June 2001 all packaging waste generated shall be reduced by at least 10% by weight (taking 1997 as a reference year[151]). According to the article 5 of the Royal Decree 782/1998, the 10% reduction objective is calculated by applying the ratio of the weight of packaging waste to the weight of the packed product.

IN THEIR PACKAGING PREVENTION PLAN COMPANIES PROPOSE A WIDE VARIETY OF PREVENTION MEASURES:

In **Belgium** the parties responsible for packaging submitting a packaging prevention plan 2001, postulated in total about 600 prevention measures for the period 5th of March 2001 to 5th of March 2004.

Table 64: Planned prevention measures in Belgium

Sector	*% companies who planned a prevention measure of a certain type*				
	Increased % of recyclable packaging	*Increased % of reusable packaging*	*Improvement of the reuse or recycling possibilities*	*Decrease of the hazardous character of packaging materials*	*Decreased use of single use packaging*

[150] Note that the 10% reduction target in Spain is a national target and not an individual target that has to be reached by each company (Ecoembes).

[151] Royal Decree 782/1998, art.5

Food industry	6%	16%	4%	9%	46%
Textile sector (textile, clothing, shoes)	2%	12%	5%	2%	51%
Plastic industry	4%	43%	7%	4%	61%
Paints/Varnishes/Printing inks	10%	24%	19%	10%	57%
Fuels and lubricants	0%	0%	0%	0	83%
Pharmaceutical industry	0%	0%	0%	0	25%
Cosmetics/ wash & cleaning products	20%	40%	40%	20%	60%
Building industry	12%	32%	4%	8%	68%
Metal industry	6%	34%	3%	6%	54%
Wood industry (including furniture)	11%	33%	11%	11%	67%

OTHER PRACTICAL CONSEQUENCES

In **Slovakia** a practical consequence is the growth of responsibility for a reduction of the quantity and of the harmfulness of materials and substances contained in packaging and packaging waste for the environment.

2.2.3.3 Weaknesses

THE OBLIGATION TO PREPARE A PACKAGING PREVENTION PLAN PLACES A BURDEN ON COMPANIES THAT IS ONLY JUSTIFIED ABOVE A CERTAIN THRESHOLD LEVEL FOR THE MINIMUM SIZE OF THE COMPANY

Because it is assumed that the obligation to prepare a packaging prevention plan places a burden on companies that is only justified above a certain threshold level, many countries implementing the system of PPrP's (Belgium, Slovakia, Spain,…) have set a threshold (either a total amount of packaging per year placed on the market or a threshold per material) on the obligation to present a packaging prevention plan.

Assessment of effects on companies in The Netherlands[152]

The financial consequences of the DPPWD for companies are to a large extent determined by the way that the concerned business fills in its obligations.

In relation to financial consequences a distinction can be made between material effects (in the context of investments, turnover developments and similar) and administrative effects (in relation to organisation, monitoring and reporting).

[152] Explanation of the PPWD in PPWD guide: information for the submission of a notification, VROM, directorate waste, Den Haag 1998

In the following the financial consequences of a covenant are indicated and if possible of (partial) individual implementation as well.

Prevention

The number of companies (mostly packagers/fillers) that are addressed by the decree for the realisation of prevention goals amounts up to about 450.000. These companies are mainly part of the categories: retail- and wholesale trade and industry. Over 98% of them appertain to medium and small sizes business.

Experience indicates that the balance of preventive measures in the end results in more benefits than costs, by savings in materials and optimisation of the product or the production process, and thus does not result in increasing material costs for business.

In case of a covenant it is very well possible to chart and implement the prevention options for the whole branch of trade by means of one or a few projects per branch. The administrative costs of this can then be spread over the whole branch and will expectantly, given the mentioned efficiency gain, be able to be paid back within reasonable term.

When there is no exemption of the individual obligations, an implementation plan per company ought to be formulated and the prevention results ought to be reported. This brings along administrative costs. These will be function of the size of the company and the amount and diversity of used packaging. Implementation plans and reports can vary in size from a short description in one page to a substantial report. The costs of this will differ per individual company and can mount up to some thousands of euro.

<u>Administrative costs in relation to organisation, monitoring and reporting</u>

Organisation costs incur from the joint implementation of the obligations under a covenant. Expectantly some millions of euro will be involved in this. It can be expected that the majority of companies will opt for representation by branch organisations or other forms of co-operation, so these organisational costs can be spread over all branch members.

The decree entails obligations in the field of notification, monitoring and reporting. Companies or groups of companies shall presumably do this at an aggregated level making use of the developed methodology by the collective system. Monitoring and the formulation of prevention plans cost under the covenant of 1991 (representing 60% of the amount of packaging) about 5,5 million euro yearly. It was expected that the total costs (administrative costs for prevention, notification, monitoring and reporting) under the covenant II would amount up to about 9 to 10 million euro yearly.

The Ministry of Economic Affairs and VROM (Ministry of Public housing, Spatial planning and Environmental management) were asked for more recent numbers on the effect of packaging prevention on companies. Unfortunately there was no more recent information available.

In the case of **Belgium** the administrative burden to public authorities amounts to the equivalent of 1,5 person full time or about 100.000 € yearly.

NO COMPARATIVE INFORMATION AVAILABLE TO UNDERPIN THE HYPOTHESIS THAT THE IMPLEMENTATION OF PACKAGING PREVENTION PLANS HAS LEAD TO A CHANGE IN PACKAGING

As a reference for the general trend in the EU-15 Figure 84 shows the packaging waste generation related to the development in the total GDP in the EU Member States. Although the time series is short the figures indicates that the packaging waste generation is almost following the growth in GDP. From 1997 to 2001 the packaging waste generation and the GDP had increased by 8,3% and 11% respectively.

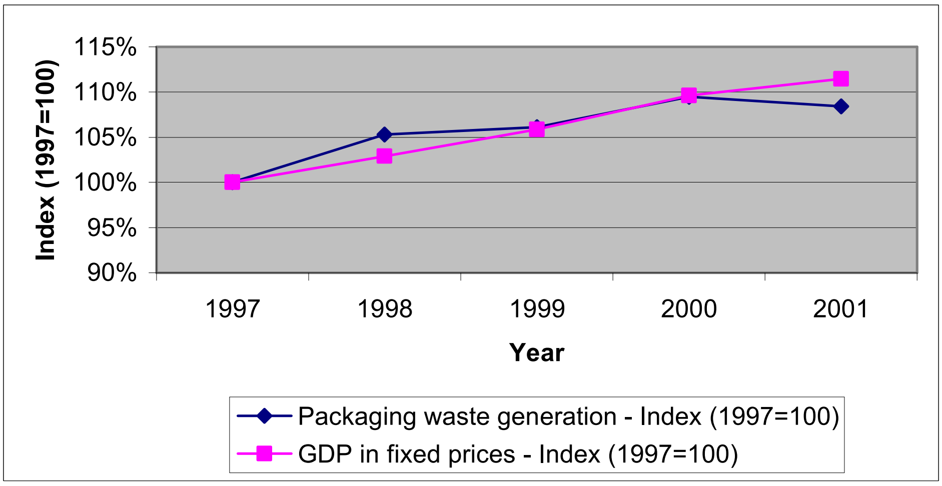

Figure 84: Development of packaging waste generation and GDP in EU-15 1997-2001

In **Belgium** the amount of submitted plans was not really a success and the quality of the plans was neither very good (only 42% approved) for the first edition of the PPrP's in 1998.

The very poor quality and the small number of approved packaging prevention plans 1998 makes a comparison of the data between 1998 and 2001 impossible. The results of the assessment of the packaging prevention plans 2004 are not yet available so no comparison between 2001 and 2004 can be made neither to see whether firms are rethinking their way of packaging and are looking at alternatives for the way they used to pack their products.

We can assume that all companies who fulfilled well their obligation of submitting a packaging prevention plan in 1998 and 2001 and had a good evaluation regarding the implementation of their plans, will have realised some prevention by one or more of the mentioned possibilities (increase of recyclable packaging, increase of reusable packaging, …).

Examples of packaging prevention in Belgium are assembled in the book "Prevent.pack, Prevention of packaging in practice", these will also be available from 20-04-04 on the website www.preventpack.be

Figure 85 shows the relation between GDP and the amount of packaging waste generated in Belgium between 1997 and 2001. We observe a decoupling between the two factors from 2000 onwards. In 2001 there is a sharp decrease of the packaging waste generation index while the GDP index stabilises at 110% (increasing consumption and liveability in relation to 1997). One possible explanation is the effect of the implementation of prevention measures in the packaging prevention plans of 1998.

In 2001 there was 138 kg of waste arising in Belgium per capita. This is relatively low in comparison to the EU-15 average of 172 kg/capita.

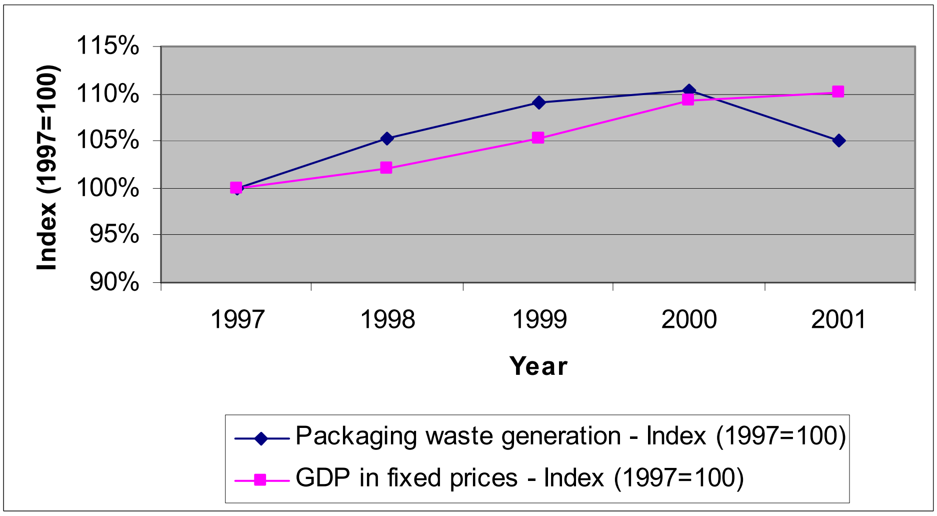

Figure 85: Development of packaging waste generation and GDP in Belgium 1997-2001

In **Slovakia** the obliged person shall ensure packaging waste collection, recovery or recycling within the extent of binding limits stipulated in a regulation of the Government of the Slovak Republic. Binding limits on the scope of appreciation of packaging waste and their recycling relative to the total weight of the packaging waste are provided for in the Decree, which became effective on February 1, 2003 (Decree of the Government of the Slovak Republic of January 15, 2003). The date for giving the first file providing information on a kind, amount, recovery and recycling for producers has been till February 15th this year.

Thus again no comparative data are available to underpin the hypothesis that the implementation of packaging prevention plans has lead to a change in packaging.

In **Italy** the consortium CONAI replaces the former consortia which were set up in accordance with the 1988 Law on Beverage Packaging, but under the new regime there are again various collection and recovery consortia for individual packaging materials. These consortia have to be approved by the Environment and Industry Ministers, and will be financed through income from activities and contributions from members. Each consortium implements its own specific program of packaging waste prevention that will form the basis for a general, national catalogue of measures to be compiled by

CONAI. Each year the consortia are to report to the National Packaging Consortium on the management and results of the specific programmes, with any evidence of problems in attaining the set targets.

Companies that do not join the system must document the appropriate measures that have been taken and submit an annual report of the results. If a company cannot prove that the necessary steps have been taken, it must join a system and pay the corresponding fees with retroactive effect plus a fine.

By April 2004, around 1.357.000 companies were members of CONAI.

Figure 86 shows packaging waste generation index lies much higher then the GDP index. However, the main relative increase is from 1997 to 1998. Thereafter, there seems to be a slight de-coupling of packaging waste from GDP growth.

In 2001 there was 194 kg of waste arising in Italy per capita. This is relatively high in comparison to the EU-15 average of 172 kg/capita.

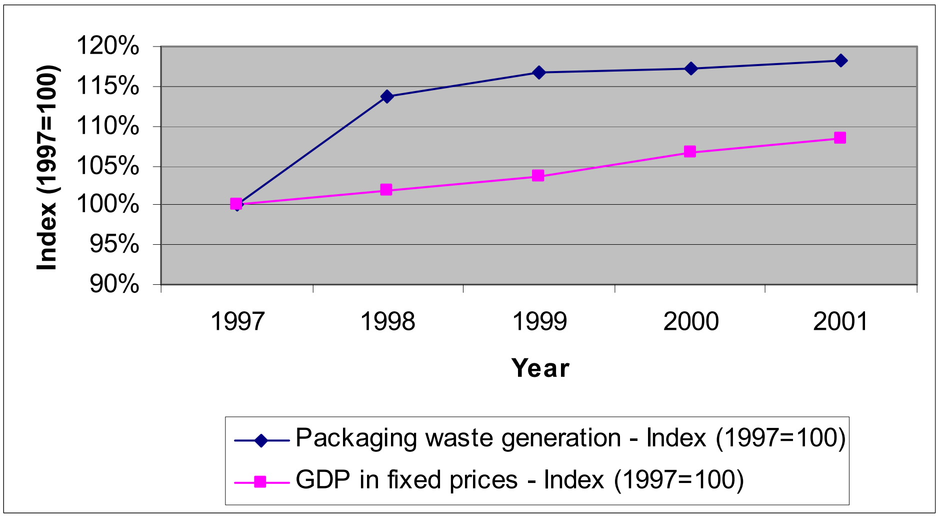

Figure 86: Development of packaging waste generation and GDP in Italy 1997-2001

In **Spain** Ecoembes presented in May 1999 11 sector PPrP's, in which 1170 companies participated. In May 2000, these PPrP's were modified and another 400 new companies were added, due to the thresholds of weight. At that time the PPrP's presented in 1999 and 2000 were united, retaining 11 sector plans in force during the period 2000-2003. The PPrP's 2000-2003 have the participation of 1842 companies in total which are affiliated to the IMS, of which the packaging represent over 80% of the packaging affiliated to the IMS. Once the term of these first PPrP's was finished, the policy of encouraging prevention has continued and new PPrP's were drawn up which will be valid from 2003-2006. Some sectors were grouped so for this period 5 sector plans remain. 2108 companies are affiliated to these 5 sector plans (ISR-CER, 2004).

The packers who mainly use glass packaging created, in 1995, their own nation-wide recovery systems in order to adapt recycling structures to the new European standards. Ecovidrio is a non-profit-making organisation created for managing the selective collection of glass waste packaging. For the Beers, Wine, Spirit and Cider sectors, Ecovidrio carries out the sector Prevention Plans and transmits them for approval on behalf of its members.

In the case of Ecovidrio, the first PPrP's were drawn up for the period 1997-2001 and afterwards the PPrP's were presented for the period 2002-2005. There are 3 sector plans and over 2000 companies are affiliated to Ecovidrio. In 1998 Ecovidrio had an operating cost for prevention plans of 14,3 million pesetas (0,09 million Euro) (ISR-CER, 2004).

Figure 87 shows the relation between GDP and the quantity of packaging waste generated in Spain between 1997 and 2001. Since 2000 there's a decoupling between the two factors. While the GDP index keeps increasing, the decrease of the packaging waste generation index might be the result of the 11 sector PPrP's presented in 1999 (and modified in 2000) by Ecoembes for the period 2000-2003 and the 3 sector PPrP's of Ecovidrio for the period 1997-2001[153].

In 2001 there was 145 kg of waste arising in Spain per capita. This is rather low in comparison to the EU-15 average of 172 kg/capita.

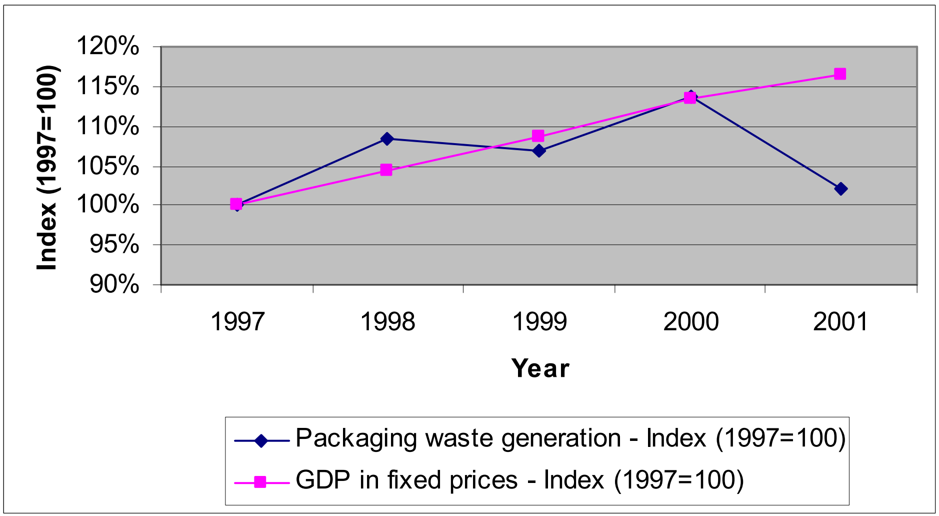

Figure 87: Development of packaging waste generation and GDP in Spain 1997-2001

In **the Netherlands** the Covenant II fixed a goal of 10% reduction of the total quantity of packaging placed on the market to be reached in 2001. Conform the report of the Packaging Committee the attained reduction is 27%. Table 65 shows the evolution between 1997 and 2001 of the quantity of packaging put on the market.

Table 65: Percentage reduction of the quantity of packaging placed on the market in The Netherlands (1997-2001) (Source: Annual Report 2001 of the Packaging Committee[154])

	1997	*1998*	*1999*	*2000*	*2001*
Increase of GNP compared to 1986 (%)	34,5	39,5	44,5	49,6	51,2
Reference value (packaging placed on the market in 1986) (Ktn)	3.147	3.264	3.381	3.501	3.538
Packaging placed on the market (Ktn)	2.674	2.562	2.592	2.557	2.582
Percentage prevention in relation to 1986 (%)	15	22	23	29	27

So in 2001 the quantity of packaging placed on the market decreased 27% in relation to the quantity of packaging placed on the market in 1986 (2.340 kT), corrected for the increase of the GNP since 1986.

[153] Ecoembes notes that there is no information to support the fact that the decoupling between GDP and packaging waste generation in Spain since 2000 is a direct consequence of the prevention plans presented by Ecoembes and Ecovidrio.

[154] In ISRcer Analyse de résultats de la stratégie de la prévention de la génération des déchets d'emballages en Belgique et en Espagne. Study commissioned by BIM/IBGE. 2004

There is a difference between the data used for the compilation of Table 65 and Figure 88. The data in Table 65 are taken from the annual report 2001 of the Packaging Committee which do not include the amount of wood packaging placed on the market as the ail of the Covenant II and the prevention obligations are based on the materials paper/cardboard, glass, metal and plastic. Figure 88 is on the other hand based on the official numbers of the European Commission.

Figure 88 shows the relation between GDP and the quantity of packaging waste generated in the Netherlands between 1997 and 2001. The two factors show a similar rising trend since 1998.

In 2001 there was 186 kg of waste arising in the Netherlands per capita. This is relatively high in comparison to the EU-15 average of 172 kg/capita.

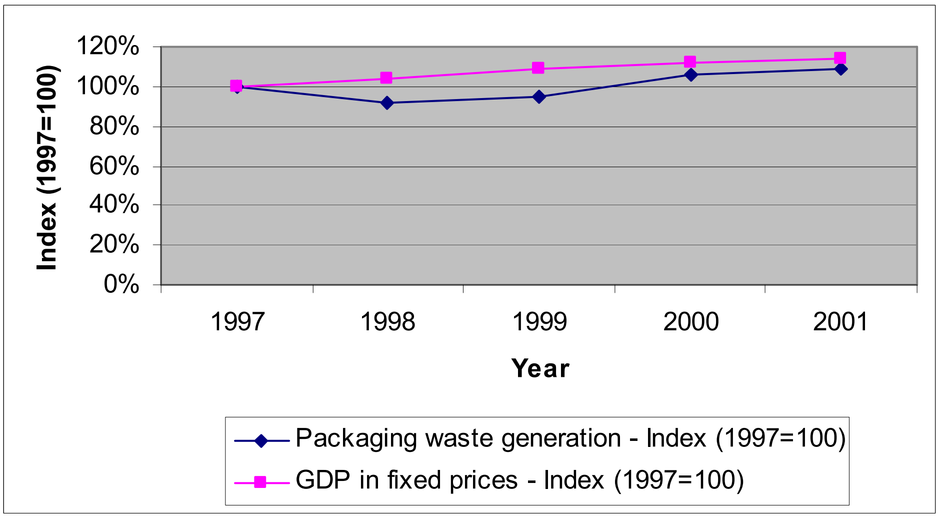

Figure 88: Development of packaging waste generation and GDP in the Netherlands 1997-2001

2.2.4 Specific issues

THE CONCEPT OF PACKAGING PREVENTION PLANS IS TO AN EXTENT SIMILAR TO DOCUMENTS FOR THE ASSESSMENT OF CONFORMITY WITH THE ESSENTIAL REQUIREMENTS

According to the concept of **Belgian** packaging prevention plans "parties responsible for packaging" have to report detailed data on how they will increase the quantity of reusable packages in proportion to the quantity of one-way packages in the next three years or how they will improve the physical qualities and features of packaging with a view either to ensuring that packaging is able to withstand more than one trip or rotations under the normal expected operating conditions or to recycling it. These are to an extent similar to the Essential Requirements (see 94\62\CE annex II). Therefore, the packaging prevention plans bear some similarity to the documentation required e.g. in the United Kingdom or France to show compliance with the essential requirements. Ultimately, these requirements are similar to conformity assessment procedures as used in other New Approach Directives.

An option could be to harmonise conformity assessment procedures in the Member States. If this is done, it might be useful to draw from the experience with packaging prevention plans.

2.3 TASK 2.C: PACKAGING PREVENTION – ESSENTIAL REQUIREMENTS

2.3.1 Definition and background

2.3.1.1 The New Approach system

The Packaging Directive is a New Approach Directive. This legislation technique is used to harmonise complex technical requirements for products on a European level. It is based on a combination of legislative and non-legislative elements. Legislation is used to set key essential requirements which should be fulfilled by all products covered by a directive and which should guarantee the free circulation of products within the Internal Market. However, legislation is not perceived to be appropriate to set technical details of product design nor would it be feasible to address a large number of details in time and resource consuming legislative procedures. Therefore, the elaboration of details is left to standardisation bodies.

The **Council Resolution of 07/05/1985**[(155)] lays down the principles of the New Approach to technical harmonisation and standards.

New Approach directives are based on the following principles:

- Harmonisation is limited to essential requirements.
- Only products fulfilling the essential requirements may be placed on the market and put into service. Member States may not restrict the free circulation within the Internal Market of products fulfilling the essential requirements.
- Harmonised standards, the reference numbers of which have been published in the Official Journal and which have been transposed into national standards, give presumption of conformity with the corresponding essential requirements.
- Application of harmonised standards or other technical specifications remains voluntary, and manufacturers are free to choose also other technical solutions, provided they can demonstrate compliance with the essential requirements.
- The enforcement of essential requirements is normally done by Member States authorities using a conformity assessment procedure provided for in the applicable directive.
- Where there is no prior authorisation requirement, this is done via the market surveillance technique (random checking of products on the market).
- Many New Approach directives have a marking requirement for products claiming conformity with the essential requirements.

The Packaging Directive is atypical because it neither has a conformity assessment procedure (see also Annex 7 for other New Approach Directives without Conformity Assessment) nor a marking requirement such as the CE mark conform the guidelines described in Decision 93/465/EEC[(156)] (more detailed informaiton is provided for in Annex 6: Legal context of the Essential requirements). A 1996 proposal by the European Commission to introduce a conformity assessment procedure and a marking requirement[157]

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[155] Council Resolution of 7 May 1985 on a new approach to technical harmonization and standards, Official Journal C 136 , 04/06/1985 p. 0001 - 0009

[156] 93/465/EEC: Council Decision of 22 July 1993 concerning the modules for the various phases of the conformity assessment procedures and the rules for the affixing and use of the CE conformity marking, which are intended to be used in the technical harmonization directives Official Journal L 220 , 30/08/1993 p. 0023 – 0039

[157] COM(96)191 final, withdrawn on 6 August 2004 by COM(2004)542.

was not pursued further by Council and therefore was withdrawn by the Commission in 2004. As outlined below, systematic market surveillance is done only in a few Member States.

The legal framework of the essential requirements and the New Approach is addressed in more detail in Annex 6: Legal context of the Essential requirements

2.3.1.2 Structure of the chapter

The essential requirements form the heart of a New Approach Directive. Compliance with the Directive is reached through compliance with the essential requirements. The procedures for assessing conformity are inseparable from the essential requirements and will therefore also be addressed in this chapter.

When assessing the essential requirements in the context of packaging prevention it is necessary to look separately at the essential requirements as such (definition in the directive and their implementation) and the conformity assessment. Therefore, the assessment in the context of the evaluation of the Packaging and Packaging Waste Directive is split up in two different phases.

The evaluation of the essential requirements will be addressed in two parts:

- Evaluation of the implementation of the current essential requirements (2.3.1.2)
- Evaluation of the pertinence of the existing essential requirements to protect public interest and in particular environmental interest (2.3.3)

The evaluation of the conformity assessment is closely linked to the development of harmonised European standards. Therefore, this evaluation will be addressed through the following issues:

- Evaluation of the standardisation process (2.3.5)
- Evaluation of the conformity assessment (2.3.6) – including possible integration of packaging environmental indicators and prevention plans

2.3.2 Implementation of the current essential requirements in the Member States

2.3.2.1 Present implementation of the ER in the MS

The implementation of the Essential Requirements legislation in the Member States is achieved through the transposition of the Council Directive on Packaging and Packaging Waste into national legislation. The date for the implementation of the essential requirements according to the Directive 94/62/EC was 01/01/2000.

To support the implementation of the ER, the Commission has issued a mandate to CEN for the development of a number of harmonised standards and several reports.

2.3.2.2 Present enforcement of the ER in the Member States

GENERAL

Under a New Approach Directive, the Member States have the obligation to ensure that the essential requirements are fulfilled. In the absence of a conformity assessment procedure, there is no requirement to do this in a particular way. If there is no packaging which does not fulfil the essential requirements, Member States have fulfilled their task. So far, no complaints have been brought to the European Commission that a Member State has not enforced the essential requirements by allowing packaging on their market which does not fulful the essential requirements.

Only two of the out of fifteen old Member States (EU-15) have set up a specific market surveillance system (France and the UK). Therefore, any effect of the essential requirements system to improve the environmental performance of packaging is likely to be the result of business internal decisions rather than of pressure by enforcement authorities in these countries. Therefore careful attention should be made in the evaluation of the effectiveness of the present ER since this can only be assessed in a situation of an effective enforcement of the ER in all the Member States of the EU-25.

The description of the existing implementation of the Essential Requirements and market surveillance systems in the UK and in France are presented in Annex 7: Description of the Existing Essential Requirement Regulations and Market Surveillance Systems.

EVALUATION OF THE IMPACT ON PACKAGING WASTE

To evaluate the environmental benefit of the current implementation is based on the evaluation of the packaging waste prevention effect of the current essential requirements. To assess this effect, the evolution of GDP and packaging waste generation (1997-2001) were plotted against each other for each of the countries with regular market surveillance and the average of all other Member States

In the UK and France, the ER were enforced in 1998. When comparing the GDP and packaging waste generation index of both countries for successive years (1997-2001), it shows that there is some decoupling of the generation of packaging waste from the evolution of the GDP in the UK. The trend is similar to the rest of EU15 but stronger in the UK. It is also comparable to the developments observed in Belgium and Spain where packaging prevention plans are used.

Based on the available data it is not possible to identify the cause of the waste prevention in the different Member States and therefore it is not possible to identify the effect of the ER nor of the market surveillance systems in place.

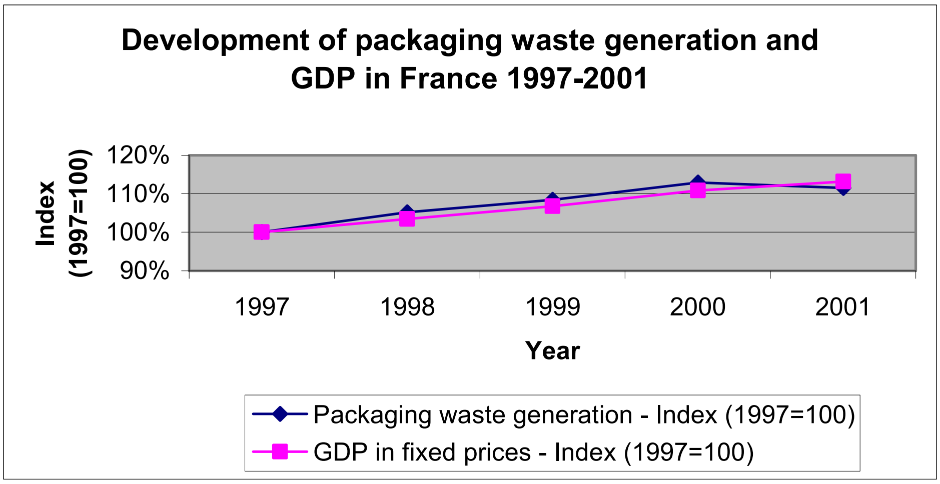

Figure 89: Development of packaging waste generation and GDP in France, 1997 – 2001

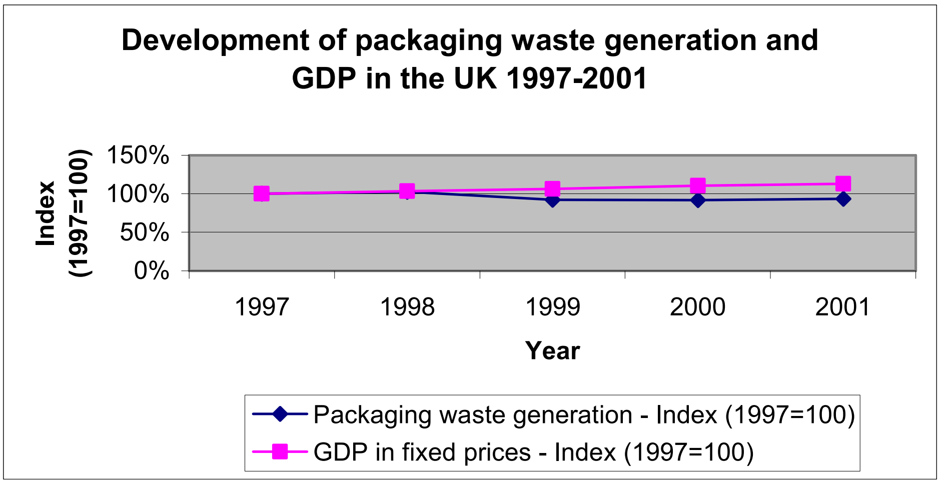

Figure 90: Development of packaging waste generation and GDP in the UK, 1997 – 2001

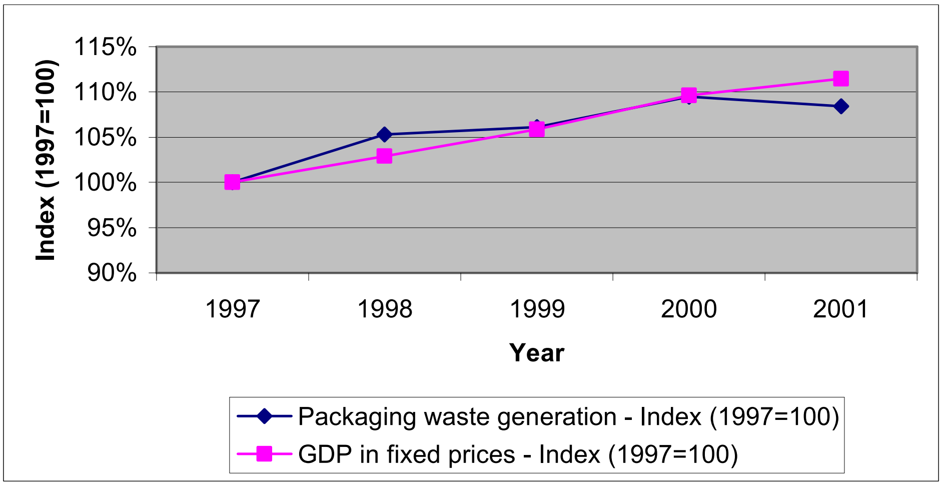

Figure 91: Development of packaging waste generation and GDP in the EU-15, 1997 – 2001

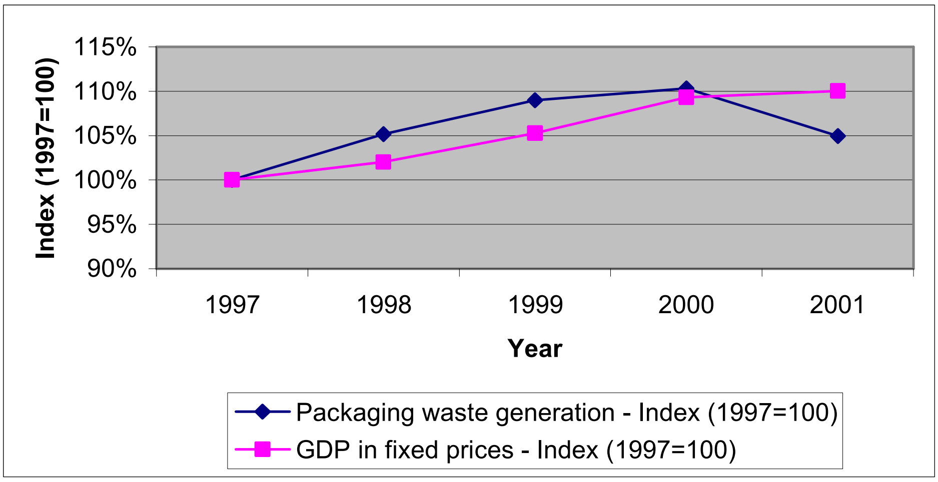

Figure 92: Development of packaging waste generation and GDP in Belgium, 1997 – 2001

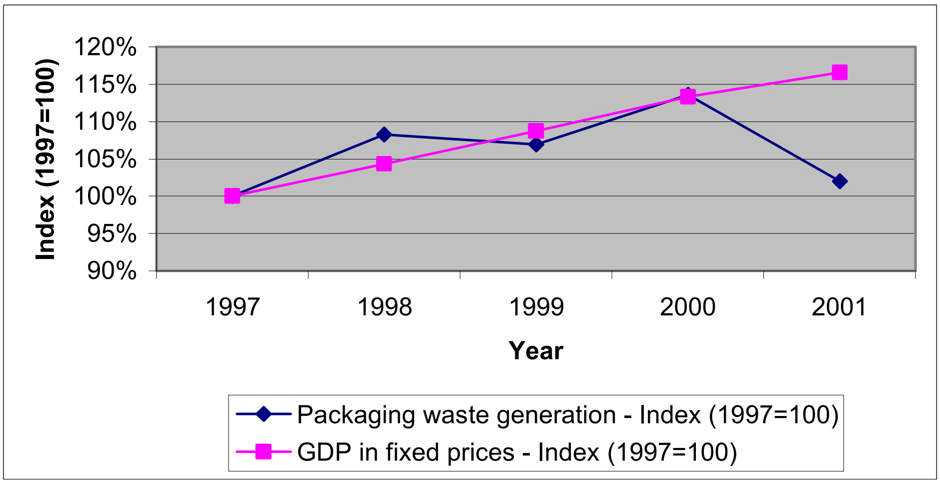

Figure 93: Development of packaging waste generation and GDP in Spain, 1997 – 2001

2.3.3 Evaluation of the pertinence of the existing essential requirements to protect public interest and in particular environmental interest

The assessment of the pertinence of the essential requirements consists especially of the evaluation whether the present essential requirements have a meaning for the environmental performance of packaging. From this point a distinction can be made between the at source prevention of the amount of packaging and the minimisation of dangerous substances in packaging at one side and the other essential requirements at the other side.

For the first two essential requirements, it is accepted that when applied they have an environmental interest since they are aimed at decreasing the pressure on the environment.

It is less evident whether the essential requirements that a packaging should be re-usable, recyclable or recoverable in the form of energy recovery have any meaning for the environmental performance of packaging. As it is unclear which packaging would not fulfil either of these requirements or whether such packaging would be necessarily worse for the environment in a life cycle perspective, this question cannot be answered conclusively.

To assess whether the present essential requirements are sufficient to protect the environmental interest, a complete environmental analysis of the packaging industry should be performed (from cradle to grave). The tendency is to assess packaging more and more through life cycle analysis to assess the real environmental and economic impacts (or benefit) of the different essential requirements on different packagings and in different regional settings.

At present, the environmental NGO's claim that the essential requirements are not sufficient to protect environmental interest. However, to be able to make a conclusion on this point, it is necessary to perform a correct calculation of the environmental impact of different kinds of packagings including differentiation between packaging materials, transport distances, etc..

2.3.4 Suitability of the New Approach technique in the context of packaging prevention

The question can be formulated as follows:

- "Is the New Approach technique of setting forward essential requirements suitable for the protection of the public interest in the context of the Packaging prevention?" or
- "Is it possible to protect public interest in the context of packaging prevention through a technique which is restricted to establishing the essential requirements that packaging must meet?"

Directive 94/62/EC aims to harmonise national measures concerning packaging and packaging waste with two objectives:

- Achieving a high level of environmental protection (minimisation of the impact of the packaging on the environment)
- Ensuring the functioning of the internal market (Packaging is an intrinsic product of the single market)

2.3.4.1 Single market context

The assessment of the new approach technique is linked to the fact that packaging has to be able to continue its role in the single market. This means that evolution of the packaging is necessary and especially with regard of the materials used. Through the establishment of the ER, the innovation of packaging is made possible to a very large extent.

The packaging industry claims that the essential requirements technique is a very good one for the regulation of the management of packaging and packaging waste with the aim to protect the environment. In general it agrees that more accurate market surveillance systems should be established within the context of the present Directive. At least parts of industry seem however reluctant towards setting up a harmonised conformity assessment procedure.

2.3.4.2 Environmental context

Directive 94/62/EC was established with the aim to minimise the environmental impact of packaging without distorting the functioning of the market.

Milieu Ltd concluded in their evaluation of the setting of product standards[158] that it is generally accepted that the task of drafting good essential requirements is made easier when the product group under consideration is:

- well defined and shares common elements that give rise to concern and
- intended to be used by industrial and professional users under limited, well defined conditions, rather than when the product group is used by a much wider target group including consumers and under many different conditions

Therefore, drafting clear essential requirements will not be easy for packaging, which does not comply with these two constraints. This will also be reflected in a difficulty to establish a clear distinction between acceptable and non-acceptable packaging in standards developed in this context. Therefore, the establishment of management standards as done by CEN is probably the best feasible approach,

[158] The New Approach in Setting Product Standards for Safety, Environmental Protection and Human Health: Directions for the future; Milieu Ltd, 2001 (Discussion Paper for Session II, Workshop on the New Approach, Copenhagen, 29-30 Nov. 2001) http://www.mst.dk/udgiv/publications/2002/87 7972-191-5/html/kap03_eng.htm#

although it may not satisfy those who expect clear rules to eliminate certain types and applications of packaging.

2.3.4.3 Conclusion

The experience with the ER of the packaging and packaging waste directive is rather limited since in most countries there is very limited enforcement and no market surveillance systems are in place (except for France and the UK). Therefore the present data concerning the environmental impact of packaging on the environment can not be used to make a full assessment of the New Approach as it is used in the Directive. It is recommended to enhance the market surveillance throughout the EU-25 during the coming years and to evaluate the residual environmental impact of the packaging and packaging waste based on more accurate data.

2.3.5 Evaluation of the existing standardisation process

The development in the legal and political framework concerning the standardisation process is presented in Annex 8: Standardisation: development of legal / political framework and process of development and adoption of the standards. Also the description of the process of development and adoption of the standards for packaging are addressed in it.

2.3.5.1 Product standards versus management standards

The standards developed by CEN are based on an approach similar to En ISO 9000 and EN ISO 14001. They do not give any requirements for individual packaging items (no thresholds or quantitative criteria).

The suitability of this kind of standards is contested by the environmental NGO's who claim that they cannot provide technical solutions on how to comply with the essential requirements of the Directive.

The standards developed by CEN (2000) were assessed by the EEB in the study "CEN at work: How the requirements of the European packaging and packaging waste directive (94/62) are bypassed by CEN standards"[(159)]. The analyses performed in the study "CEN at work"[(159)], concludes that the standards developed by CEN are not consistent with the general requirements of the Directive.

The industry on the other hand is very much in favour of the self-control system as it was developed in the CEN standards. The main reason consists of the high financial cost for the industry of other potential standardisation and conformity assessment systems.

2.3.5.2 Stakeholder involvement

During the development of the CEN standards under the second mandate, the stakeholder involvement was much more integrated in the process. Through ECOS, it was possible for the environmental NGO's to participate in this standardisation process. However during the revision of the standards, the environmental NGOs did not acitively participate in the process. This is to a large extent due to the fact that the environmental NGOs are not in favour of the system of the essential requirements and of the approach chosen by CEN (management standards).

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[159] CEN at work: How the requirements of the European packaging and packaging waste directive (94/62) are bypassed by CEN standards, A legal analysis for The European Environmental Bureau (EEB) by Susanna Paleari (EEB Publication 2000/15)

2.3.6 Conformity assessment and marking

2.3.6.1 Current situation

The current legal situation and existing conformity assessment systems are presented in Annex 9: Conformity assessment procedures: current situation.

2.3.6.2 Conformity assessment procedure proposal for Directive 94/62/EC

The following conformity assessment procedures were evaluated by our team:

INTERNAL CONTROL PROCEDURE

The internal control procedure without incorporation in a quality system is a conformity assessment with limited control on the conformity of the products with the relevant ER. The notified body has to control on basis of the technical documentation provided for by the manufacturer. The manufacturer issues the certificate of conformity. The system is very flexible for the industry. It asks for a close cooperation between the packaging industry and the notified body. The assessment of the conformity asks for a specific know-how of the authorities of the different packaging industries. Therefore it is very difficult for the notified body to assess the conformity.

USE OF QUALITY SYSTEM (SUCH AS ISO 9001 / ISO 9002 / ISO 9003)

A manufacturer is given the possibility of using an approved quality system for the purpose of demonstrating compliance with the ER. The manufacturer issues the certificate of conformity.

Two distinct groups of procedures can be defined:

- third party examines/controls the manufacturers' internal production control activities,
- third party type or design examination combined with third party approval of product or production quality assurance systems, or third party product verification

An example of the first option is the procedure established at Tetra Pak:

> At Tetra Pak the CEN conformity assessment is part of the ISO 14001 certification. The CEN standards are integrated in the "innovation process" which describes how products are developed and/or improved. CEN standards are linked to the design for the environment program, also including internal LCA's for all new products put on the market. The sites working with these tools are than certified under ISO 14001. The information is included in the documentation / audit report provided by the ISO certification body.

This system is perceived by the industry as very flexible due to the fact that the design and production can be managed in-house and that no approval of the notified body is necessary. Due to the fact that external control of the system is performed through the certification of the quality system, the industry claims that the system can deliver a sufficient confidence as regards to conformity of products to the relevant essential requirements.

The second option is more reliable from the environmental perspective since the design is controlled and needs to be certified. It is perceived by the packaging industry as less flexible since an administrative procedure has to take place before innovation is possible.

UNIT VERIFICATION OF DESIGN AND PRODUCTION

Each individual packaging is examined by a notified body, which issues a certificate of conformity. This means that all the innovation of packaging will be slowed down due to the administrative cycle of control of the design and production process. Following the principle of proportionality, this may be over-burdensome for a product such as packaging. Therefore it is not advisable in the context of packaging.

THIRD PARTY APPROVAL OF FULL QUALITY ASSURANCE SYSTEMS

This procedure being more stringent than the unit verification is not a suitable option from economical point of view for the packaging industry.

CONCLUSION

At present, the internal control procedure is the most applied conformity assessment procedure. From the point of view of the control of compliance however, it is not a suitable system since no active control of the notified body is foreseen which makes the actual enforcement of the ER very difficult.

The use of a quality system such as ISO 9001 / ISO 9002 / ISO 9003 is perceived by the large industrial companies as the most suitable conformity assessment procedure. This system allows the industry to provide the necessary information to prove compliance with the ER through as quality system that is controlled by a third party. To assure the possibility of a real compliance control, the quality system should at least include a conformity assessment in the design phase and in the production phase. For the smaller companies, such a quality system can be rather expensive.

The option of implementing a unit verification of design and production system or a third party approval of full quality assurance systems are assessed to by the packaging sector as being not flexible enough. Packagings are products, which are generally redesigned at least each five years and therefore it is claimed not to be feasible to go through a unit verification system or third party approval of full quality assurance system for each packaging put on the market. From environmental point of view, these systems are however seen as the most reliable systems for conformity assessment.

COST FOR IMPLEMENTATION OF THE ESSENTIAL REQUIREMENTS FOR THE PACKAGING INDUSTRY

The implementation of the prevention aspects of the essential requirements is estimated to have little cost implications for the packaging industry (EUROPEN). This is due to the fact that a minimisation of packaging has been established for economic reasons in the first place and not as a result of the ER.

Costs implications assessed by EUROPEN are as follows:

- £150 000/company/ year for a company assuming to have a range of 500 products (SKUs) with 4 items of packaging associated with each SKU (2 000 packaging items) and assumingthat only 20% (100 SKUs) change in any given year.
- £600 000/company/ year for the same company that would have develop dossiers for its entire range of packaging

2.4 TASK 2.D: PACKAGING PREVENTION – HEAVY METALS AND OTHER HAZARDOUS SUBSTANCES

2.4.1 Definition and background

The aim of this chapter is to assess possible options to reduce the environmental impacts of packaging as regards the presence of noxious and other hazardous substances and materials in packaging.

The assessment is focused on the four heavy metals (lead, cadmium, mercury and hexavalent chromium) which are the subject of article 11 of Directive 94/62/EC and of which the sum of concentration levels in packaging or packaging components shall not exceed 100 ppm by weight.

The present concentration levels in Packaging are investigated with special attention to the packaging of which the concentration levels are above 10 ppm. All food-contact packaging is excluded from this assessment since they fall under more stringent regulations than Directive 94/62/EC.

The legal context of heavy metals and other hazardous substances in packaging is addressed in Annex 10: Legal context Heavy metals and dangerous substances.

2.4.2 Implementation of article 11 of Directive 94/62/EC in the Member States

The enforcement legislation for article 11 of Directive 94/62/EC in the Member states (EU-15) was established in the report "Heavy metals in Packaging on the Belgian Market"[(160)]. The overview is presented in Annex 11: implementation in the member states of article 11 of Directive 94/62/EC.

2.4.3 Present concentration levels of the four metals of article 11 in packaging (Lead, Cadmium, Mercury and Hexavalent chromium)

The four heavy metals mentioned in Article 11.1 of Directive 94/62/EC on packaging and packaging waste are: Lead (Pb), Cadmium (Cd), Mercury (Hg) and Hexavalent chromium (Cr^{VI}). Hereunder the term heavy metals will be used for the above mentioned four heavy metals.
The present concentration levels of these four heavy metals were assessed on the basis of four existing packaging surveys:

- CEN report CR 13695-1[(161)]
- Heavy metals and recycling of Glass, EC[(162)]
- Survey of the Content of Heavy Metal in Packaging on the Danish Market[(163, 164, 165)], **DEPA**
- Heavy metals in packaging on the Belgian Market[(166)]

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[160] Heavy Metals in Packaging on the Belgian Market, N.De Brucker et al., 2001 commissioned by the Belgian Federal Department of Environment
[161] CEN report CR 13695-1: Requirements for measuring and verifying the four heavy metals and other dangerous substances present in packaging and their release in the environment - Part 1 : requirements for measuring and verifying the four heavy metals present in packaging
[162] Heavy metals and recycling of Glass, Proyectos Medio Ambientales S.A., april 1999, commissioned by European Commission DG XI – E3
[163] Survey of Content of Heavy Metal in Packaging on the Danish Market, Environmental Project No. 349, DEPA 1997
[164] Heavy Metals in Packagings Check Analyses – 1998, Arbejdsrapport fra Miljøstyrelsen no. 3, DEPA 2000
[165] Heavy Metals in Packagings Check Analyses – 1999, Arbejdsrapport fra Miljøstyrelsen no. 8 DEPA 2000
[166] Heavy metals in packaging on the Belgian Market, VITO, 2001 (Commissioned by Belgian Federal Department of the Environment)

The overview of the surveys as is presented in Annex 12: overview of Surveys on heavy metals in packaging evaluated.

2.4.3.1 Glass packaging

UNDECORATED GLASS PACKAGING

Mercury (Hg) and Cadmium (Cd)

All the studies point out that mercury (Hg) and Cadmium (Cd) are only present in minor levels in undecorated glass containers and most often they could not be measured using standard detection methods. In the packaging survey for the Belgian market(166), 4 glass samples of different colours (blue, brown, green, clear) were analysed using the ICP-AES technique (method sensitive to low concentrations. Levels of Cd between 2,5 ppm and < 0,5 ppm were detected. The Hg levels were under the detection limits of 0,1 and 0,2 ppm. The assessments of the Danish EPA(164,165,163) are consistent with the above mentioned results. Hg and Cd were measured using double determinations by X-ray technique. The levels of Hg and Cd were below the detection limit of 10 ppm for all samples.

Chromium Cr^{total}, Cr^{III} and Cr^{VI}

Trivalent chromium (Cr^{III}) is added intentionally during the container manufacturing process to obtain the green colour. This results in high levels of total Cr in coloured and especially in green glass.

In the study "Heavy metals and recycling of Glass"(167), it is estimated that levels up to 3000 ppm are present into green glass. Although no tests were performed on the distribution between trivalent and hexavalent Cr, it was estimated that Cr^{VI} produced due to oxidation-reduction conditions in the furnace does not surpass 10 ppm. The measurements performed in the DEPA surveys pointed out that the concentrations of total Cr are in the following ranges: 40-1800 ppm for 1997, 29-2200 ppm for 1998 and 16-3300 ppm for 1999. It was estimated (without performing scientific measurements) that the fraction of hexavalent Chromium is only a minor fraction of the total Chromium fraction in coloured glass and that therefore their concentration level is low.

The packaging survey for the Belgian market(168) , was based on the knowledge of the former surveys and for a set of critical packagings it was decided to provide for a more complete assessment of Chromium and its distribution between trivalent and hexavalent Chromium. For clear glass, the Cr level was below the detection limit (WD-XRF technique). The total levels of Cr in brown glass sometimes contain more than 100 ppm. The total levels of Cr in green glass are comparable to the former studies namely between 340 and 2640 ppm. The results of the Cr^{VI} determination (IC-DPC and SIDMS) reveal that all samples have Cr^{VI} levels lower than 6 ppm.

These measurements provide prove for the assumption (made in the DEPA surveys and the Proymassa study that the production of hexavalent Cr out of trivalent Cr in glass in the furnaces is very low. It can be concluded that the Cr^{VI} in glass are not critical and are below 6 ppm.

Lead (Pb)

Lead (Pb) is the only one of the four heavy metals in significantly high concentrations in undecorated glass containers, this is linked to the glass recycling process. The lead impurities in glass **originate** from two sources: the separable impurities and the non-separable impurities in glass cullet from separate

167 Heavy metals and recycling of Glass, Proyectos Medio Ambientales S.A., april 1999
168 Heavy metals in packaging on the Belgian Market, VITO, 2001

collection. The separable impurities consist of ceramics, porcelain, stones, lead wrappers from old wine bottles (banned since 1993).etc. They can be removed to a large extend by using metal separation (magnetic and induction). The non-separable impurities origin from: Pb bearing glass cullet (recycled glass, lead crystal, automobile window glass, mirrors, TV and computer screens, etc.), glass decorated with enamel (as a melting agent – contribution estimated at 4 ppm through recycling chain), filter dust, fuel oil, inseparable impurities from the glazing industry (up to 25% PbO) The only method to reduce these impurities is to prevent them from entering in the recycling chain (citizen awareness-raising or alternative recycling circuits). For *example: If a 330 gram crystal ashtray enters the recycling chain, a 1 tonne batch of cullet, will have a lead content of 100 ppm. If 1 tonne batch contains 1,75 kg of crystal, the batch will have a lead content in excess of 525 ppm.*[169]. It will, however, not be possible to eliminate lead, which is already in the recycling chain, by any other method than reducing glass recycling.

In the survey Heavy metals and recycling of Glass[169], average lead concentrations in undecorated glass containers were found in the range of 40 to 349 ppm. The link between the Pb concentrations and the recycling chain was investigated in the EU-15. It was concluded that in countries with a recycling rate above 45%, lead concentrations above 100 ppm are common.

Table 66: Container glass recycling rate and Pb concentrations in container glass[169]

Country	*% Recycled*	*Pb Concentration (ppm)*	*Number of samples*
Austria	78	215	>200
Denmark	63	120	52
Finland	50	40	6
France	50	160	>300
Germany	75	165	> 1000
UK	27	72	69
Ireland	39	42	11
Italy	53	349	22
The Netherlands	80	130	> 20
Sweden	61	100	52

Some recycling plants are able to produce glass containing only 50 mg/kg of lead using exclusively internal cullet, but there are also circumstances related to the use of foreign cullet and to process management, where peaks of 1000 mg/kg Pb may occur without any chance of intervention and control.

In the Danish EPA survey of 1997[170], the lead concentration levels in various glass container types with different colours (clear, green, brown, with/without print) was assessed. From the 13 samples, 3 containers had a Pb level higher than 100 ppm. For the evaluation in 1998[171] and 1999[172], respectively 49 and 50 wine bottles with an optimal spreading concerning the origin were purchased. The testing results show that the present threshold of 100 ppm is exceeded in 35 cases (71%) in 1998 and in 38 cases (76%) in 1999 by the lead content only. All the wine bottles have a lead content higher than 10ppm (the minimum measurement amounted to 26 ppm in 1998 and to 27ppm in 1999).

CEN Report CR 13695-1[173] concludes that at a low recycling rate (30%) Pb-concentrations below 100 ppm can be obtained compared to 100-250 ppm or more at higher recycling rates. The study on heavy metals in Packaging on the Belgian Market[174], concluded that the average value of Pb present in glass packaging in Western Europe can be estimated between 150 and 300 ppm.

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169 Heavy metals and recycling of Glass, Proyectos Medio Ambientales S.A., april 1999
170 Survey of the Content of Heavy Metal in Packaging on the Danish Market, EP No. 349, DEPA, 1997
171 Heavy Metals in Packagings Check Analyses – 1998, AfM no. 3, DEPA, 2000
172 Heavy Metals in Packagings Check Analyses – 1999, AfM no. 8, DEPA, 2000
173 CEN Report CR13695-1
174 Heavy metals in packaging on the Belgian Market, VITO, 2001

Table 67: Lead measurements in container glass available on Belgian Market(174)

Container colour	# samples	# samples with Pb levels > 100 ppm	Pb levels < 100 ppm	Pb levels > 100 ppm
Undecorated				
Clear	18	4	<15 – 80	110 – 130
Brown	10	2	<12 - 93	110 – 130
Green	16	9	<10 - 91	110 – 347
Blue	1	1	-	167 (ICP-AES)
Decorated glass	10	7	<33 – 85	448 – 8840

Total Heavy metal content – Cd, Cr, Hg, Pb

A detailed overview of the heavy metal concentrations in different glass container colours in different Member States of the EU-15 according to the different studies assessed is presented in Annex 12.

Derogation for undecorated glass packaging

Due to the importance of the existing recycling targets and taking into account the time frame needed for the adaptation of recycling processes, the EC adopted a derogation on glass packaging(175). It allows the exceeding of the 100 ppm limit by weight after 30/06/2001. However, the exceedance may only be caused as the result of the addition of recycled materials and not due to intentionally introduced heavy metals during the manufacturing (Article 4). It also includes the control of the individual glass furnaces (Article 5). The decision shall expire on 30/06/2006, unless extended (Article 6).

DECORATED GLASS

In the study on heavy metals in Packaging on the Belgian Market(174), decorated glass is divided into 3 different types: multi-trip bottles, one-trip bottles and decorated tableware. The amount of decorated glass represents less than 1% of the total container glass production. During the manufacturing of decorated glass, the enamels become part of the glass matrix. These chemically stabilised enamels can not be separated form the glass container and are thus to be considered as a single packaging component. (colouring). Two heavy metals are used in enamels: lead and cadmium. Lead is included in the formulation of frits (basic glass, main constituent of the enamel) and is strictly needed to give fundamental properties to enamels. Cadmium is used in red and yellow pigments, as CdSSe and CdS.

The literature consulted for the critical analysis of packaging on the Belgian market(176) pointed out that the concentration levels differ in the range of 40 to 4000 mg/kg from container to container dependent on the decorations and containers. Lead is the main part of heavy metal employed (more than 90%). The measurements showed in 70% of the cases (7 samples out of 10) high Pb and Cd levels. Lead levels vary between <33 and 8840 ppm and Cd levels between <18 and 1470 ppm.

The conclusions of the CEN Report CR 13695-1(177), state that the decorated glass impurity has a minor impact on the recycling process (due to very low quantities). For the environmental impact it is estimated that the leaching is undetectable and the emissions resulting from incineration are very low.

175 Commission Decision 2001/171/EC of 19 February 2001 establishing the conditions for a derogation for glass packaging in relation to the heavy metal concentration levels established in Directive 94/62/EC
176 Heavy metals in packaging on the Belgian Market, VITO, 2001
177 CEN Report CR13695-1

LEAD CRYSTAL

Lead crystal contains high levels of lead oxide which is one of it's essential constituents (24% or 30% for full lead crystal). The other heavy metals (Cd, Hg and Cr^{VI}) are not used. The manufacturing and use of crystal glass is regulated in Council Directive 1969/493/EEC(178). Packaging is not the main function served by crystal packaging. It is a luxury packaging and kept by the consumer. Therefore they do not contribute to common packaging waste stream although they can give rise to problems during the recycling process.

2.4.3.2 Plastic packaging

Heavy metals are not an essential constituent of plastic materials their presence in plastics are mostly linked to the colouring of the plastic. The packaging covered by Directive 94/62/EC are mainly transport packagings: crates, pallets, coloured nets, plastic shopping bags, non-food containers (bottles and other), etc.

Crates and pallets

The CEN Report CR 13695-1(177) states that crates and pallets manufactured after 1994 do not contain colorants on Cadmium basis. The levels of the other heavy metal (Cr, Pb and Hg) is stated to be lower than 10 ppm each in all crates and pallets.

CRATES

The Danish EPA survey of 1997(179), assessed 15 different crates for beverages and bottles with a variety of colours (green, orange, red, brown). Hg levels were for all the samples below the detection limit. Cd levels between 200 and 1300 ppm were found in 4 red crates. It was estimated that the samples dated from before 1980 and therefore were not in violation with the Directive 94/62/EC. Pb concentrations higher than 100 ppm were found in 4 cases (linked to the colours red, orange and green). Cr levels higher than 100 ppm were measured in 6 samples. It was assumed (based on the colours of the crates – red and orange) that some of the high concentrations could be Cr^{VI}.

In the Belgian packaging market analysis(180) 21 household packaging crates were assessed on their heavy metal contents. The results are shown in the table below.

Table 68: Heavy metal concentrations in crates on the market in Belgium(180)

	Hg	*Cd*	*Cr (Cr^{total} and Cr^{VI})*	*Pb*
• **samples with level >100 ppm**				
Number of samples	0	9	Cr^{total}: 4 Cr^{VI}: 0	4
Concentration levels (ppm)	-	236 – 3820	Cr^{total}: 444 – 117	107 – 287
Colours	-	black, light brown, light green, orange, red, yellow	Black, dark green, orange/green	Black, Dark blue, Light brown, Orange/green
• **samples with levels higher than detection limit and <**				

178 CD 69/493/EEC of 15/12/1969 on approximation of laws of the MS relating to crystal glass OJ L326, 29/12/1969
179 Survey of the Content of Heavy Metal in Packaging on the Danish Market, EP No. 349, DEPA, 1997
180 Heavy metals in packaging on the Belgian Market, VITO, 2001

100 ppm				
Number of samples	1	4	Cr^{total}: 4 Cr^{VI}: 0	6
Concentration levels (ppm)	1,1	32-90	Cr^{total}: 25 65 Cr^{VI}: -	89 – 4,1
Colours	-	Dark brown, Dark green, Light blue (90ppm)	Dark blue, Dark green, Light brown, Orange/green, Red,Yellow	Black, Dark brown, Dark green, Orange,Red

The results confirm the assumptions of the CEN Report CR 13695-1(181) and of the DEPA packaging survey(182) that high levels of Pb, Cd and Cr in crates are due to colouring agents and that the levels of Hg and Cr^{VI} are negligible.

However, based on the available information, it is not possible to assess the compliance of the crates with article 4 and 5 of the derogation for plastic crates and pallets (Decision 1999/177/EC(179)) since no information is available on the use of secondary raw materials in the tested crates.

PALLETS

DEPA packaging survey performed in 1997(182), sampled 7 pallets. Hg concentrations were below the detection limit except for one sample (1,8 ppm). Cd levels were all above 100 ppm and 1 pallet had Pb concentration above 100 ppm. In the Belgian packaging market analysis(180) 10 pallets (industrial packaging) were assessed for their heavy metal content. The results of the survey are summarised in the table below. The results differ from the DEPA study especially in Cd contents measured.

Based on the available information, it is not possible to assess the compliance of the crates with article 4 and 5 of the derogation for plastic crates and pallets as provided for in Decision 1999/177/EC(183) since no information is available on the use of secondary raw materials in the tested pallets.

Table 69: Heavy metal concentrations in pallets on the market in Belgium(184)

	Hg	***Cd***	***Cr*** ***(Cr^{total} and Cr^{VI})***	***Pb***	***Total heavy metal content***
• **samples with level >100 ppm**					
Number of samples	0	0	Cr^{total}: 2, Cr^{VI}: 0	0	3
Concentration levels (ppm)	-	-	Cr^{total}: 5988 – 115	-	
Colours	-	-	Green, blue	-	Green, blue, grey
• **samples with levels higher than DL and < 100 ppm**					
Number of samples	1		Cr^{total}: 4 Cr^{VI}: 0	3	3
Concentration levels (ppm)	1,13		Cr^{total}: 12 – 16	52 – 87	68-82 (minimum)
Colours	Grey		Black, grey	Grey, black	Grey, black

181 CEN Report CR13695-1
182 Survey of the Content of Heavy Metal in Packaging on the Danish Market, EP No. 349, DEPA, 1997
183 Commission Decision 1999/177/EC of 8 February 1999 establishing the conditions for a derogation for plastic crates and plastic pallets in relation to the heavy metal concentration levels established in Directive 94/62/EC
184 Heavy metals in packaging on the Belgian Market, VITO, 2001

Other plastic packaging (to which the derogation of Decision 1999/177/EC does not apply)

In 1989, the German Bundesministerium für Forschung und Technologie evaluated heavy metal contents in different plastic packagings for(185). The high heavy metals present in the different packaging materials are presented in the table below.

Table 70: Heavy metal concentrations in packaging on the German Market in 1989(185)

	Cd	*Cr$^{(VI)}$*	*Hg*	*Pb*
Coloured nets		X		X
Yellow-red PE foils		X		X
Plastic bags (Gold, Yellow, Orange, Red, Green)		X		X
Caps (Yellow, Orange, Red, Green)	X			
Non-food bottles				
Yellow	X			X
Orange	X	X		X
Green	X			
Food packaging, nets, PET bottles (red)	X	X		X

Packaging nets were assessed in 1998 by the Austrian Consumer Association VKI[186] and in 1999 nets in 6 European countries were assessed on their heavy metal content(187). It was concluded that for the production of packaging nets, heavy metal pigments based on lead and hexavalent chromium were still used. The results from the above mentioned surveys are presented in the table below.

Table 71: Heavy metals in packaging nets assessed in Austria and 5 other Member States(187)

Monitoring moment	Number of nets evaluated	Nets with total heavy metals above 250 ppm	%	Concentration levels for Cd, Hg Cr^{VI} and Pb (ppm)
Austria 02/1998	*12*	*6*	*50,0%*	*Between 2963 and 14709 ppm*
Austria 05/1998	*15*	*14*	*93,3%*	*Between 1650 and 19154 ppm (average 9513 ppm)*
Austria 08/1998	*36*	*15*	*41,7%*	*Between 3507 and 26049 ppm (average 13256 ppm)*
Belgium 1999	*52*	*7 (2 yellow nets and 5 orange nets)*	*13,5 %*	*Between 2297 and 17407 ppm (Average 9094 ppm)*
Austria, Italy, Belgium, Ireland, Portugal and Spain	*300*	*30*	*10,0%*	*Between 268 and 22186 ppm (average 8753 ppm) Hg < 10 ppm Cd < 10 ppm*
Yellow	*79*	*8*	*10,1 %*	*Cr < 50 ppm in 271 samples / 9 other up to 17840 ppm*
Orange	*73*	*19*	*26,0%*	
Red	*123*	*3*	*2,4%*	*Pb < 50 ppm in 254 samples / 55 other samples up to 17840 ppm*

DEPA(188) assessed the heavy metal contents in the following plastic packagings: PE, PP, PVC, PS, EPS, PET and (PA, EVOH, PC). The assessment was split-up between non-reusable virgin plastic, reusable

185 Brahms, Eder, Greiner (1989), Papier-Kunststoff-Verpackungen, Eine Mengen und Schadstoffbetrachtung, Berlin.
186 Verein für Konsumenteninformation
187 K. Brunnhofer, B. Beck, H. Sedy (1999), Schwermetalle in Lebensmittelverpackungen (Project 1999/10487), Bericht für die Kommission der Europäischen Gemeinschaften, VKI (Verein für Konsumenteninformation), Wien.
188 Survey of the Content of Heavy Metal in Packaging on the Danish Market, EP No. 349, DEPA, 1997

plastic packaging, returnable plastic packaging (crates for beverages and bottles) and returnable plastic packaging (pallets). The results are shown in the table below.

Table 72: Heavy metals in plastic packaging on the Danish Market in ppm (188)

	Hg	*Cd*	*Pb*	*Cr**
Non-reusable virgin plastic (32 samples)	< DL	< 3	< 10 (exception for 2 samples: between 10 and < 100)	For 2 samples > 100 (green colour)
Reusable plastic packaging (9 samples)	< DL	< 4	2 samples > 100	1 sample Cr^{III} > 100 (colour green) 2 samples Cr^{VI} > 100 (PP red and box with red print)
Returnable plastic packaging (crates for beverages and bottles) (15 samples)	< DL	4 red crates: levels between 200 and 1300 (production date before 1980)	4 samples > 100 (red, green and orange)	6 samples > 100 (uncertainty concerning the Cr^{VI} content – red and orange crates)
Returnable plastic packaging (pallets). (7 samples)	< DL except one sample: 1,8	All samples > 100	< 100 except 1 sample (brown): 1400	5 samples: 100 to 400 (uncertainty concerning the Cr^{VI} content

*Note * : No distinction was made between Cr^{III} and Cr^{VI}. / DL: Detection Limit*

In the Belgian packaging market analysis(189) plastic packaging other than crates and pallets has been split up in HDPE household packaging, PET household packaging, other household packaging and industrial packaging different from crates and pallets.

Table 73: Heavy metals in plastic packaging different from pallets and crates on Belgian Market(189)

	Hg	*Cd*	*Pb*	*Cr*	*Cr^{VI}*	*Total*
HDPE household packaging (8 samples and 6 subsamples)	< DL	< DL	< DL (exc. 1 sample: 49 ppm)	< DL (exc. 3 samples: 72 ppm, 2ppm and 1,2 ppm)	-	< DL (exc. 4 samples) all< 100 ppm
PET household packaging (4 samples)	< DL	< DL	< DL	< DL	-	< DL
Other household packaging						
Nets (4 samples)	< DL	< DL	Orange: 1350 and 9870 ppm Red: 3 ppm Yellow: 664 ppm	Orange: 219 and 2520 ppm Red: 4,1 ppm Yellow: 154 ppm	Orange: 2,9 and 71 ppm Yellow: 8,5 ppm	3 samples > 100 ppm
Shopping bag (8 samples)	< DL	< DL	• 5 samples < DL • 3 yellow bags: 13280 – 16700 ppm	• 5 samples < DL • 3 yellow bags: 3860 – 3060 ppm	Assessed for 2 yellow bags: 13 and 22 ppm	• 5 samples < DL • yellow bags: >4000 ppm
Other (11 samples)	< DL	< DL	< DL	< DL	-	< DL

189 Heavy metals in packaging on the Belgian Market, VITO, 2001

	Hg	Cd	Pb	Cr	Cr^{VI}	Total
Covers (12 subsamples)	< DL	< DL	< DL (exc. 1 sample: 33 ppm)	< DL (exc. 2 samples: 9 ppm and 37 ppm)	-	< DL (exc. 2samples) all < 100 ppm
Industrial packaging different from crates and pallets (12 samples)	< DL	< DL	• 5 samples < DL • 7 samples between 9 and 4 ppm	< DL (exc. 1 sample: 8ppm)	-	Nearly always < DL

DL: Detection limit

The results are similar to the findings of DEPA(190) and of VKI(191). In general the plastic packaging different from crates and pallets does not contain levels of heavy metals above 100 ppm. However two critical packagings can be defined namely shopping bags (mostly yellow) and orange and yellow packaging nets. These packagings have Pb and total Cr levels above 100 ppm (between 664 and 16700 ppm(192)). Detailed analysis using IC-DPC and SIDMS pointed out that a small part of the Chromium is present under the form of hexavalent chromium. The levels measured are between 2,9 and 71 ppm(192).

2.4.3.3 Metal packaging

The **CEN Report CR 13695-1**(193), states that the use of lead solders in metal packagings has been discontinued and that pure tin soldered or welded side seams progressively displaced lead solders and that printing inks on metal packaging were once a potential source of heavy metal contamination. However, the suppliers of SEFEL(194) assure that current ink products for metal decoration processes do not contain added pigments or dryers based on Cd, Cr(VI), Hg or Pb other than small quantities of impurities resulting from manufacture under commercial industrial conditions."

Heavy metal contents in aluminium packaging were assessed as being approximately the following(193):

- Pb: between 10 and 80 ppm (depending on the origin of the raw and recycled materials)
- Cd, Hg < 10ppm
- CrIII: as alloying element or for surface treatment
- CrVI: not present

DEPA(190), analysed 62 samples of metal packagings consisting of plate, aluminium and steel packaging. The findings of the study were the following:

- Hg and Cd are always below the detection limit,
- Cr levels of about 100 ppm are present in Fe-based plates. It was assumed that it is metallic Cr.
- Pb levels between 3 and 87 ppm were found in Fe-based plates
- Soldering in non-food cans contains Cr levels > 600 ppm

A high content of Pb in soldered tins was detected by DEPA in 1997(195). During the follow up in 1998(196), soldered tins were scares (1 sample) and therefore also tins with rolled joints were analysed (2 samples).

190 Survey of the Content of Heavy Metal in Packaging on the Danish Market, EP 349, DEPA, 1997
191 K. Brunnhofer, B. Beck, H. Sedy (1999), Schwermetalle in Lebensmittelverpackungen (Project 1999/10487), Bericht für die Kommission der Europäischen Gemeinschaften, VKI (Verein für Konsumenteninformation), Wien.
192 Heavy metals in packaging on the Belgian Market, VITO, 2001
193 CEN Report CR13695-1
194 Secrétariat Européen des Fabricants d'Emballages Métalliques Légers
195 Survey of the Content of Heavy Metal in Packaging on the Danish Market, EP 349, DEPA, 1997
196 Heavy Metals in Packagings Check Analyses – 1998, AfM no. 3, DEPA, 2000

The total content of Cr, Cd and Hg were all below 10ppm. The Pb content in the soldered tin exceeded the 100ppm limit (150ppm), the Pn in tins with rolled joints exceeded 10 ppm (50ppm and 36ppm).

In the **Belgian packaging market analysis**(192) metal packagings have been split up aluminium household packaging, steel household packaging and metal industrial packaging. The results of the measurements for aluminium packaging, are similar to those of DEPA(195,196) and CEN(193). Pb levels are below 100 ppm and the Cr is only present in the trivalent form. Also the results for steel household packaging are comparable to the DEPA(195,196) and CEN(193) results. Cd and Hg are below the detection limits (except using IC-DPC and SIDMS analysis and then < 1 ppm). The total Cr amounts to concentrations above 100 ppm. However, those can be attributed to Cr(O) or Cr^{III} (proven through IC-DPC and SIDMS analysis for Cr^{VI}(190). High Pb contents in soldered tins were measured as they were in Denmark(195,196). Therefore, it can be concluded that lead-containing soldering is still used.

Table 74: Concentration of heavy metals in metal packaging on Belgian Market in ppm(192)

	Hg	*Cd*	*Pb*	*Cr^{total}*	*Cr^{VI}*
Aluminium household packaging (10 samples)	< DL (up to 18)	< DL (up to 54) (exc. 1 sample: 0,83)	• 3 samples < DL (up to 13) • 6 samples > DL and < 100 • 2 samples > 100 (115-119)	• 3 samples < DL (up to 5) • 1 samples > DL and < 10 (27) • 6 samples > 100 (130-256)	< 0,2
Steel household packaging (29 samples and 11 subsamples)	< DL (up to 35) (exc. 1 sample: 0,26)	< DL (up to 57)	• 28 samples < DL (up to 47) • 11 samples > DL and < 40 • 1 sample > 100 (417 – subsample)	>100 (p to 4360) (Except 2 samples > 100 (85 and 90))	< 0,2
Metal industrial packaging (9 samples)	< DL (up to 42) (exc. 1 sample: 0,51	< DL (up to 18)	• 5 samples < DL • 3 samples between DL and 36 3 samples > 100 (103, 5570 and 198500)	Cr^{total}: between 68 and 54 320 (only 1 sample < 100)	3 drums assessed: 0,31 , 3,8 and 660

*DL: Detection Limit

The industrial metal packagings are especially drums. In 30% of the Belgian cases, a Pb content above 100 ppm was measured and in one case, a Cr^{VI} level of 660 ppm was measured in one drum (10%)(190). The high heavy metal content can be linked to the pigments in the paint on the drums (lead and zinc chromate pigments) (197)). It should however be mentioned that the use of heavy metals in pigments for industrial containers has been widely discontinued(198).

2.4.3.4 Paper and cardboard packaging

DEPA(199) analysed paper and cardboard packaging consisting of: paper, card board, corrugated board and pulp. The 19 samples of labels, papers and boards had Cd and Hg levels below the detection limits and the measured levels of Pb and Cr were very low.

The **CEN Report CR 13695-1**(200), states that the heavy metal contents in paper and card board are due to contamination of natural white pigments (kaolin, clay, calcium carbonate) which are used as fillers and/or as surface coatings. The natural contamination is estimated at levels below 10 ppm for Cr^{III} and below 15 ppm for Pb. The total Pb level is not higher than 50 ppm.

197 Heavy metals in packaging on the Belgian Market, VITO, 2001
198 European Aluminium Association (EAA), stakeholder comment on the draft final report

For the **Belgian market**[(197)] the assessment was performed on household (15 samples and 4 subsamples) and industrial packaging (6 samples and 1 subsample) of different colours. For most packagings, the heavy metal contents were below the detection limits (WD-XRF technique) except for 4 samples. They amounted to a maximum of 22 ppm for Cr and to 20 for Pb.

Based on the above studies, it can be concluded that the existing levels in paper and board are only minor impurities and are not due to deliberately added substances.

2.4.3.5 Other packaging

DEPA[(199)] analysed other packaging consisting of wood, rubber and cork packaging. For the 7 samples assessed the levels of Cd and Cd were not detectable and the Pb and Cr concentrations were low.

WOOD, CORK PACKAGING

The **CEN Report CR 13695-1**[(200)], includes an overview of the natural contamination levels in wood and cork as a raw material. Those are respectively for wood: Cr<3ppm, Pb< 10ppm, Cd<1ppm, Hg<10ppm and for cork: Cr^{VI}<10ppm, Pb< 10ppm, Cd<10ppm, Hg<10ppm. The total heavy metal content of wood is assessed to be lower than 100 ppm for pure wood and components. Some wooden packaging can contain higher heavy metal levels due to treatments with noxious substances but these are only used for military requirements of for exportation outside the EU. For cork no increase in heavy metal content takes place due to surface treatment.

The analysis of wood packaging present on the Belgian market[(197)] showed no heavy metal concentrations at detectable levels for the WD-XRF technique (based on 5 industrial wooden packaging samples and 2 for wooden household packaging). This is similar to the findings of the CEN report.

OTHER PACKAGING

For the Belgian market[(197)] shining/metallic wrapping foil and plastic foils coated with an aluminium layer (e.g. packaging of potato chips) were analysed. In a shining wrapping foil with a red and gold coloured surface, elevated Cr and Pb concentrations were measured. The Cr speciation with SIDMS detects up to 210 mg/kg Cr^{VI}. The Cr content of a blue/silver coloured wrapping foil amounted also above 100 mg/kg (no Cr^{VI} analysis). These results indicate that some wrapping foils, especially gold and silver coated, can contain elevated metal concentrations above the prescribed limit.

CONCLUSIONS

At present the heavy metal contents are in most assessed packagings under the limit value of 100 ppm (Pb, Cd, Hg and Cr^{VI}).

For the undecorated glass and for plastic crates and pallets derogations exist due to the fact that contamination with heavy metals are present originating from the recycling of contaminated secondary raw materials (colouring agents with heavy metals, lead capsules of bottles, etc.) For these packagings it is at present not possible to assure the 100 ppm level without banning the recycling of materials. The impact of the presence of these rather high levels of heavy metals in glass has a minimal impact on the human health and the environment. Therefore it is preferable to continue to recycle the container glass even if this means that the 100 ppm limit can not be achieved.

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[199] Survey of the Content of Heavy Metal in Packaging on the Danish Market, EP 349, DEPA, 1997
[200] CEN Report CR13695-1

For the other packagings that were evaluated for their heavy metal contents some of the packagings analysed exceeded the 100 ppm limit for example: packaging nets, metal packagings and shopping bags. However, it should be taken into account in these cases it were often the complementary additions to the packaging (inks, etc.) that contained high heavy metal contents. It should be mentioned that it is possible that there exist other packagings who exceed the 100 ppm limit (for example shining wrapping foil – as found in the Belgian survey).

2.4.4 Evaluation of the possibility of a reduction of the permissible concentration level for the four heavy metals from 100 ppm to lower levels

The evaluation of the reduction of the permissible concentration level for the four heavy metals to a level lower than 100 ppm has to be elaborated in function of the technical possibilities, the environmental impact of lower limit values, the possible positive impact on human health and the financial implications involved for the industry.

2.4.4.1 Technical feasibility of lower limit values for heavy metals

The technological feasibility of the further reduction of the heavy metal contents in packagings are a function of the use of secondary raw materials and their possible contamination and of the background values (level of impurities) in the primary raw materials used.

PACKAGINGS WITH HIGH RECYCLING LEVELS

Undecorated glass and plastic crates and pallets are packagings for which a high recycling rate exists. Due to the impurities in the secondary raw materials, they have in many cases still heavy metal contents above the 100 ppm limit value depending on the recycling rate.

From technological point of view, packagings with heavy metal levels lower than 100 ppm could be produced when banning the recycling of the secondary raw materials. Since this is in conflict with the European Union waste policy and taken into account that the rather high levels of heavy metals in glass have a minimal impact on the human health and the environment; this option will not be evaluated and it is assumed that a limit value lower than the 100 ppm is not feasible.

PLASTIC PACKAGINGS DIFFERENT FROM CRATES AND PALLETS

Plastic packagings in which no secondary raw materials are used are known for their very low levels of heavy metals, meaning that they are often below the detection limits of the techniques used in the evaluated studies. Exceedance of the 100 ppm limit value is mostly due to the use of printing inks with contaminations of heavy metals.

From a technological point of view, it is feasible to produce primary plastic with heavy metal contents lower than the 100 ppm limit since in most cases this is already the case. However, to set forward a more stringent heavy metals limit, a clear overview of the possible contaminations in the production processes should be evaluated. Also the feasibility to prevent these impurities should be assessed.

METAL PACKAGINGS

The impurities in the primary materials for metal packagings are in some cases significant. For example for aluminium, the Pb background value is estimated to be between 10 and 80 ppm.

The assessment of a lower limit value for the heavy metals in metal packagings should be performed based on a profound knowledge of the background values in the primary materials and on the technical constraints to purify the primary raw materials.

Due to the limited information available on this point and due to the relatively high Pb levels in some primary materials, it is estimated that the 100 ppm limit should not be adapted without a thorough preliminary feasibility study.

PAPER AND CARDBOARD PACKAGINGS

At present the levels of Cd and Hg in paper and cardboard packagings are most often below the detection limits of the methods used in the assessed studies. The levels of Pb are estimated not to be higher than 50 ppm.

However to have a clear view on the possibility to set a different limit value, a profound study should be performed on the correct present values of the heavy metals present in the paper and cardboard packagings and on the effect of the recycling rate on these contaminations.

OTHER PACKAGINGS

For the other packagings as for the ones assessed above, it are the contamination of the primary materials and of the production process (inclusive recycling processes), that determine the technical feasibility to obtain heavy metal levels lower than 100 ppm. For example for wood, it was assessed by CEN that the total heavy metal content of pure wood is lower than 100 ppm but no clear view on the exact levels has been assessed.

2.4.4.2 Environmental impact of lower limit values for heavy metals

No scientific information is available concerning the environmental impact of limit values for heavy metals lower than 100 ppm in packagings. Nor are there assessments of the possible positive impact on human health.

Therefore the environmental impact of potential other limit values has not been assessed.

2.4.4.3 Financial implications of lower limit values for heavy metals

The financial implications of setting forward other limit values for the four heavy metals, should be assessed for the different materials and types of packagings. Based on the available information it is not possible to assess the financial feasibility of potential lower limit values.

2.4.4.4 Conclusion

Due to the lack of information concerning the background values of the heavy metals in the different primary materials, the potential contamination during the production processes and the financial implications , it is not possible at this moment to formulate a recommendation about the establishment of stricter limit values for heavy metal contents in packagings. We recommend that all stakeholders would be involved in the potential development of such limit values.

2.4.5 Antimony and Chlorines

2.4.5.1 Antimony

GENERAL

Antimony trioxide is mainly used as flame retardant synergist and as a PET (Polyethyleneterephthalate) catalyst Current methodologies used by regulators for the ranking of the environmental hazards of chemicals were originally developed for organic chemicals and are based on the PBT (Persistence, Bioaccumulation and Toxicity) criteria. As metals and inorganic metal compounds behave differently than organic chemicals, the current PBT criteria are not appropriate to antimony. For example persistence measurements for organic substances is frequently assessed using biodegradation measurements and therefore do not apply to metals. Unlike organic substances, bioaccumulation and bioconcentration factors (BAFs/BCFs) of metals are often inversely related to exposure concentration, and BCFs/BAFs are not reliable predictors of concern for chronic toxicity or food chain accumulation. The adequacy on the use of the PBT criteria for inorganic compounds and metals has therefore severely been questioned by the GHS (2003)[201] and REACH (2004)[202]

- **Risk Assessment of KemI**

In October 2000, antimony trioxide was published on the 4th priority list of Existing Substances Regulation 793/93/EC, which initiated a Risk Assessment process. The Risk Assessment is compiled of a full health and environmental hazard review, which includes an exposure assessment. The Swedish Chemical Inspection Agency (KemI), the rapporteur on the Risk Assessment, released a first draft Risk Assessment Report in July 2004. It stated that: "it is suggested not to consider antimony as a PBT substance".

- **ATOS[203]**

Antimony-based catalysts have been used throughout the PET industry since the beginning with the full approval of regulatory agencies. Furthermore, both WHO and EFSA recently raised the limits for antimony trioxide for intake, migration in food and guidelines for acceptable levels in drinking water.

- **Environmental NGOs[204]**

Since at present no agreed procedure for assessing the persistence of inorganic substances exists the tendency exists to make use of the precautionary principle and to consider Antimony as a non-desired

[201] GHS, 2003. Globally harmonized system of classification and labeling of chemicals (GHS). United Nations, New York and Geneva, 2003.– Chapter 3.10: Hazardous to the aquatic environment.
"For inorganic compounds and metals, the concept of degradability as applied to organic compounds has limited or no meaning. Rather the substance may be transformed by normal environmental processes to either increase or decrease the bioavailability of the toxic species. Equally the use of bioaccumulation data should be treated with care".

[202] REACH (2004) - Annex XII: Criteria for the identification of persistent, bioaccumulative and toxic substances, and very persistent and very bioaccumulative substances.
"This Annex lays down the criteria for the identification of i) persistent, bioaccumulative and toxic substances (PBT-substances), and ii) very persistent and very bioaccumulative substances (vPvB-substances). This annex shall not apply to inorganic substances, but shall apply to organometals".

[203] Stakeholder contribution ATOS to the study

[204] Stakeholder contribution EEB to the study

substance in packaging although antimony trioxide is not listed as toxic in Annex I of the Classification and Labelling directive.

Conclusions

Current methodologies based on the PBT (Persistence, Bioaccumulation and Toxicity) do not apply for the ranking of the environmental hazards of antimony and metals and inorganic metal compounds in general. Currently, a risk assessment for antimony trioxide (DAT) is ongoing. The conclusions of this Risk Assessment which includes an exposure assessment will most possibly provide additional information to come to scientific based conclusions concerning the risk of antimony trioxide in general..

RISK FOR THE ENVIRONMENT THROUGH THE USE FOR PACKAGING PRODUCTION

The release of antimony in the environment is linked to the burning of PET. Hereunder emission in to the ambient air and the effect of the antimony in the solid combustion residues (ashes) is assessed.

Emissions to the air

When incinerating in modern incinerators, equipped with efficient dust removal systems, antimony compounds are concentrated in the residue (bottom ash) and as solid products in the fly ash. Therefore they should have no difficulties in meeting legal limits for the emissions into ambient air[205]. Only the older incinerators that do not cool the flue gases, but apply direct quenching of hot gases before particulate removal, could find problems in meeting the limits. In this case, a part of the antimony present in the fly ash is collected in the quenching water, which must be purified before final disposal in order to meet the emission limits.

Additionally, studies carried out on large-scale waste incinerators have shown[206,207] that increasing the proportion of mixed plastics in the feed stream to incinerators is not harmful to the environment. On the contrary, the overall composition of flue gases was significantly improved[205] by this increase.

Solid combustion residues

In the incineration of MSW, generally the contribution of plastics to the formation of ash is small: moreover, the most common inert materials are calcium carbonate, talc and silicates and these are not critical to the harmfulness of the ash.

Additionally studies have shown that harmfulness of ash from MSW incineration is reduced by the presence of plastics. Total carbon and total organic carbon are lower: the addition of 15% plastics to MSW can halve TC and TOC in the ash. Heavy metal contribution from polymers is not significant compared to their overall concentration in the ash.

Another element of risk is the possibility that harmful substances might leach out of the ash, after its disposal in landfills. Elution analyses have been carried out[206] on the ash from incineration of conventional MSW and of MSW to which mixed plastic waste had been added, to verify whether the limits established by the German disposal directive for landfill (TA Siedlungsabfall) were met. The concentration of each elutant was always lower than the limit in the German directive, and in most cases was not affected by or decreased with the increase of the amount of plastics in the feed. Also the

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[205] D. van Velzen, H. Langenkamp and G. Herb, "Antimony, its Sources, Applications and Flow Paths into Urban and Industrial Waste: a Review", Waste Manage Res 1998: 16: 1: 32-40
[206] F. Mark, A. Kayen and J.-L. Lescuyer, "MSW Combustion: Effects of Mixed Plastics Waste Addition on Solid Residues and Chlorinated Organic Compounds", APME Report, December 1994
[207] U. Einsele, "Zur Problematik der Brandgase von Textilien", Melliand Textilberichte 69 (1988), 820-827

amount of dioxins and furans in the ash was measured: it was always less than the limits set by the German regulations, and the increase of the content of plastics in the feed to the incinerator reduced it.

POSSIBLE SUBSTITUTIONS

Several possible alternatives for the antimony catalysator exist or are being developed and could be used in packaging[208], when proven to be better. From technical point of view it is therefore possible to produce plastics without antimony although antimony trioxide is the leading catalyst in terms of performance and product quality.

The existing alternatives to antimony trioxide are based on two different metals. One of those alternatives is quite efficient and produces high quality PET resins, but its use is severely limited because of the fact that the natural availability of this metal is insufficient even to supply the European market. Furthermore, the depth of evaluation with respect to health and safety is not comparable to what is available on antimony trioxide. The other alternative is still at its infancy from a technical point of view. With the commercially available products it is very difficult to produce packaging resins of a sufficiently high quality and safety performance for public acceptance. A lot of development has to be done before a viable alternative to antimony trioxide will be available[(209)].

With regard to the use in flame retardant plastics, the performance of antimony trioxide as a synergist for brominated compounds is the leading solution to reach the highest required fire safety standards. According to ATOS (stakeholder comment), recent studies show that the ATO/flame retardant combinations have the most environmental and health data supporting their use compared to alternatives.

Conclusions

However, to draw conclusions on the possibility to substitute antimony, the different available substitutes should be assessed from environmental and economic point of view. The evaluation should include the possible environmental impact and the economical feasibility.

The profile of alternatives to antimony trioxide with regard to health and safety, environment impact and technical and financial feasibility have to be continuously evaluated. Since there is no straightforward solution available today, the main focus should be on closing the data gaps for antimony trioxides and to come to unprejudiced conclusions on its risk profile.

2.4.5.2 Chlorines

INTRODUCTION

Chlorine is used for the production PVC (polyvinyl chloride) plastic packaging. During production and incineration, dioxin may be generated. The significance of these amounts is debated.

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[208] For example ecocatalyst fril Zimmer, antimony-free catalyst from Teijin, etc.
[209] Stakeholder comments from Plastics Europe on the draft final report

RISK FOR THE ENVIRONMENT THROUGH THE USE OF PVC

PVC Incineration

On the average in the EU, 38-66% of the chlorine in the input of incinerators of MSW comes from PVC[(210)]. The European Union Commission published in July 2000 a Green Paper on the Environmental Issues of PVC[(211)]. About dioxin production allegedly linked to PVC incineration, the Commission states "It has been suggested that the reduction of the chlorine content in the waste can contribute to the reduction of dioxin formation, even though the actual mechanism is not fully understood. The influence on the reduction is also expected to be a second or third order relationship. It is most likely that the main incineration parameters, such as the temperature and the oxygen concentration, have a major influence on the dioxin formation". The Green Paper states further that "at the current levels of chlorine in municipal waste, there does not seem to be a direct quantitative relationship between chlorine content and dioxin formation".

PVC production

As far as by-products of PVC production are concerned, the Green Paper on the Environmental Issues of PVC[(211)].the EC states that "continuous improvements in the [PVC] production processes have taken place over the years". It further acknowledges that voluntary Charters have been signed, starting from 1995, in which "strict emission limits for a number of chemicals were set" and that compliance was/will be verified through independent audits. The Charters cover all manufacturing process steps and types of waste. They set limits on all relevant harmful compounds. Hazardous waste products are destroyed, generally on the production site, in installations complying with the tough regulations covering the incineration of hazardous waste.

Formation of very small quantities of dioxins can occur in one of the production steps leading to the production of PVC monomer. These dioxin molecules are absorbed by the solid catalyst and hence are easily contained by filtration and controlled treatment of this catalyst. Heavy ends from purification processes are normally incinerated on site. The HCl thus generated is recycled into the production. Dioxin emissions have to meet the same stringent EU limits as applying to municipal waste incinerators. The production of PVC itself and of PVC-based products takes place at temperatures far below those required for dioxin formation[(212)].

RECYCLING OF PVC

A recent study[(213)] comparing PVC packaging with its competing materials, pointed our that PVC in packaging is decreasing (food packs, blister packs, shrink foils and a minor role in bottles segment). The low recycling rate of PVC packaging is due to the fact that PVC packaging nowadays consists more and more of smaller items, whose collection and sorting and potential recycling operations would not be sustainable, be it for environmental or economic reasons (e.g. contaminated mixed waste, too low volumes, non-"perennial" stream, no market outlet ….).

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210 Bertin Technologies study for DG ENV – The influence of PVC on quantity and hazardousness of flue gas residues from incineration" – 2000

211 Green Paper on Environment Issues of PVC, COM (2000) 469

212 Review of Enviromental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes; Enviros Consulting , UK (2004).

213 LCA of PVC and of principal competing materials, commissioned by EC, 2004

POSSIBLE SUBSTITUTIONS

In the EC-study on the LCA of PVC(213), the principal competing materials are assessed. For packaging those are PET, glass and polyolefins. Taking into account that the material to be chosen depends on the final function, the packed material, the takeback or disposal system available, the content to be packed, etc; For each product, would a substitution be contemplated, one should take into account all these parameters. The debate concerning the necessity of substituting PVC has been ongoing for several years at the EU level, e.g. between environmental NGOs and industry, but there is so far no consensus on the desirability of such a substitution.

LCA approaches can indicate the importance of material choices within a given life cycle and potential environmental impacts of a system (including products) including of possible alternatives. Therefore they can be a reliable source of input for environmental risk assessments although it is not a tool to assess the risk to human health.

2.5 TASK 2.E: PACKAGING PREVENTION – PRODUCER RESPONSIBILITY

2.5.1 Definition and background

The growth of economies is outstripping improvements in resource productivity and pollution control. It has been reported that between 1990 and 1995, the amount of waste generated in Europe increased by 10%. The OECD estimates that 45% more waste could be generated in 2020 than in 1995[214]. The result is a net increase of the resource inputs into the economy. From an environmental perspective this presents a future of continued resource depletion, increased pollution, climate instability, and reduced biodiversity. The environmental challenge to industry is to find ways of significantly reducing the environmental impact per unit of consumption. Estimates vary for the scale of the challenge. Some claim that a fourfold increase in eco-efficiency is required, others claim that a ten or even sixteenfold increase is necessary.

Producer responsibility, as a means of achieving waste policy objectives, has been in use for many years. An official statement by the Swedish Government in 1975 was probably the first to describe the idea of producer responsibility.

Since the early 1990s, the environmental policy approaches adopted by governments have increasingly incorporated elements of producer responsibility or extended producer responsibility (EPR) partly due to the increasing quantities of waste being generated and also the growing shortage of landfill capacity and the increasing complexity of the waste stream. EPR seeks to place the responsibility for the life cycle of a product onto producers thereby acting not only as a waste management policy but also acting to prevent pollution upstream and encourage the optimisation of the use of resources such as materials and energy. In effect it internalises the external costs of waste management through a combination of economic and physical responsibility and therefore theoretically provides an incentive to manufacturers to design products which have minimum impact on the environment.

Extended Producer Responsibility (EPR) is defined by the OECD as

"a policy in which the producer's financial and/or physical responsibility for a product is extended to the post-consumer stage of the product's life cycle. It specifically focuses on reducing the environmental impacts of a product at the post-consumer phase. There are two key features to an EPR policy:

- The responsibility for a product at its post consumption phase is shifted upstream in the production-consumption chain, to the producer; and
- It provides incentives to producers to incorporate environmental considerations into the design of their products."

It is argued by EUROPEN that the term 'producer responsibility' is being mis-interpreted in waste legislation[215]. EUROPEN suggests that the use of the term to mean that the producer has complete responsibility for a product throughout its life cycle is both unrealistic and in contradiction with the principles of shared responsibility and polluter pays. The EUROPEN view is that producer responsibility should be assigned to the producer of the environmental impact and not to the producer of the product and that responsibility should be shared and allocated according to the environmental impact triggered by each player in the supply chain.

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[214] EU Focus on waste management. http://www.europa.eu.int/comm/environment/waste/facts_en.htm

[215] Producer Responsibility Defined – A briefing paper. Europen. December 1998

Producer responsibility (as defined by the OECD) is used for a number of products and waste streams in the EU including packaging, WEEE (waste electrical and electronic equipment), batteries and ELV (end-of-life vehicles). EPR has increased in prominence since the introduction of the Packaging and Packaging Waste Directive (94/62/EC) in 1994 although several countries such as Germany and The Netherlands were already pursuing producer responsibility approaches prior to this date. Germany's 1991 Packaging Ordinance is probably the most widely publicised legislation relating to EPR but many deposit/refund systems for beverage containers predate this. Since this time, many other Member States have developed policies encompassing producer responsibility, specifically relating to packaging waste.

The importance of EPR is confirmed in the European Parliament report 'Towards a thematic strategy on the prevention and recycling of waste'[216]. This report stresses that the objective of the strategy must be prevention of the generation of waste and sustainable resource management and confirms that manufacturer responsibility should continue to be an essential feature of Community waste policy. However it warns that this should primarily be regarded as a financial responsibility so that options which are socially or environmentally preferable are not precluded. The report also underlines the importance of the implementation of the concept of individual producer responsibility in order to steer towards design for waste prevention for priority end-of-life product waste streams.

A range of policy instruments exist for implementing EPR. The exact mix of measures applied will be dependent on the goals and objectives of the overall policy. The OECD[217] highlights three basic categories of instrument:

- Take-back policies, often associated with targets
- Economic instruments eg Deposit/refund systems (which encourage reuse), advance disposal fees (which cover the cost of disposing of used products) and material taxes (eg taxes on virgin materials aimed at reducing their use)
- Standards eg minimum recycled content.

Typical approaches adopted in the EU in relation to producer responsibility for packaging waste predominantly involve take-back obligations with associated targets for recovery and recycling, and deposit/refund systems. Some Member States have also used the concept of packaging prevention plans as outlined in chapter 2.2 to reduce quantities of packaging which become waste by encouraging minimisation and re-use. Taxes and bans on different disposal options, for example, landfill taxes and landfill bans also serve to encourage minimisation and recycling.

2.5.2 Implementation of producer responsibility for packaging in the Member States (EU15)

The Packaging and Packaging Waste Directive is not a producer responsibility directive. However, many Member States have implemented this Directive through the use of Producer Responsibility legislation, many of which are based on producer take-back requirements. To comply with the legislation, producers must be able to take back their products and assume responsibility for waste management after use. However for a lot of packaging, especially sales packaging, return to an individual producer is virtually impossible. Legislation therefore generally allows organisations within the packaging chain who have responsibility for achieving targets for packaging waste management to comply either individually or through a producer responsibility organisation (PRO) to which the producer pays fees in proportion to the

[216] European Parliament. Report on the communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste (COM(2003) 301 – C5-0385/2003 – 2003/2145(INI)). Committee on the Environment, Public Health and Consumer Policy

[217] OECD. Extended Producer Responsibility. A Guidance for Governments

amount of packaging placed onto the market. A brief overview of the legislation in the EU15 is given in Annex 14

2.5.3 Differences between the systems

Despite apparent similarities between Member States, for example, the use of Producer Responsibility Organisations to which businesses can delegate their obligations on payment of a fee, use of the Green Dot etc, the systems set up in the different Member States vary widely. Inherent differences between systems, as reported by B. Fishbein[218] include:

- The allocation of responsibility between government and industry

  Table 75 below divides Member States (EU15) into three categories depending on where the responsibility for waste management lies. This table indicates that in the majority of Member States, a system of shared responsibility operates between industry and the municipalities. Comparison of the costs arising by Member State is virtually impossible however due to the different approaches to cost allocation.

Table 75: Management of Packaging Waste in the EU15[219]

Description	*Countries*
Industry is fully responsible for covering all costs. Municipalities can be involved in separate collection on behalf of the industry	Austria, Germany, Sweden
Industry and Municipalities share responsibility. The industry covers costs of sorting and recycling. Municipalities are in charge of separate collection and their costs are reimbursed	Belgium, Denmark, Finland, France, Ireland, Italy, Luxembourg, Portugal, Spain
Industry and municipalities share responsibility. The industry covers the costs of recycling. Municipalities are in charge of separate collection and receive revenues through selling the collected materials	United Kingdom, the Netherlands

Other differences between systems as reported by Fishbein include:

- The mandated levels of recovery/recycling
- The types of collection systems used, for example the DSD in Germany collects sales packaging via kerbside and bring systems. The kerbside collection involves collection of material via yellow bags or bins directly from the individual households. The UK system has, to date, relied mainly on the recovery of commercial and industrial packaging for some materials which is collected via individual contracts by for example, reprocessors directly or waste management companies.
- The use of deposit/refund mechanisms
- The use of Producer Responsibility Organisations and the mechanisms by which these PRO's operate. For example, some handle only household packaging waste whilst others handle both household and commercial/industrial waste.

[218] Fishbein B. EPR: What Does it Mean? Where Is It Headed? INFORM

[219] Source Producer Responsibility. An investigation into the strategic issues and environmental and economic impacts related to the implementation of Producer Responsibility legislation in the UK. Associate parliamentary Sustainable Waste Group. May 2004

2.5.4 Evaluation of the impacts of producer responsibility schemes for packaging

The aim of most of the legislation outlined in Annex 1 is to reduce the impact that packaging has on the environment through the reduction of waste via minimisation initiatives and recovery and to reduce the impact/pollution load upon disposal. Despite the length of time that some schemes have been in place, there is generally little data available relating to the actual environmental or social effects/impacts of producer responsibility schemes.

2.5.4.1 Environmental impacts of producer responsibility schemes in the EU 15

RECOVERY AND RECYCLING

In terms of environmental impacts, there is no doubt that recovery and recycling activities have been boosted by the impact of the Packaging and Packaging Waste Directive in many countries although in some, such as Germany, the Netherlands and Sweden, mechanisms and systems were already in place and recovery and recycling was already occurring. Figure indicates recovery and recycling for the EU 15 as a total.

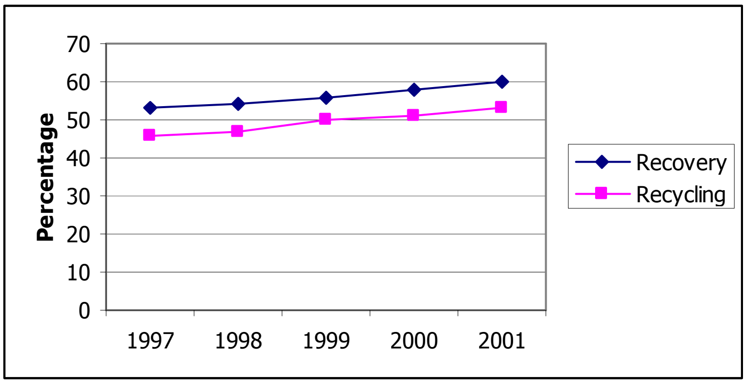

Figure 94: Recovery and recycling in the EU15

PACKAGING WASTE GENERATION

Despite the year on year increase in the % recovery and recycling achieved, this was not matched by a decrease in the amount of packaging waste being generated. Packaging waste arisings across the EU15 increased year on year up to 2000 but showed a decrease in 2001 despite minimisation initiatives. Reasons for this may stem from issues such as the increasing number of single person households and the increasing amounts of disposable income available.

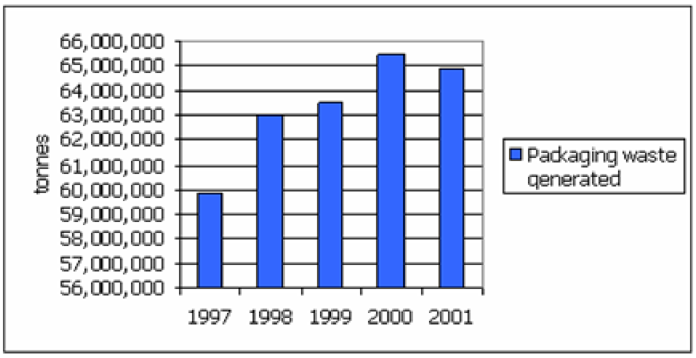

Figure 95: Packaging waste generated

PACKAGING MINIMISATION

In terms of packaging minimisation, it is difficult to isolate changes which have resulted from the introduction of the Packaging and Packaging Waste Directive from changes which would have occurred anyway through innovation and as a result of other influences such as economics. For example, the weight of aluminium and steel beverage cans has been decreasing steadily since the 1980s as shown in Figure 96 and Figure 97. This is more likely to be have been driven by cost-optimisation and continuous improvement than by than legislation, especially considering the timescales involved.

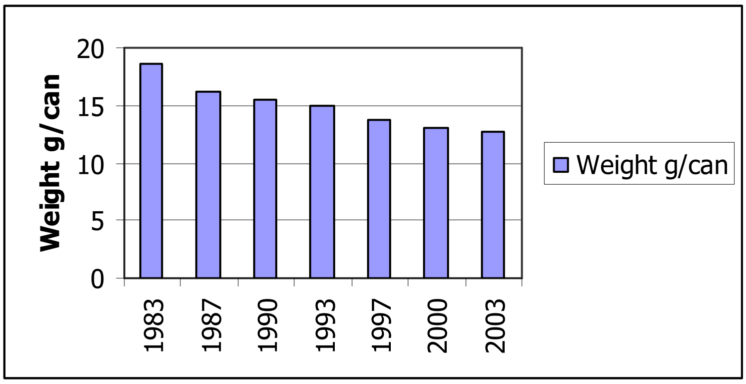

Figure 96: : Weight of Aluminium beverage cans[1]

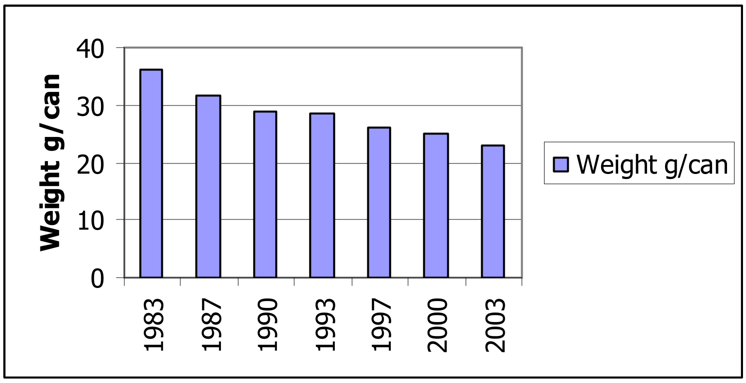

Figure 97: Weight of steel beverage cans

Change in packaging formats can also lead to overall reductions in the weight of packaging used. Data reported in the study "Packaging's Place in Society"[220], indicates that minimisation, combined with the diversification of packaging formats in use has resulted in a net reduction in the packaging used per litre of soft drinks consumed. Overall between 1997 and 2002, there was a 20% reducing in the quantity of packaging (sales and transit packaging combined) used to pack 1 litre of soft drinks in the UK.

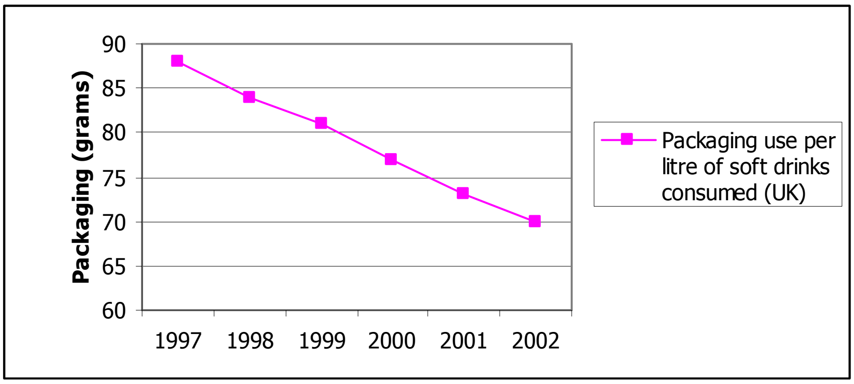

Figure 98: Packaging use per litre of soft drinks consumer (UK) – primary, secondary and tertiary packaging

One INCPEN publication[221] contains numerous examples of packaging reduction, for example, the reduction in weight of a 1 litre plastics detergent bottle from around 120grams in the 1970's to around 50 grams in 2000. Plastic carrier bags have seen a reduction in their thickness from around 47microns to 25 microns.

2.5.4.2 *Financial impacts of Producer responsibility schemes in the EU 15*

In terms of packaging, most countries within the EU have imposed take back obligations on producers with an option to join approved schemes and transfer obligations to it. Producers pay fees depending on the weight and type of packaging for which they are obligated. Comparison of these schemes in terms of costs, even for those based on the Green Dot is difficult due to inherent differences in terms of set up, remit etc. Some schemes handle sales and transport packaging, some only sales. Fees are sometimes payable as weight based fee but can also include unit fees. In Austria, Belgium and Germany the fees are calculated to cover the total costs of the waste management of the different packaging materials whereas in France for example, industry shares the costs with the municipalities. In the UK, the only system based on a tradable commodity, the PRN (Packaging Waste Recovery Note), the costs relate only to the PRNs and not to costs associated with collection and handling. PRN prices fluctuate on a monthly basis as a result of market forces.

Pro-Europe have assessed the fees for different Green Dot organisations for various types of packaging and the results are shown in Table 76 below.

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[220] Pira International and University of Brighton. Packaging's Place in Society – Resource efficiency of packaging in the supply chain for fast moving consumer goods. Biffaward Programme on Sustainable Resource Use

[221] INCPEN. Packaging reduction – Doing more with less.

Table 76 : Green Dot fees for various types of packaging

		Fees for 2004 (€ cents)					
System	*Country*	*Glass bottles (0.35kg)*	*Tetrabrik (1l) (0.027kg)*	*PET Bottles (1l) (0.030kg)*	*Aluminium can (0.015kg)*	*Steel can (0.03kg)*	*Cardboard box (1kg)*
ARA – Altstoff Recycling Austria AG	*Austria*	2.73	0.21	2.1	0.645	1.02	11.5
CEVKO	*Turkey*						
Der Grüne Punkt – Das Duale System Deutschlnad AG	*Germany*	2.559	2.291	3.531	1.229	1.101	17.232
Ecoembalajes España, S.A.	*Spain*	0.39	0.421	0.573	0.122	0.153	5.1
Eco-Emballages S.A.	*France*	0.24	0.44	0.64	0.14	0.14	12.32
EKO-KOM	*Czech Republic*	0.681	0.124	0.254	0.051	0.076	4,597*
Asbl FOST Plus vzw	*Belgium*	1.0255	0.6153	0.8667	0.194	0.1542	1.51
Green Dot (Cyprus) Public Comp. Ltd	*Cyprus*						
He.R.R.Co.	*Greece*	0.7465	0.19499	0.2351	0.0626	0.1877	5.05
Latvijas Zalais Punkts	*Latvia*	1.2688	0.1468	0.2855	0.0816	0.1631	1.088
Materialretur A/S	*Norway*	3.38	0.36	3,26**	1.63	1.63	0.6
Öko-Pannon Pbc	*Hungary*	0.028	0.012	0.0156	0.00198	0.003	0.25
ReKoPol Ltd	*Poland*	0.09	0.024	0.0159	0.01245	0.0102	0.45
REPAREGISTERED	*Sweden*	1.41	0.16	0.88	0.2	0.39	5.97
Sociedade Ponto Verde S.A.	*Portugal*						
VALORLUX asbl	*Luxembourg*	0.5075	0.7495	0.8619	0.2241	0.1224	0.32
Saliasis Taskas (ZT)	*Lithuania*	0.595	0.038	0.054	0.074	0.148	1.4
ENVI-Pak, a..	*Slovak republic*	0,4375***	0.03375	0.135			1.25

**Deposit fee (not within Materialretur)
*** Generally Slovak fees are based on kg not items. Additional info:

- Consumer (in € cents): metals – 2.75
- Transport/group (in € cents): plastic – 0.45, paper – 0.125, glass – 0.125, metals – 0.275
- Composites have the same fee as paper

Table 76 indicates the huge variation in the fees charged by the different organisations. As an example, Table 77 below highlights the differences between Germany and Belgium.

Table 77: Selected countries

		Fees for 2004 (€ cents)					
System	*Country*	Glass bottles (0.35kg)	Tetrabrik (1l) (0.027kg)	*PET Bottles (1l)* (0.030kg)	Aluminium can (0.015kg)	Steel can (0.03kg)	Cardboard box (1kg)
Der Grüne Punkt – Das Duale System Deutschlnad AG	*Germany*	2.559	2.291	3.531	1.229	1.101	17.232
asbl FOST Plus vzw	*Belgium*	1.0255	0.6153	0.8667	0.194	0.1542	1.51

These differences are highlighted diagrammatically in Figure 99 below which was taken from a report produced by the Associate Parliamentary Sustainable Waste Group[222]. This graph indicates the costs to industry per ton of recycled material in different Member States. The low cost associated with the UK is attributed to the use of the PRN system which allows packaging recycling to be met at least cost to the obligated businesses and to the economy as a whole. This has also been assisted by the use of commercial and industrial waste as the main source of material for recovery. Increased targets will require more uplift of material from the more difficult household waste stream involving greater involvement of local councils which are currently not incentivised under the Producer Responsibility Obligations and therefore costs are likely to increase.

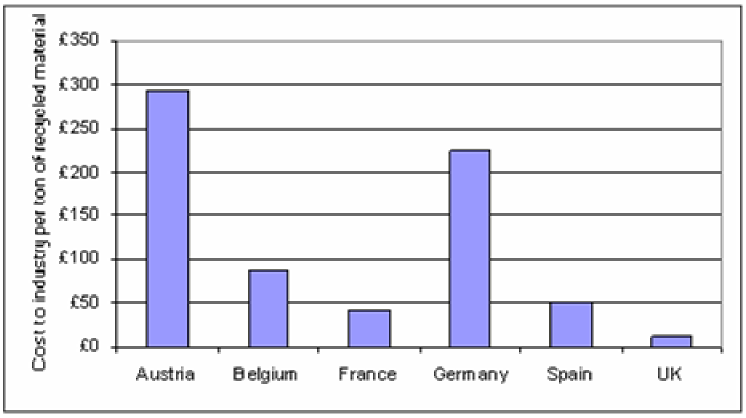

Figure 99: Cost to industry per ton of recycled material

The same report also compares recycling rates versus costs. This indicates that compliance in Germany in 2001 cost €12.5million per percentage point of recycling, in France it cost €6.8million and in the UK compliance cost €2.4million. However the study reports two areas of caution:

222 Associate Parliamentary Sustainable Waste Group. Producer Responsibility. An investigation into the strategic issues and environmental and economic impacts related to the implementation of Producer Responsibility legislation in the United Kingdom, March 2004. PSWG0101A: 27 May 2004

- The complicated arrangements for calculating obligations in the UK means that administration costs have been higher in the UK than in comparative European countries
- The costs of collecting packaging waste from the household waste stream are predicted to be significantly higher eg modelling the estimated increase in recovery of 2.8 million tonnes against the estimated increased costs of £481 million provides a marginal cost for increasing recovery of £171 per tonne.

The proposal for amending the Directive[223] estimated that, based on the extrapolation of data, the total financing need for packaging recycling in the EU15 can currently be estimated at €5-8bn per annum (around 0.1% of European GDP). The cost of meeting the revised targets by 2008 has been estimated to be an additional £390-572 million for the UK alone[224].

2.5.4.3 Social impacts of Producer responsibility schemes in the EU 15

There is little information available relating to the social impacts of producer responsibility schemes. On the face of it producer responsibility legislation might seem to be irrelevant in terms of social impact as it places responsibility for product throughout its life cycle onto the producer. However to be able to ensure packaging recovery and recycling consumers are often required to participate. In many Member States, the recovery of sales packaging plays a major role in fulfilling obligations. This requires separation at source by the householder and a certain degree of knowledge relating to material type and logos which may be displayed on the packaging. In Germany, lightweight packaging is collected in yellow bags or bins directly from individual households and the cardboard fraction in blue bins. Glass is often collected through a bring system.

Deposit/refund systems also require action by the consumer in the form of return of used packaging but in this case they are incentivised through the deposit system.

Other impacts of producer responsibility include job creation, not only directly in the recycling and re-use industries but also in terms of administration of producer responsibility organisations and collection and manipulation of data. Balanced against this however must be the loss of job in other sections of the waste management industry due to the diversion of material from final disposal. DSD claim that the effects of the dual system in Germany include total investments by German industry of more than €20 billion and the creation of approximately 17,000 jobs[225].

2.5.4.4 Producer Responsibility in selected countries

GERMANY

Germany was the first country to implement a law based on EPR specifically for packaging. On 19 April, 1991, the German Parliament passed an Ordinance on Avoidance of Packaging Waste which came into force on 12 June 1991. The revised Ordinance came into force on 28 August 1998. The goal of the

[223] The proposal for a European parliament and Council directive of 2001 amending Directive 94/62/EC on packaging and packaging waste Brussels COM (2001)

[224] House of Lords Select Committee on the European Union. Packaging and Packaging Waste: Revised Recovery and Recycling Targets. Session 2001-02 33rd Report. The Stationery Office Limited

[225] http://www.gruener-punkt.de/Background___Information.272+B6Jkw9MSZub0ZsYXNoPSZiYWNrUElEPTI3MiZ0dF9uZXdzPTUxMSZjSGFzaD1jN2U3MGQ0OTYy.0.html

Packaging Ordinance was to reduce packaging waste and avoid waste disposal by placing responsibility for packaging waste on producers.

The Ordinance places obligations on manufacturers and distributors making them responsible for the reuse and recycling of used packaging. To meet these obligations, industry was given the option of organising systems which would assume responsibility for the collection, sorting and recycling of packaging and which would run alongside traditional waste disposal systems. DSD, Duales System Deutschland AG, a private company was therefore established to assist organisations to meet their obligations. Producers pay a licence fee on an annual basis based upon the amount and type of packaging placed onto the market. The Green Dot symbol was created by DSD as a mechanism to identify those products participating in the Dual System.

The DSD encountered several problems shortly after the initial set up which led to a financial crisis which would have led to its collapse were it not for a bale out plan involving government, industry and waste managers. The problems encountered by the DSD included:

- Larger amounts of material than expected were initially collected
- Free riders (ie organisations using the Green Dot without payment of the licence fee)
- Waste being deposited in DSD system which was not licensed
- Licence fees were based on volume of total packaging material and failed to account for widely differing costs of individual materials.

The licence fees in Table 78 were those originally imposed by the DSD in Germany. These were based on the volume of packaging and took no account of material type or density[226]

Table 78: DSD fees before September 1993[227]

Volume	*Fee/package*
<15ml	Free
15ml-200ml	1pf
0.2l-3l	2pf
>3l	20pf

These volume fees failed to account of differences in weights of material processed per volume unit and for the differing costs of sorting and recycling individual material types and therefore provided no incentive for manufacturers to minimise packaging used or consider material type. The changes to the fee structure adopted in October 1993 were in two parts, a weight related charge and a unit related charge with the weight related charge being material specific. This change therefore took account of the weight and material types and reflected better the different costs associated with different materials.

Impact of the legislation

The goal of the Packaging Ordinance was to reduce packaging waste and avoid waste disposal. It has been reported that during the 1990s the recycling rate increased by a factor of 6[228].

However data supplied by the EC indicates that the percentage recycling rate for packaging waste in Germany has actually decreased from 81% in 1997 to 76% in 2001.

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[226] Extended Producer Responsibility Phase 2: Case Study on the German Packaging Ordinance. OECD ENV/EPOC/PPC(97)21/REV2. 15 May 1998
[227] Scarlett L et al. Packaging, Recycling and Solid Waste. Policy Study No 223. June 1997
[228] Case Studies on waste minimisation practices in Europe, European Environment Agency, 28/01/2003

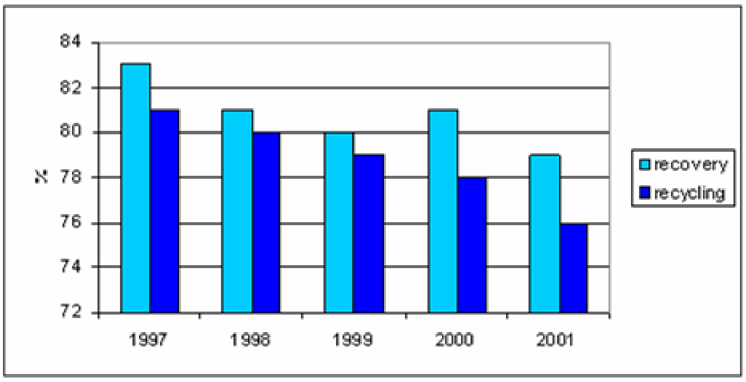

Figure 100: Recovery and recycling in Germany

In terms of the success of the dual system, the German Ministry of Environment has reported[229] that since the Packaging Ordinance first came into force and despite the initial problems relating to free riders and the disposal of some non packaging waste in the dual system the policy has shown some success, for example,:

- Manufacturers have changed their packaging habits by considering disposal options during the design and production process.
- Packaging has become lighter and smaller due to differences in the fees charged by the Dual System. Some packaging with proportional higher licence fees have been replaced by packaging with lower fees
- There is a trend towards the use of reusable transport packaging.
- New recycling technologies are being developed
- The use of packaging has been considerably reduced in Germany. In 2000 there were around 1.5million tonnes less packaging than in 1991.

Evidence from submissions to the EU indicate that packaging waste generation increased from 1997 to 2000 but showed a downturn in 2001. Packaging per capita shows a similar trend as shown in Figure 101:

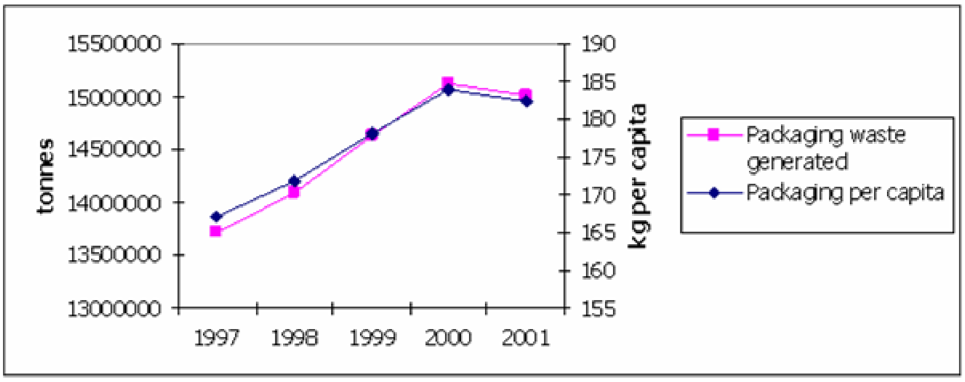

Figure 101: Packaging waste generation

229 Schmid T. Extended Producer Responsibility As an Instrument to Reduce Packaging Waste: The German Experience. Proceedings of OECD Seminar on Extended producer Responsibility: EPR Programme Implementation and Assessment. Part 1: Taking Stock of Operating EPR Programmes. ENV/EPOC/WPNEP(2003)10/PART1/FINAL. OECD 13-14 December 2001

To encourage the reuse of beverage containers, the German legislation contained a stipulation that a mandatory deposit would be imposed if the national market share of refillable containers fell below 72%. As this happened, a mandatory deposit was introduced on nonrefillable containers for packaged water, beer and carbonated drinks. A series of court actions followed resulting in a very piecemeal approach to the introduction of the system. The case has also been referred to the European Court of Justice.

THE NETHERLANDS

Dutch product policy places particular emphasis on the responsibility of producers. Producer responsibility has been implemented for the most important waste streams by means of agreements between producers and importers, by regulation or by a combination of the two as indicated in Table 79.

Table 79: Producer Responsibility in the Netherlands[230]

Waste stream	*Voluntary*	*Regulatory*
End-of-life cars	x	X
Car tyres		X
Batteries		X
Packaging waste	x	X
Paper / cardboard	X	
Plastic films for agriculture	x	X
PVC exterior building materials	X	
PVC piping	X	
Hazardous photographic waste		X
Electrical and electronic equipment		X

Packaging producer responsibility was implemented through a combination of measures including waste prevention, product and material re-use goals and product policy. The original Packaging Covenant was agreed in 1991. The purpose of a Covenant was "to increase the flexibility to choose the optimal and most efficient ways of improving the environmental performance of activities through self-regulation"[231]. The original Covenant was replaced by Packaging Covenant II in 1997 and then Covenant III in 2002. The Packaging Regulations, in force since August 1997, impose obligations on producers and importers of packaging but these individual obligations do not apply to businesses which sign the Covenant. The Covenant approach places considerable demands on the self regulating capability of industry but the Government has powers to withdraw the exemptions for Covenant signatories and impose taxes and take back obligations.

Objectives and targets of Covenant III include:

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230 Ministry of Housing, Spatial Planning and the Environment. Producer Responsibility. Waste in the Netherlands. June 2001

231 OECD Extended Producer Responsibility. Phase 2. Case Study on the Dutch Packaging Covenant. ENV/EPOC/PPC(97)22/REV2. 15 May 1998

- a requirement that the total volume of paper and board, glass, plastics and metal packaging in 2005 may not be more than two thirds the growth in GDP over that period
- a requirement that at least 70% of packaging waste must be recycled by 2005
- placing a duty on every company to separate packaging waste arising on their premises

Since January 1996 it has been illegal to landfill used packaging.

Impact of the legislation

Table 80: Total amount of packaging generated in the Netherlands[232]

Year	*Materials ('000 tonnes)*				
	Plastics	*Paper/board*	*Glass*	*Ferrous metals*	*Aluminium*
1991	645	1,688	558	263	46
1992	647	1,658	523	325	49
1993	538	1,500	504	201	18
1994	613	1,415	463	189	19
1997	611	1,449	469	216	
1998	500	1,336	453	236	
1999	479	1,402	495	217	
2000	458	1,311	494	220	
2001	486	1,377	512	211	

The OECD study reports that all of the reduction goals set in the Covenant for 1994 were achieved, except for plastic packaging. The study also reports that other studies[233] have helped to identify hundreds of innovative packaging adaptations including complete rethinking of the use of packaging. These results have helped to encourage companies to redesign the production and use of packaging, eg by producing lighter materials and/or smaller packaging and to use less composite materials.

Between 1985 and 1995 the recycling rate[234] for total waste[235] increased from 50% to 73% and surpassed the national target of 67% set for 2000. The recycling rate for household waste jumped from 16% to 42% between 1990 and 1995 but has not progressed much since 1998: at 45% in 2000 it was below the 60% national target set for 2000[236]. The greatest increase was between 1990 and 1994 when household was recycling rose from 16% to 38% in 1994.

However, a report from The Green Alliance includes a quote from Hans Jager of Stichting Natuur en Milieu who states that "We assumed that producer responsibility regulation would encourage companies

[232] Data for 1991-1994 from OECD. Data for 1997-2001 packaging waste generated from EC

[233] Stichting Verpakking en Milieu (1993), verpakkingsontwikkeling 1992: uitvoering convenant verpakkingen in beeld , Stichting Verpakking en Milieu, The Hague. Also 1994,1995 and 1996

[234] recycling figures also includes reuse and composting

[235] includes household waste, commercial waste, tyres, end-of-life vehicles, agricultural waste, manufacturing waste and waste from energy production.

[236] Hill J et all. Creative policy packages for waste: lessons for the UK. Green Alliance 2002

to change products and make them more compatible for recycling but this did not happen. There are a lot of collection systems in place, so that industries do not have to do the processing of the waste themselves, but these collective systems decrease the incentive to change their products. There is no incentive towards better design between companies within the same category because there is no differentiation of the extra price paid by the consumer on the basis of the products' recycling performance". In terms of waste reduction efforts he goes on to comment that "Economic growth is encouraging the consumption of more products and recycling is only keeping up".

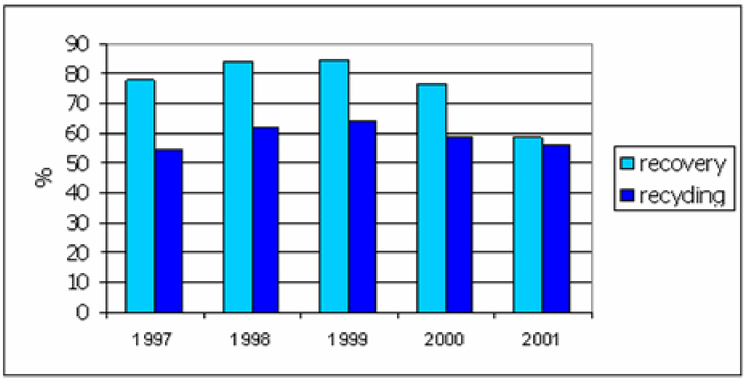

Figure 102: % Recovery and recycling in the Netherlands

SWEDEN

Producer responsibility was originally introduced in Sweden in 1994 for packaging, wastepaper and tyres and has since also been introduced for end-of-life vehicles and electrical and electronic products. The Packaging and Packaging Waste Directive was fully implemented in Sweden in July 1997 through the Ordinance on Producers' Responsibility for Packaging (SFS 1997:185). Under the Ordinance, producers must ensure that collection systems are in place to allow the separation of packaging from other types of waste and that packaging collected "is removed and reused or disposed of in some other environmentally acceptable way"[237]. Priority is given to reuse.

A number of material recovery companies have been established to administer the collection and recovery of waste. Plastkretsen (plastic packaging), Returwell (corrugated board), Svensk Kartongåtervinning (packaging made from paper, board and cardboard) and MetallKretsen (shhet metal and aluminium) formed REPA, a subsidiary company, to organise the collection of fees.

Impact of the legislation

A study undertaken by the Commission to Review Producer Responsibility for the Swedish Ministry of Environment to evaluate the environmental effectiveness and economic efficiency of EPR programmes in Sweden found that the main environmental policy objectives for producer responsibility had been achieved[238] ie reduced quantities to landfills and resource efficient use of material and energy.

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[237] Ordinance on Producers' Responsibility for Packaging

[238] Linell A. Resources in Return: A review of Sweden's EPR Programmes. Summary of the Report from the Commission to Review Producer Responsibility, Proceedings of OECD Seminar on Extended producer Responsibility: EPR Programme Implementation and Assessment. Part 1: Taking Stock of Operating EPR Programmes. ENV?EPOC?WPNEP0.03(2003)10/PART1/FINAL. OECD 13-14 December 2001

Annual follow-ups are carried out to assess the impact of producer responsibility. The total quantity of packaging placed on the market has increased by two percent[239].

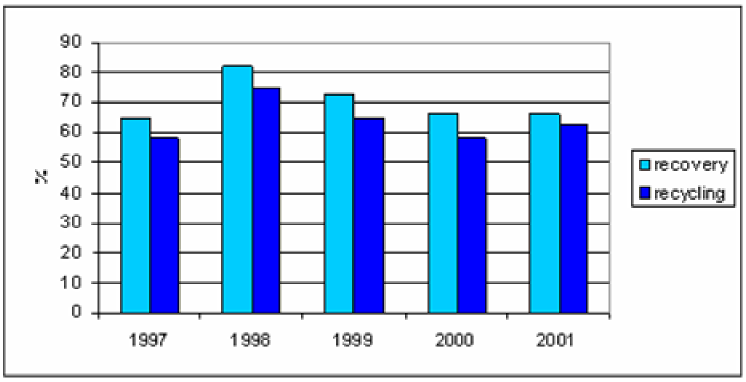

Figure 103: % Recovery and recycling in Sweden

UK

The UK implemented a system based on shared producer responsibility whereby companies forming part of the packaging chain each take on recovery and recycling obligations depending on the activities performed ie production of raw materials, converting, packing/filling, selling, importing.

The mechanism of compliance is the Packaging Waste Recovery note (PRN system), a tradable commodity issued by reprocessors and whose price is based on market forces. Criticisms of the UK approach have been raised. One article[240] states that "The British system of packaging waste recycling was not introduced as a means to achieving environmental goals, but in order to ensure legal conformity with the EU Packaging Directive (94/62/EC) at the lowest possible costs while giving paramount priority to a radically market-driven policy." The article goes on to state that "The British system has not proved able to develop any true dynamism in upsizing recycling proportions and creating collection systems, recycling and recovery capacities, developing new technologies and enhancing packaging efficiency". These claims can however be disputed. Evidence from Defra indicates an increase in packaging recovery from 3,580kT to 5,348kT from 1999 to 2003. Information from Valpak indicates that reprocessor investment from PRN revenue has included, for example, new alternative markets for using surplus green and mixed coloured glass in the aggregates industry, installation of automated glass colour sorting technology at major UK glass reprocessors (capacity for sorting up to 300kT of mixed glass has now been installed), investment in improved cleaning processes to enable board manufacturers to increase the proportion of recycled wood in their products (this has enabled some companies to increase the proportion of recycled wood in their products from 15% to 60%) and new processes to produce products such as damp proof course and other alternative building products from recycled plastic.

In terms of system costs the article by Dr Wollny states that "The system costs of about £55 million [77 million Euros] relate only to the PRNs. This figure contains neither the collection and handling costs not the disposal costs saved, and thus reflects neither the costs to the economy nor the real costs for the companies involved." However a research team at Berlin's Technical University compared the British and German method of meeting the packaging Directive and concluded that the British system is a better, more cost effective system encouraging competition, innovation and investment. Valpak, the UK's largest

[239] Collect and recover! – Follow up of producer responsibility for 2002

[240] Prof. Dr. Volrad Wollny. Packaging Waste Recovery in the United Kingdom. Mainz Technical College

compliance scheme also believe that achieving compliance at the lowest possible cost is a major benefit of the UK scheme. The Berlin Technical University did however criticise the paper based PRN system indicating that an electronic system would reduce costs and increase efficiencies.

The price of PRNs is based very much on supply and demand. Table 81 indicates some of the variations seen to date. Whilst there has undoubtedly been an increase in capacity, the uncertainty surrounding prices affects willingness to invest as investment is more difficult to justify (though not impossible). For businesses using packaging, low PRN prices provide little incentive for minimisation of packaging or investment in assessing the impact of different product/pack combinations. For the recovery and recycling industries, uncertainty may limit investment in new technologies as well as collection and sorting equipment. PRN/PERN revenues over the period 1998 to 2002 generated approximately £280 million[241] (392 million Euros) however during this time no regime existed to allow an audit of spend relating to monies earned from the sale of PRN/PERNs to be conducted

Table 81: PRN prices[242]

	November 2001 £/tonne	*November 2003 £/tonne*	*June 2004 £/tonne*
Glass	22-28	7-10	23-27
Paper	20-28	2-5	9-10
Aluminium	20-25	9-12	21-26
Steel	20-24	2-5	12-16
Plastics	45-60	3-6	8-10
Mixed – energy recovery	16-20	2-6	2-4
Wood – recovery	16-20	2-6	8-10

As a result of low processing costs in countries such as India, China and the Far East, increasing amounts of packaging waste have been exported. This has led to significant reductions of PRN prices for some materials such as plastics. Packaging users are unwilling to invest time and money to achieve the low levels of contamination and high levels of sorting required by UK reprocessors. Material shipped out to the Far East is sorted at a much lower cost[243][244]. In 2002, it has been reported that there was a 50% increase in packaging waste exports from the UK. It is likely that China will impose stricter controls on the import of waste in the future[245] which might have a major impact on the UK's ability to meet its obligations.

The ACP estimates that "the UK will need in the region of 1.3 million tonnes of extra material in order to meet its targets. This is extremely challenging and will require a rapid increase in domestic kerbside and

[241] ACP: The recommendations of the Advisory Committee on Packaging – June 2003.

[242] www.letsrecycle .com/prices/prnPrices.jsp

[243] Pira International. Development of Options for Enhancing Commercial and Industrial Film Collection. PLA 0018. April 2004. WRAP. ISBN: 1-84405-095-5

[244] Vidal J. The UK's new rubbish dump. The Guardian. 20 September 2004

[245] Pitcher G. Deadline set for export to China. Materials Recycling Week. Vol 183, no 21, 28 May 2004

bring systems."[246] A House of Lords Select Committee report[247] estimated that the increased targets would cost the UK in the region of £390 million to £572 million (546 million to 800 million Euros) (2008 deadline) although evidence from DEFRA (Department of Food and Rural Affairs) suggests that the costs of complying with the recovery and recycling obligations have been far lower than expected[248]. Estimates from Valpak suggest that the total cost of compliance for the UK in 2008 is likely to be in the range £150m to £200m.

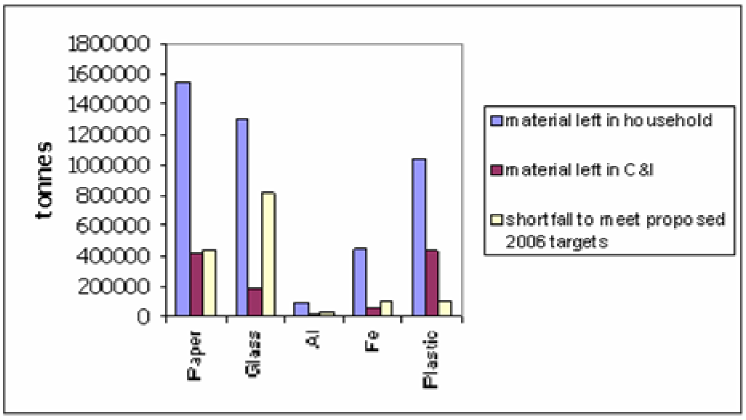

Figure 104: Residual available material[249] (2000)

Packaging waste generation as shown in Figure 105 showed a sharp decline between 1998 and 1999 but there was an increase in 2001.

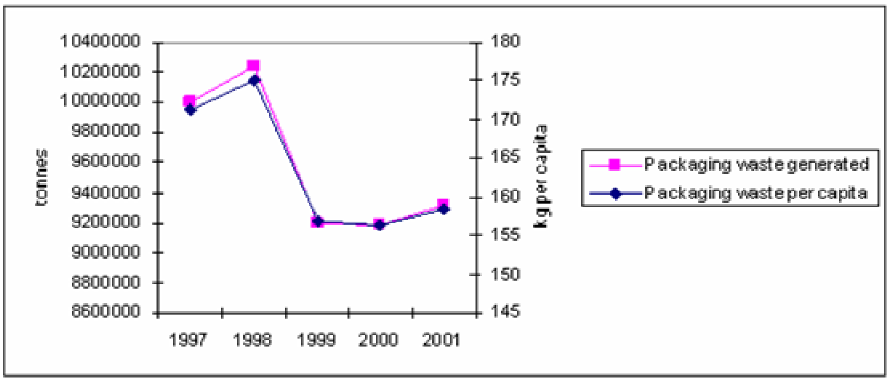

Figure 105: Packaging waste generation in the UK

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[246] ACP. The Recommendations of the Advisory Committee on Packaging – June 2003.

[247] Select Committee on the European Union. Packaging and Packaging Waste: Revised Recovery and Recycling Targets. Session 2001-02 33rd Report. The Stationary Office Limited

[248] www.defra.gov.uk/environment/waste/topics/packaging/faq.htm

[249] DERA. Report of the task force of the Advisory Committee on Packaging. November 2001.

2.5.5 Strengths and weaknesses of producer responsibility as an option to encourage packaging prevention

2.5.5.1 Strengths

EPR, through placing obligations on the producers to pay for waste management (ie shifting waste management costs from the public sector back to the private sector) encourages the consideration of life cycle impacts in the design phase. Producers should encompass the responsibility for impacts of the whole life cycle from material selection though manufacturing to disposal and not just responsibility when the product becomes waste.

Shared producer responsibility encourages supply chain collaboration as it involves not only consideration of the impacts at the design phase but at all stages including manufacture, transportation and disposal.

EPR can deliver high recycling rates although in some countries such as Denmark which has no producer responsibility legislation, recycling rates are still high. However for some countries, producer responsibility has provided the impetus which would otherwise have been lacking.

2.5.5.2 Weaknesses

The literature highlights a number of possible weaknesses of the system of producer responsibility and these are outlined below.

The aim of EPR is to encourage sustainable use of resources but EPR does not necessarily influence product design. Some argue that EPR is a clear application of the "producer pays" principle however producers will always search to reduce overall costs, for example costs associated with raw material, compliance etc. The costs associated with EPR (eg the Green Dot in Germany) could also be passed onto the consumer through increased product prices.

EPR itself crosses over into other policy areas such as Essential Requirements, prevention plans, and reuse through deposit/refund systems. It is therefore difficult to separate improvements (eg minimisation, increased diversion from landfill etc) caused by producer responsibility from other effects such as economics and the Essential Requirements. For example, many countries have imposed bans on the landfilling of packaging which is suitable for recycling or incineration. In many cases the taxes imposed on waste management also favour recycling and/or incineration.

There has been a change in packaging over recent years, especially in terms of lightweighting. This could however have occurred due to economic reasons. For example, the weight of steel and aluminium beverage cans has been decreasing since 1980s. This is more likely to have been driven by cost-optimisation and programme of continuous improvement rather than legislation.

PR schemes are likely to need to be complemented by other instruments in a waste strategy such as landfill bans. IPP (Integrated Product Policy) signals a shift away from seeing EPR as an end in itself and more as one of a suite of available options. IPP recognises that tools such as EPR and economic instruments need to be used in a way that is appropriate to the product being addressed. IPP will provide a coherent framework for the use of many existing environment related product policies.

Many countries have implemented take back obligations on producers. For many types of primary packaging, such as that which is used in households, the return of packaging to the producer is not feasible. The OECD highlight that packaging waste is -

- Highly mixed
- Sometimes contaminated

- Disposed of in high volumes from many sources
- Generated by a large number of producers
- Generated within a short time span after production

and is therefore not suited to meet the primary goals of return to the producer and recycling[250] unless collective schemes such as producer responsibility organisations are used.

Fluctuating markets can be a problem for producer responsibility schemes. In the UK PRNs were introduced as a means for obligated businesses to demonstrate compliance and to stimulate collection and recycling. These have developed as a free market commodity with associated fluctuations in the price per tonne (see Table 82) although prices have somewhat stabilised. When prices are high, reprocessors have an incentive to invest in recycling but a collapse in the prices, as happened towards the end of 2003, reduces confidence leading to an overall drop in reprocessing capacity as companies move out of the market to other, more profitable areas. The fee structures must also reward companies that choose to design less wasteful and more economically recyclable products.

Table 82 : PRN prices

	November 2001 *£/tonne*	*November 2003* *£/tonne*
Glass	22-28	7-10
Paper	20-28	2-5
Aluminium	20-25	9-12
Steel	20-24	2-5
Plastics	45-60	3-6
Mixed – energy recovery	16-20	2-6
Wood – recovery	16-20	2-6

Implementing producer responsibility can lead to inefficiencies. For example, waste management schemes may operate side by side, as for example, in Germany where the DSD system for packaging waste operates side by side with traditional waste disposal provided by local authorities.

The primary purpose of EPR is to provide incentives to producers to redesign products in order to make them more environmentally sound through minimisation for example. However costs could theoretically be passed onto the consumer which negates this effect. However, where sustainable consumption is being encouraged, higher prices can lead to a reduction in the number and type of purchases made. For EPR to be effective, mechanisms employed need to ensure that some of the financial cost is borne by the producer.

In some cases, such as Finland, Member states had recovery systems in place and functioning well before the introduction of the Packaging and Packaging Waste Directive. Finland had systems in place for corrugated board and glass plus some industrial/commercial systems such as beer and beverage bottles, crates, pallets and roll containers. The Council of state decree introduced producer responsibility and PRO's were set up with associated fees necessary for running the system which introduced economic impacts for companies.

[250] OECD Extended Producer Responsibility: Phase 2: Case Study on the German Packaging Ordinance

It was the opinion of PTR that the quantity and type of packaging placed in the market depends on the products put on the market, their requirements, logistics, trade customers and consumers, rather than producer responsibility.

Both Sweden and Finland have sparse populations which require long transport distances which are not defendable from an environmental aspect.

2.5.6 Conclusions

Few studies have been undertaken assessing the environmental, economic and social effects of Producer Responsibility schemes. This is partly due to the inherent difficulties associated with assessing improvements caused by PR and those caused by other effects. Comparisons between different Member States are hampered by, for example,

- Differences in the definition of waste
- Differences in data collection methodologies
- Differences in the set up of schemes
- Links to other policy approaches

If success is measured by the levels of recycling achieved, then all Member States have increased the overall rates and have therefore achieved success. However, this has not however necessarily been accompanied by an overall decrease in packaging waste production per capita. Despite strong evidence of routine and continual packaging minimisation by industry, rising incomes have led to rising consumption, which has negated packaging minimisation and prevented falls in packaging waste production per capita. In other words, producer responsibility has augmented other (arguably stronger) incentives for packaging minimisation such as routine economic pressures, and has achieved packaging prevention, but not enough to counteract rising consumption.

It is unlikely that an EPR system would succeed without financial incentives or appropriate enforcement. Voluntary schemes that are in place tend to be backed up by the threat of legislation should the voluntary measures not succeed together with other incentives such as landfill bans or high landfill taxes. To successfully lower packaging waste per capita, EPR may need to be backed by somewhat stronger financial incentives and enforcement. To lower packaging waste levels further still in order to achieve decreases in packaging waste in absolute terms, stronger financial incentives and enforcement would be needed. The amount needed would depend on economic circumstances: the more strongly GDP rises, the more strongly consumption rises, and the greater the efforts to support EPD efforts need to be.

The packaging sector is already ahead of many sectors in that it has already broken the connection between growth and consumption, since the amount of packaging waste is rising more slowly than GDP. There are signs in some of the member states with the highest GDP that this gap is broadening (the consumption of packaged goods may tail off in the case of high income consumers, because there is a limit to how many goods they can consume and instead they tend to spend more on services: for example, there is a limit to how many televisions a home can contain, and high-income households show some tendency to buy more services such as holidays instead of more goods such as televisions). While recognising the impressive waste reduction efforts of the packaging sector, it seems appropriate for society to continue to apply EPR as an aid to further increasing the gap between growth in packaging waste and growth in GDP.

2.6 TASK 2.F: PACKAGING PREVENTION – PREVENTION TARGETS AND LANDFILL BANS

2.6.1 Implementation in the Member States

The implementation of prevention targets and landfill bans in the Member States will be discussed in this paragraph.

Waste prevention includes both quantitative and qualitative prevention:

- quantitative prevention refers to a reduction of the amount of waste generated;
- qualitative prevention refers to a reduction of the hazardousness of waste generated[(251)].

The qualitative prevention is addressed in the chapter on the heavy metals and other hazardous and noxious substances in packaging. The quantitative limit values for the amount of packaging to be prevented are discussed in paragraph 2.6.1.1.

The implementation of landfill bans in the Member States is discussed in 2.6.4.

2.6.1.1 Qualitative packaging prevention targets

Qualitative packaging prevention targets are included in the Packaging and Packaging Waste Directive via the ER. Therefore, they will not be assessed in this chapter.

2.6.1.2 Quantitative packaging prevention targets

Different Member States (EU-15) have introduced quantitative (waste) prevention targets at national level. The approaches used aim at qualitative prevention through either the reduction of packaging consumption growth (at source reduction) or the packaging waste arising[(252)]. The implementation of the application of quantitative prevention targets is described for Belgium, Spain, The Netherlands and Denmark.

BELGIUM – QUANTITATIVE PACKAGING PREVENTION TARGET

The Belgian Law on Product Standards[(253)] and the Royal Decree setting Product Standards for packagings[(254)] transpose the essential requirements of Directive 94/62/EC into national legislation. Article 11§2 of the Law on Product Standards consists of a national quantitative packaging production prevention target. It stipulates a standstill provision for the weight of disposable packaging on the market. Any person putting packaged products on the national market which are packed in disposable packaging (non-reusable/one-way packaging) is obliged to pay attention that the ratio between the weight of the packaging and the weight of the product put on the market in this packaging does not increase. The reference ratio is the existing ratio at the date of entrance of the law. This means that for each packaging material, the following ratio cannot increase: total weight of one-way packaging / total

[251] COM/2003/0301 final - Towards a thematic strategy on the prevention and recycling of waste
[252] European Packaging Waste Management Systems, ARGUS in association with ACR and Carl Bro, February 2001 commissioned by the European Commission DGXI.E.3.
[253] Law of 21/12/1998 on product standards (Wet betr. de productnormen ter bevordering van duurzame productie- en consumptiepatronen en ter bescherming v.h. leefmilieu en de volksgezondheid), Belgisch Staatsblad, 11/02/1999
[254] Royal decree of 25 March 1999 setting product standards for packaging (Koninklijk besluit houdende bepaling van productnormen voor verpakkingen), publication in Belgisch Staatsblad 01/04/1999

weight of the goods marketed. (It should be noted that some dispensations to this obligation are foreseen when the packaging incorporate recycled material, for hygiene, security and conservation reasons or for other specific technical reasons.)

Companies that pack goods or who subcontract the packaging of goods, have to present a prevention plan to the Interregional Packaging Commission (IVCie). It contains the planning for the prevention of packaging for a period of 3 years.

The system concerns only the primary packaging and not the transport packaging. This is a weakness of the system as it has been demonstrated by Packforsk[255]. Not considering the system as a whole can lead to unintended and unwanted results. An example of this from Packforsk is illustrated in the image below.

Ginger biscuits are normally wrapped in a thin plastic bag and placed in a cardboard Carton box. To achieve source reduction and produce a lighter package, the film and carton system was replaced by a stronger plastic bag. However this bag requires a stronger transport package, a corrugated board box instead of shrink film. The consumer does not see the transport package and thus he sees the plastic bag as a more environmentally adapted package. This example concerns a carton box containing 275g and a plastic bag containing 350g ginger biscuit. This new primary package provided less product protection and many of the biscuits were damaged

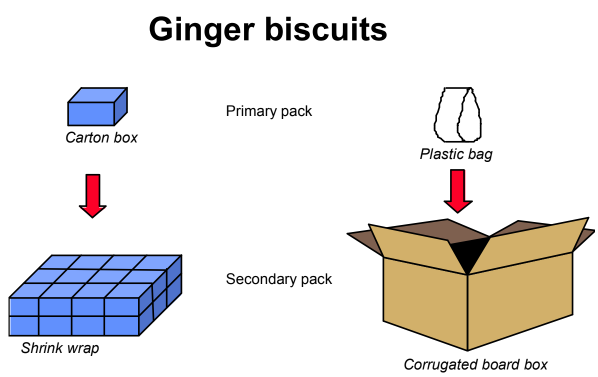

Figure 106: Packaging of ginger biscuits

THE NETHERLANDS – QUANTITATIVE PACKAGING WASTE PREVENTION TARGET

In the Netherlands, a packaging waste prevention targets have been stipulated in the Packaging Convenant[256,257,258]. It is a voluntary agreement, between the government, local authorities and several parties in the packaging industry. The target consists of a reduction target of packaging consumption growth.

Convenant II, stipulated that in the Netherlands the quantity of packaging to be newly introduced on the market in the year 2001 is to be at least 10% lower than the quantity of packaging introduced in the year 1986 (adjusted for economic growth)[257]. The 10% reduction objective is calculated by applying the ratio of the weight of packaging waste to the weight of the packed product. The Convenant distinguishes between qualitative and quantitative waste prevention. One of the protocol directives states that manufacturers and distributors of packaging must annually determine the total environmental load

255 Erlöv L., Löfgren C., Söräs A., Packaging – a tool for the prevention of environmental impact. Rapport nr 194, June 2000. Packforsk (Sweden)
256 Convenant I for the period 01/01/1990 till 31/12/1997
257 Convenant II for the period 01/01/1998 till 31/12/2001
258 Convenant III for the period 01/01/2003 till 31/12/2005, approved on 4/12/2002

of their packaging, with an emphasis on the amount of material used (quantitative), the possibility of recycling and the use of secondary (recycled) materials (both qualitative)(259).

A qualitative and quantitative comparison of the German and Dutch government policies on packaging waste, was performed in 1998(259). It was concluded that to little data is available to make an estimation of the effective prevention. Therefore, no concrete data on this issue were available.

SPAIN– QUANTITATIVE (PACKAGING) WASTE PREVENTION TARGET

Packaging waste prevention target

The law 11/1997 of 24 April 1997(260), on Packaging and Packaging Waste transposes Directive 94/62/EC. Article 5.c sets the quantitative prevention target for the national territory of Spain. It provides for a minimum weight reduction of 10% of the total amount of packaging waste produced by 30/06/2001. The reference year used is 1997(261). At present the Spanish government assessed that the packaging waste prevention target has an effect. This is discussed in more detail in paragraph 2.2).

Waste prevention target

The Spanish National Plan for Municipal Waste (2000-2006)(262) refers to the weight reduction provided for in the legislation and sets additionally the objective to stabilise municipal solid waste generation per capita at 1996 levels by 2002 (this corresponds to a reduction of 6% assuming a constant population growth). Eurostat data indicates that Spanish MSW generation increased from 390 kg/capita in 1996 to 621 kg/capita in 1999, suggesting that it is highly unlikely that the target will be achieved by 2006(263). It is however not possible to come to conclusions based on these figures since all municipal waste is concerned and no split-up to packaging waste is provided for.

DENMARK – QUANTITATIVE WASTE PREVENTION TARGET

Waste prevention target

The Danish government's waste action plan for the period 1998–2004 (Waste 21)(264), provides for the objective to stabilise the total volume of waste by 2004 and to gradually reduce it thereafter. The target aims at decreasing all waste, not only packaging waste.

Latest packaging waste assessments

Recent assessments estimate that waste generation in Denmark increased by 17% over the period 1994-2000 and that it will further increase by about 27% between 2000 and 2020(263).

DEPA commissioned a study on the packaging supply in Denmark for the year 2001(265). This study revealed that the packaging amounts to 191 kilogram per inhabitant per year and accounts for 8% of the

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259 A qualitative and quantitative comparison of the German and Dutch government policies on packaging waste,1999, M. Aarts et al. (Free University in Amsterdam)

260 The law 11/1997 of 24 April 1997, on Packaging and Packaging Waste (Ley 11/1997, de 24 de abril, de Envases y Residuos de Envases (BOE nº 99, de 25.04.97)

261 Royal Decree 782/1998, of 30/04/1998, BOE nº 104, de 01.05.98, por el que se aprueba el Reglamento para el desarrollo y ejecución de la Ley 11/1997, de 24 de abril, de Envases y Residuos de Envases.

262 Plan Nacional de Residuos Urbanos 2000-2006 (Urban Wastes National Plan for 2000-2006), Desarrollo de la Ley 10/98 de 21 /04(Article 5), Ministerio de Medio Ambient, Secretaría General de Medio Ambient, Dirección General de Calidad y Evaluación Ambiental, Madrid, 5 de enero de 2000

263 COM/2003/0301 final - Towards a thematic strategy on the prevention and recycling of waste,

264 Waste 21 (Affald 21), Waste management plan 1998-2004, version 1.0, Ministry of Environment and Energy, Danish Environmental Protection Agency (DEPA),14/12/1999

total waste production. The packaging has increased with 2,5% (in weight) in 2001 relative to the year 2000. This is the highest amount since the eight years of Danish packaging statistics.

No conclusions can be drawn concerning the impact of the general waste prevention target on the packaging waste prevention based on the available information.

EU-15 – QUANTIATIVE WASTE PREVENTION TARGET

The packaging prevention targets as such are not set forward at European level. Only waste prevention targets are discussed at present.

The Community's 5th Environmental Action Programme of 1993 (5EAP) [(266)] included a prevention target for municipal solid waste. The objective consisted of stabilising the annual municipal solid waste generation at an "EC average of 300 kg per capita (the EU average for 1985) on a country by country basis no exceedance of 300 kg per capita". It did not identify a deadline by which this target should be achieved nor the measures necessary to achieve it.

In the resolution of the European Parliament on the [(267,268)] on the communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste[(269)], the European Parliament calls for: the adoption of a quantitative target for the reduction of waste generation of 20% by 2010, taking 2000 as base year.

In the 6EAP[(270)] no quantitative prevention target was set forward since it was estimated that insufficient waste management data were available to come to a scientific waste prevention target. The only target set forward was the decoupling of the waste production from the economic growth.

<u>Impact of the prevention target</u>

In the Commission communication on the global assessment of 5EAP[(271)], commissioned by the European Parliament and Council[(272)] the waste prevention set forward in the EEAP was evaluated. It was

[265] The packaging supply in Denmark in 2001 (Emballageforsyningen i Danmark 2001), Environmental Project No. 831, Danish EPA Soil & Waste 2003, (performed by LOGISYS A/S) financed by the Programme for Cleaner Products, (www.mst.dk/udgiv/publikationer/2003/87-7972-822-7/html/)

[266] "Towards Sustainability", the European Community Programme of policy and action in relation to the environment and sustainable development (5EAP), approved by the Council and the Representatives of the Governments of the Member States on 1 February 1993, Official Journal C 138/59

[267] Minutes of 20/04/2004, based on Document No. A5-0176/2004 - Provisional Edition European Parliament resolution on the communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste (COM(2003) 301 - C5-0385/2003 - 2003/2145(INI)) - DRAFT REPORT on the communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste 2003/2145(INI))Committee on the Environment, Public Health and Consumer PolicyRapporteur: Karl-Heinz Florenz

[268] Ammendments 1-57 to the draft report Motion for a resolution of the European Parliament on Communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste (COM(2003) 301 – C5-0385/2003 – 2003/2145(INI)), AM\525587EN.doc PE 340.786/1-57, 24 February 2004, Committee on the Environment, Public Health and Consumer Policy, Draft report, Karl-Heinz Florenz

[269] COM/2003/0301 final - Towards a thematic strategy on the prevention and recycling of waste,

[270] Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme, Official Journal L 242, 10/09/2002 P. 0001 - 0015

[271] COM/99/0543 final - Europe's environment: What directions for the future? The global assessment of the European community programme of policy and action in relation to the environment and sustainable development, 'Towards sustainability' COM/99/0543 final

[272] Decision No 2179/98/EC of EP and Council of 24/09/1998 , OJ L275 , 10/10/1998

concluded that: "In 2000 Waste prevention measures have not stabilised production of waste nor its hazardousness."

Reliable analyses for the packaging waste streams as such are not available at present at EU level. Therefore it is not possible to estimate the evolution of the packaging waste in the municipal waste stream.

2.6.2 Evaluation of quantitative prevention targets

2.6.2.1 Waste prevention targets

General waste prevention targets

Although (general) waste prevention has been a priority in the waste strategy of the Community, limited progress has been made so far to turn the objective of waste prevention into practise. Even in the Member States with a specific (packaging) waste prevention target set forward in national legislation or in national waste management plans, the waste prevention was not successfully.

The effect of general waste prevention targets on packaging waste prevention has not been investigated. However, since the overall effect is missing, it can be assumed that this is not a good tool to increase the prevention of packaging waste.

2.6.2.2 Packaging prevention targets

Most stakeholders estimate that packaging prevention targets (packaging generation prevention targets, prevention at source), can help to encourage the prevention of packaging (Europen, EEB). In Belgium and Spain this system is operational and the industry has to inform the authorities by means of packaging prevention plans (see 2.2).

2.6.2.3 Quantitative evaluation

A quantitative evaluation of the development of packaging put on the market in countries with waste prevention targets versus countries without such targets is done by plotting the evolution of GDP and packaging consumption against each other.

- Belgium

The implementation of the quantitative packaging waste prevention target in Belgium started in 2000. In the plot of the GDP versus the packaging waste production it is clear that since 2000 a decoupling of the packaging waste from the economic growth has been established. However, based on these data it is not possible to draw conclusions on the direct link between both. It has for example to be taken into account that also the packaging prevention plans were introduced in Belgium. The levels however are still higher than the 1997 packaging waste production.

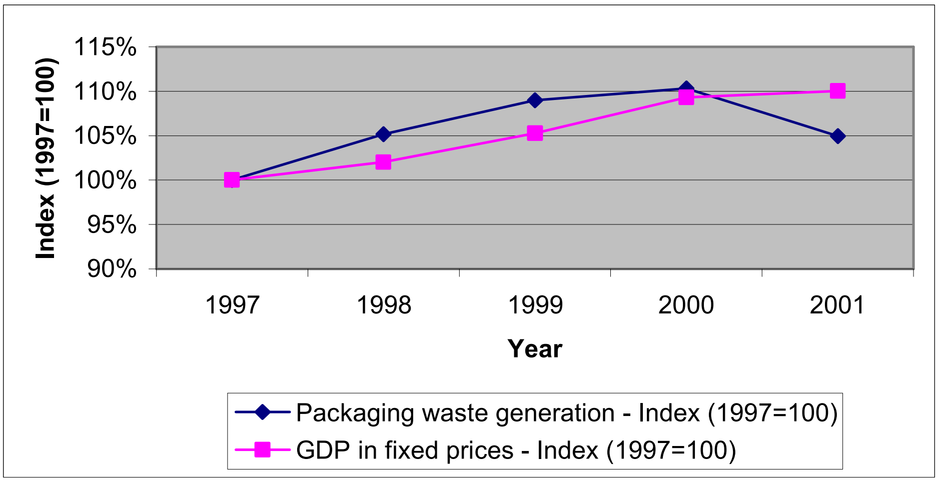

Figure 107: Development of packaging waste generation and GDP in Belgium 1997-2001

- Spain

The target for Spain consisted of a minimum weight reduction of 10% of the total amount of packaging waste produced by 30/06/2001. This target has not been achieved since the waste production has increased with 2%. However, a decoupling of the packaging waste production from the GDP growth has been established.

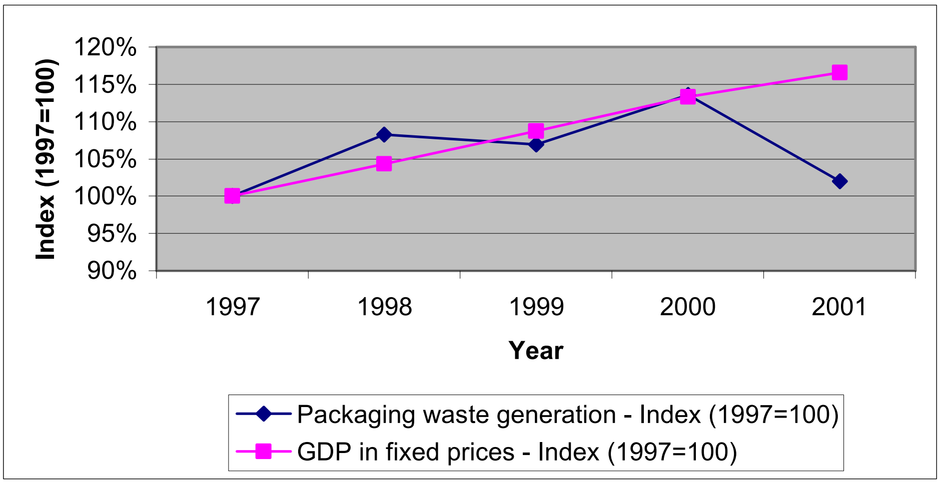

Figure 108: Development of packaging waste generation and GDP in Spain 1997-2001

The quantitative packaging waste prevention target for The Netherlands consisted of the fact that the quantity of packaging to be newly introduced on the market in the year 2001 has to be at least 10% lower than the quantity of packaging introduced in the year 1986 (adjusted for economic growth). When evaluating the situation in 2001, it can be concluded that this objective was obtained.

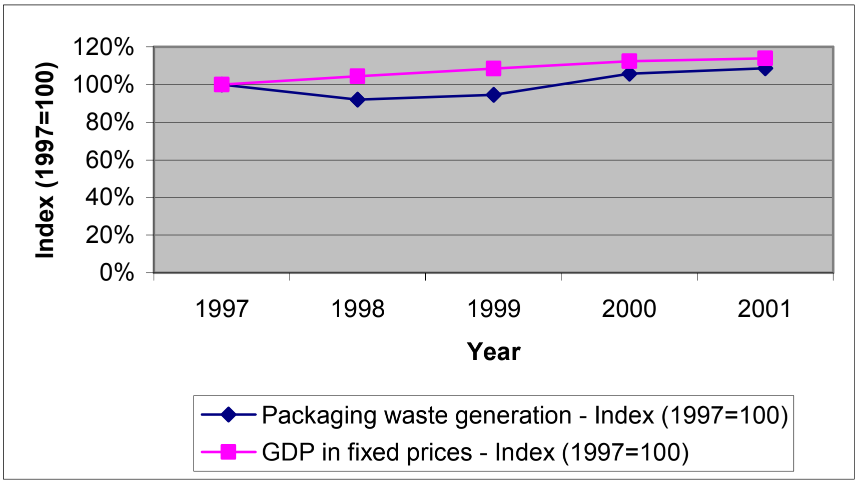

Figure 109: Development packaging waste generation and GDP in The Netherlands 1997-2001

- Europe

On the European level, a limited decoupling of the packaging waste production from the GDP has been established. However, to interprete that this means that the packaging waste prevention targets are the only driving force behind the higher decoupling in the before mentioned Member States, not enough information is available concerning the different causes.

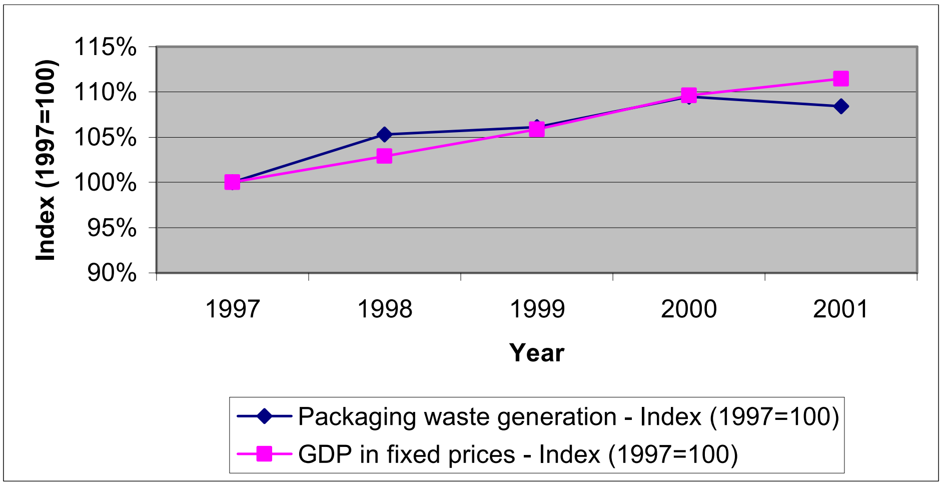

Figure 110: Development of packaging waste generation and GDP in Europe 1997-2001

2.6.3 Identification of parameters to be used for enforcement of packaging prevention targets

Waste statistics

Operational, quantified waste prevention targets have to be based on a comprehensive environmental and economic analysis. Each Member State has to report annually on the wastes concerned under the

Packaging and Packaging waste directive. The first complete set of waste generation and management data (for the complete waste management sector) will be available in 2006 (data of the reference year 2004) conform the waste Statistics regulation(273). A first trend assessment of waste generation will be possible at the time of availability of two data sets in 2008 (data of 2004 and of 2006). These data can at that time be used to make an evaluation of the relative environmental impact of the packaging waste to the total waste fraction.

Life-Cycle-Assessment

The existing waste prevention targets have focused on the weight or volume of waste generated (sometimes in relation with the amount of packed product). However, it is questionable whether weight or volume, are always the most appropriate indicators of the environmental burden of waste. It proposed that waste prevention targets should take into account the environmental impacts of the prevented waste in all the stages of the product life cycle(278). The different stages consist of product design, production, sale systems, consumption, disposal systems and including the transport at all stages(274).

2.6.4 Implementation of landfill bans

EU LEVEL – PROGRESSIVE LANDFILL BANS

On EU level at present only a progressive restriction for the landfilling of biodegradable municipal waste and for non-treated waste is provided for in EU Landfill Directive of 1999(275). The limit is not specifically introduced to restrict the disposal of packaging waste in landfills, but to reduce the organic components of waste being landfilled and has as a result an influence on the biodegradable packaging.

In its latest (April 2004) resolution(276,277) on the communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste(278), the European Parliament calls for:

- the quantities of waste for disposal to be reduced to a minimum, in particular by means of the most extensive ban possible on landfill of recoverable waste by the year 2025, and requests the Commission to submit a phased timetable which might take the following form:
- from 2010, an 80% ban on landfill of non-pre-treated waste with biodegradable components;
- from 2015, an 80% ban on landfill of paper, cardboard, glass, textiles, wood, plastics, metals, rubber, cork, pottery, concrete, brick and tiles;
- from 2020, a 90% ban on landfill of all recoverable waste;

273 Regulation (EC) No 2150/2002 of EP and of Council of 25/11/2002 on waste statistics OJ L332 , 09/12/2002
274 How to achieve prevention at European Level and the role of local initiatives, G. Vogel, Head, Vienna University of Economics and Business Administration, Department of Technology and Commodity Science
275 Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, Official Journal L 182 , 16/07/1999 P. 1 -19
276 Minutes of 20/04/2004, based on Document No. A5-0176/2004 - Provisional Edition European Parliament resolution on the communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste (COM(2003) 301 - C5-0385/2003 - 2003/2145(INI)) - DRAFT REPORTon the communication from the Commission: Towards a thematic strategy onthe prevention and recycling of waste2003/2145(INI))Committee on the Environment, Public Health and Consumer PolicyRapporteur: Karl-Heinz Florenz
277 Ammendments 1-57 to the draft report Motion for a resolution of the European Parliament on Communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste (COM(2003) 301 – C5-0385/2003 – 2003/2145(INI)), AM\525587EN.doc PE 340.786/1-57, 24 February 2004, Committee on the Environment, Public Health and Consumer Policy, Draft report, Karl-Heinz Florenz
278 COM/2003/0301 final - Towards a thematic strategy on the prevention and recycling of waste,

- from 2025, a 90% ban on landfill of all residual waste, except where this is unavoidable or hazardous (e.g. filter ash).

This means that a landfill ban may be introduced which is not focused on packaging as such but on material flow basis.

NATIONAL LEVEL

Different countries have introduced specific landfill bans or progressive landfill taxes, which aim at decreasing the amount of waste disposed of in landfill. An overview of the present and foreseen bans and taxes is presented in Annex 16: Landfill bans or progressive landfill taxes in the EU Member States.

2.6.5 Evaluation landfill bans

Landfill bans redirect the generated waste to other waste management methods such as recovery (material or energy) and incineration without energy recovery. They have no impact on the prevention at source (avoidance of packaging where it is not needed; reduction of environmental impacts due to changes in production and consumption patterns).

The main effect of the introduced landfill bans has been the incineration without energy recovery, which has even a bigger environmental impact than the disposal in landfill. Therefore a ban for the disposal of packaging waste without any accompanying measures will not have an effect on the prevention of packaging or on the establishment of higher recycling or reuse rates.

Landfill bans or taxes can be implemented in combination with other measures such as a ban on incineration of packaging waste without energy recovery to increase the packaging recycling and recovery. In the case of preferred material reuse, a taxation or ban on incineration with energy recovery can be envisaged.

As an example it should be noted that for paper and board packaging which are covered by the Landfill Directive (targets biodegradable waste), the targets have contributed to recycling rates quite considerably in countries where accompanying measures such as separate collection of used paper and board products were introduced.

3. TASK 3: PACKAGING REUSE

3.1 INTRODUCTION

The Packaging and Packaging Waste Directive (94/62/EC), alongside setting targets for recovery of packaging, encourages the establishment of reusable packaging systems. Article 5 of this Directive states that "Member States may encourage the reuse of packaging". The task for this report was stated as being that "options shall be identified and assessed for a stronger harmonisation of measures to encourage reusable packaging on a Community level, including possible Community measures to encourage reusable packaging where environmentally beneficial".

Encouragement of reuse was written into the Directive due to the potential of reuse to contribute to the packaging waste minimisation aims of the Directive. Several member states introduced measures to protect existing systems and encourage new ones. These measures tend to be aimed at consumer packaging.

The figures below show trends in the market share of reusable and single-trip packaging for beer and soft drinks in Western Europe from 1998 to 2007 (future years are projections)[279]. The black bands in the figures represent refillable glass bottles.

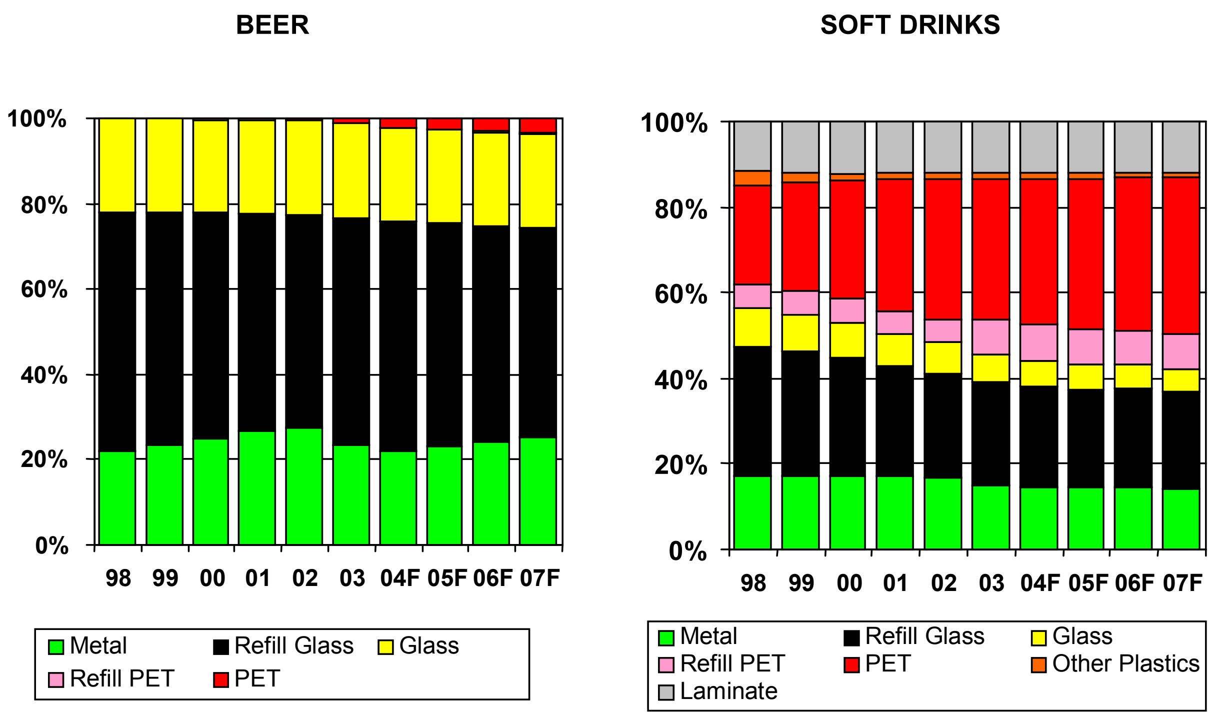

Figure 111: Market share of refillable and single-trip packaging in Europe

[279] INCPEN member company analysis, 2004

These are average European figures. They are the result of one company's research, although most stakeholders agree with them, for example: "The current trend observed in all EU is a decrease in the market share of refillables. Countries where no specific measures were put in place to protect reusable beverage packaging are now countries where one-way containers dominate the market."[280] However not all stakeholders agree with the future projections; users of refillable bottles have expressed the opinion that market shares are likely to decline faster than shown unless suitable protection measures are in place. In terms of the past position, country-specific figures from different sources show a similar picture. The example below shows the decline in Austrian refillable packaging[281]. "The Austrian system is now at risk completely," according to the German Refill Alliance. The decline in Austrian refillable packaging is also the background for a voluntary Sustainability Agenda of the Austrian beverage industry for the period 2005-2007 agreed between the Austrian beverage industry and the government.

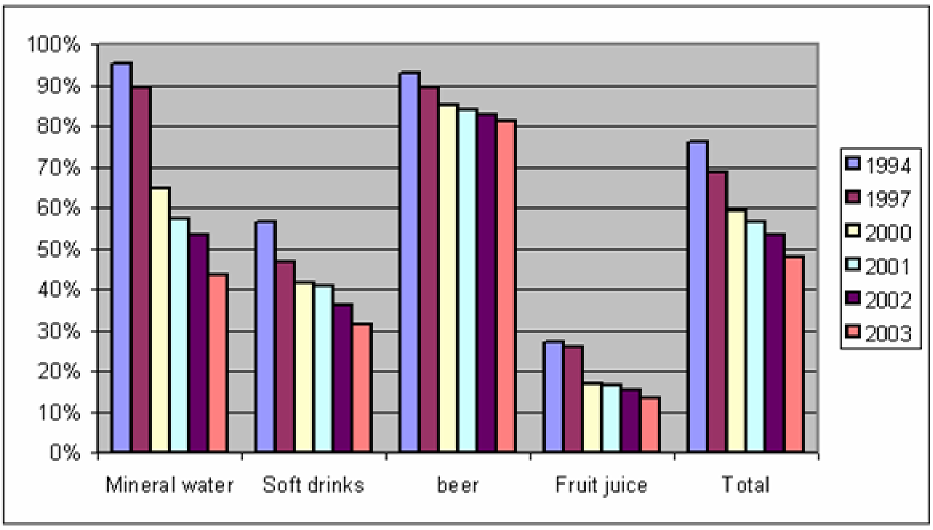

Figure 112: Market share of refillable drinks packaging in Austria

3.2 THE PARAMETERS DEFINING REUSE

3.2.1 Examples of reusable packaging systems

There are many examples of existing reusable packaging systems in Europe.

In Germany, over 230 mineral water bottlers share refillable glass and PET bottle systems[282]. The system is organised by an industry cooperative (the GDB). The pool consists of over two billion bottles and 175 million crates, making it one of the largest refillable packaging pools in the world. Since the late 1990s over one billion Euros has been invested in refillable PET bottles and these now make up over a third of the bottles in the pool. The water companies tend to be relatively small (average 50 employees) and the distribution of their products is usually strongly localised, with much of the water only being transported a few kilometres. Very little is distributed nationally and less than 10% is exported (in marked contrast to French water producers for example). Return rates are high: not only are deposit systems in place to

[280] German Refill Alliance, 2004, stakeholder submission

[281] German Refill Alliance, 2004, stakeholder submission

[282] GDB, 2004, Refillables Success Story (stakeholder submission)

encourage consumers to return bottles, but additionally, German consumers recognise the standardised bottles as mineral water bottles and understand the importance of returning them.

A similar system also exists in Germany for beer. The system is used by more than 1000 small breweries. The breweries share standardised bottles in a pool system (brand differentiation is achieved by labelling, each brewery having its own distinctive labels). Retailers have bottle collection facilities. Consumers often buy beer in case lots (using reusable plastic crates) and shop for beer by car. Distribution and reverse-distribution distances are generally short; with an average return total trip distance of 94km. Trip rates are high due to inherent consumer support and financial incentives. A financial deposit system exists whereby the deposits applying to single-trip packaging are higher than the deposits applying to refillable packaging. The deposit system makes the retail price of beer in refillable bottles similar to that of beer in single-trip packaging.

In Austria, refillable PET bottles are used for soft drinks. Introduced in 1990, the market share of refillable PET bottles grew in the first few years, but has declined more recently due to competition from single-trip PET bottles. The return rate by consumers is high (98%) although the refilling plants reject bottles with greater frequency since PET bottles cannot be washed and refilled as many times as glass bottles.

In Denmark, glass and PET bottles for a variety of alcoholic and soft drinks are standardised (approximately ten types of standardised refillable bottle exist).

In the UK, around 50% of beer is sold in refillable bulk kegs (compared with, for example, Denmark, where only 9.5% is sold in refillable kegs[283]). Kegs are supplied to pubs and returned to fillers in an efficient closed loop system. The bulk nature of the packaging and the closed-loop efficiency of the keg system mean that it is likely to be more environmentally efficient than refillable bottle systems, but of course bulk delivery is specialised and unlikely to be feasible in situations where consumers purchase beer for home consumption.

Also in the UK, a system exists for delivery of milk using refillable glass milk bottles. Bottles are delivered to homes by efficient electric vans. Consumers return empty bottles by placing them outside their house to be picked up during the next delivery. The distribution of the milk is localised and return rates are high. Simple disposable aluminium foil lids are used and the colour of these indicates the type of milk, so no labelling is required on the bottles. The situation of different brands competing for consumer attention in a retail environment does not exist and so milk bottles do not need to look enticing for marketing purposes: their appearance is functional rather than aesthetic. The float (the extra number of bottles the system requires to cater to peaks in demand and to allow for the bottles held by fillers, retailers and consumers) is relatively small because milk is consumed quickly and demand is relatively stable. Relatively little extra transport is incurred in returning empty bottles because they are picked up and carried on the electric vehicles as part of the same delivery routes as the full bottles. (Once the dominant form of milk packaging, currently 20% of milk sold in the UK is packaged in this way and the amount is declining by a tenth each year.)

In Norway, soft drinks in refillable containers have a market share of around 98%, and beers in refillable containers have a market share of 44%. Economic instruments based on a Pigovian model are aimed at internalising external costs to promote reuse and recycling. The tax encourages high recycling rates for one-way containers: in order to achieve high return rates and pay lower taxes, the beverage industry has voluntarily built up a deposit system for one-way containers. The return rate that ensures the lowest tax level is determined by the Ministry of Environment each year and is different for the different materials.

[283] Andreas Golding, 2000, Reuse of Primary Packaging Final Report: Part II Country Reports

(Further details of incentive systems for a variety of reusable packaging systems can be found in Appendix 17).

3.2.2 Features causing the success or decline of reusable packaging

Successful reusable packaging systems have two basic features in common:

- Localised product distribution (and therefore low transport impacts: reuse systems incur greater environmental impacts during transport than single-trip packaging because refillable packaging weighs more and requires more reverse distribution, so reusable packaging fares best in terms of transport impacts when travelling relatively short distances; large beverage producers can normally solve this problem via the creation of a network of filling plants).
- High return rates (the environmental impact of reusable packaging decreases the more times it is reused; high return rates depend on such aspects as the efficiency of the closed loop nature of the product distribution and reverse distribution system and tight control of the consumer stage).

These features can be placed under stress by societal changes. For example, stress can be placed on reusable packaging systems if:

- International trade increases or the cost of transport gradually falls in real terms (low transport costs and open markets tend to lead to greater availability of non-local goods; reusable packaging is disadvantaged by higher transport distances – although when compared with single-trip packaging that is equally localised, reusable packaging systems benefit from lower fuel costs since they require extra transport due to reverse distribution).
- Companies seek to increase their sales through exports or centralise manufacturing to achieve economies of scale (centralised manufacturing disadvantages refillable packaging: "fillers are getting larger and larger over time and they are centralising production, which increases their interest for one-way packaging"[284]).
- Consumers come to prefer a wider choice of more imported goods (reusable packaging is usually less feasible for such goods) or tend to choose products packed in perfectly new-looking, brand-unique packaging (since reusable packaging is often a non-brand-specific shape and will seldom look as immaculate as single-trip packaging).
- Lifestyle changes cause consumers to consume more out of the home (for example having a soft drink while out shopping: the fastest growing segment is the convenience segment, which is dominated by out of home consumption, when consumers tend to prefer containers that can be disposed of immediately).
- Consumer needs or fashions change faster than reusable packaging can adapt (the investment in reusable packaging stocks means that the packaging cannot be changed as rapidly as single-trip packaging can be).
- Consumers require a greater range of pack sizes due to increased variability of households (such as more people living alone: packs which are too large for consumers' needs can lead to product wastage which usually causes greater environmental impact than appropriately-sized packaging[285]; since refill systems rely on standardised containers they may be less able to meet consumers' needs for a wide variety of portion sizes).

Conversely, single-trip packaging will be placed under pressure if:

- Consumers begin to place more value on local products and avoid imported products.

[284] German Refill Alliance, 2004, stakeholder submission

[285] Kooijman, 2001, INCPEN

- Society becomes more homogeneous and more home-based (so that wide varieties of pack size and products designed for easy out-of-home consumption are unnecessary) and less urbanised (so that consumers are closer to food producers).
- Transport costs rise or barriers to trade increase (so that local products are favoured).
- Companies have incentives to decentralise and build local manufacturing operations (so that the incentives to localise outweigh the incentives to centralise).

Although there are some signs that in future transport costs may begin to rise (the price of crude oil is currently at an all-time high) and consumers may come to value local products to a greater degree (the concept of food miles is attracting growing interest), many of the societal changes in the last century appear to have been of the type identified as tending to disadvantage reusable packaging. This is why, according to some stakeholders, "supporting measures are key to ensuring the future of reusable/refillable packaging in Europe"[286]. (All stakeholders seem to agree that reusable primary packaging may face an uncertain future without supporting measures, but stakeholders are divided about whether such support should be given.)

3.2.3 Life cycle assessments of reusable and single-trip primary packaging

The findings of LCA studies have been subject to fierce debates among experts and stakeholders. Many of the results presented below continue to be subject to challenge from both experts and stakeholders who consider the results and their interpretation too favourable for one-way packaging and experts and stakeholders who consider the results and their interpretation too favourable for reusable packaging.

LCA results are highly dependent on the parameters and assumptions that are made about product supply systems, such as electricity generation methods (which differ greatly from country to country), transport distances, return rates, recycling rates, the existence of control mechanisms or incentives such as deposits, and so on. These features of product supply systems depend on the particularities of society in which the packaging system exists, including consumer behaviour and choices. Many industry stakeholders have therefore voiced concern that the use of LCA to identify single answers to the question of whether reuse or recycling are "environmentally preferable" without considering these particularities may produce flawed results.

LCA design depends on the particular systems being studied and the aims of the study, and cannot be decided with complete scientific objectivity. This is one of the reasons why the many LCAs that have been undertaken in this area have often been unable to reach conclusions or reach opposing conclusions. If these features are separated out, studies tend to be in agreement to a greater extent than first appearances might suggest:

- Studies that focus on product supply systems with low transport distances (ie localised production, distribution and consumption) and high return rates (usually achieved through tightly-controlled distribution systems such as industrial systems or deposit consumer systems) tend to show that reusable packaging systems are environmentally and economically desirable. For example, the German Refill Alliance reviewed specific examples where such parameters exist and concluded: "Refillables are found to be superior in terms of economic and environmental performance in all cases, except when several specific circumstances are present at the same time. In those cases, they are mostly found to be equal.[287]"
- Studies that focus on product supply systems that have low return rates and longer transport distances tend to show that one-trip packaging is preferable. To give one typical example, a study

[286] German Refill Alliance, 2004, stakeholder submission

[287] German Refill Alliance, 2004, stakeholder submission

of refillable versus single-trip PET bottles showed that refillable PET appeared preferable in markets with short transport distances, and single-trip PET appeared preferable in markets with long distances (although the results were highly dependent on the assumptions used such as the PET recycling rate[288]).

In the middle ground, studies which assume high return rates and high distribution distances or vice versa, or which assume moderate values for both, often tend to reach inconclusive results. This is not because the studies are flawed but because the environmental (and, often, economic) differences between the competing packaging systems are not clear enough. Depending on assumptions for which no objectively correct values can be used (e.g. electricity generation methods; weighing of impact categories against each other), one or the other type of packaging will fare better or worse

All stakeholder experts with whom reuse was discussed during the preparation of this study agreed on this general trend. In terms of identifying the maximum feasible transport distance for reusable consumer packaging, opinions differed as to where the 'break-even' point might be, but the differences of opinion were not insurmountably large. Initially some stakeholders expressed concern at the selection of studies reviewed in the first draft version of this study, fearing that the selection might be biased in some way. Therefore, instead of selecting certain studies for discussion, all the studies supplied by all stakeholders have been reviewed in reaching conclusions.

To give a sample of the LCAs reviewed, below is a table provided by the German Refill Alliance summarising four LCAs (the summary conclusions are those of the Alliance and other conclusions are possible). These LCAs demonstrate the environmental success of certain refill systems in Scandinavia and Germany where return rates tend to be high (due to deposits, quotas and so on) and distribution distances tend to be relatively short (due to localised product supply systems such as the local mineral water producers in Germany):

EXAMPLE SUMMARY OF FOUR LCAS				
	LCA 1	**LCA 2**	**LCA 3**	**LCA 4**
Country	Norway (15 people per sq km)	Netherlands (480 per sq km)	Germany (184 per sq km)	Denmark (129 per sq km)
Peer review	No	Yes	Yes	Yes
Scope	Refillable PET system for mineral water/soft drinks compared to one-way system with the same conditions	Three 1.5l PET scenarios: current refillable, modified refillable, future one-way	Refillable glass and PET bottles and one-way PET bottles. Small and large sized bottles and return in crates are included	Refillable and one-way glass and PET bottles, aluminium and steel cans
Transport	240 km (direct distribution) to 490 km (indirect delivery)	100-250 km from filler to distribution centre plus 50-100 km from centre to supermarket: total 150-350 km	Refillables: 150-200km from filler to store One-way: 250-300km	12km to 310km Average 170 km round trip
Trip rate	12.75 for 0.5l 16.5 for 1.5l	12-25 for scenario 1 12-30 for scenario 2 Sensitivity analysis 10-35	15 for 0.5l PET 14-16 for 1-1.5l PET 21 for 0.33-0.5l Glass 50 for 0.7- 1.0l Glass	20 for 0.5l PET 40 for 0.25-0.33l Glass
Return rate	97% for both one-way and refillable	99.8% for both one-way and refillable	70% for small one-way PET and 90-99% for large 97% for small refillable PET/ glass and 99% for large	90% for one-way 98.5% for refillable
Deposit system	Yes for both one-way and refillable	Yes for both one-way and refillable	Yes for both one-way and refillable	Yes for both one-way and refillable
One-way recycled content	25%	50%	50%	0 %
Summary conclusions	The two PET systems are about equal from an environmental point of	Refillable PET comes out as the environmentally superior option	Refillable PET clearly comes out as the environmentally superior	Refillables and aluminium cans have the best environmental

288 German Refill Alliance, 2004, stakeholder submission

EXAMPLE SUMMARY OF FOUR LCAS				
	LCA 1	**LCA 2**	**LCA 3**	**LCA 4**
	view		option	performance

LCA 1: Miljøvurdering av gjenvinnbare og gjenfyllbare PET-flasker brukt som drikkevareemballasje i Norge", Stiftelsen Østfoldforskning (STØ), 2003.

LCA 2: LCA voor meermalige en eenmalige verpakkingssystemen met statiegeld voor frisdranken en waters", TNO (Netherlands Organisation for Applied Scientific Research), 2001.

LCA 3: Ökobilanz der PET Stoffkreislauf Flasche und anderer Getränke-verpackungssysteme ifeu - Institut für Energie und Umweltforschung Heidelberg, 1999.

LCA 4: Life Cycle Assessment of Packaging Systems for Beer and Soft drinks, Chalmers Industriteknik and Institute for Product Development, Danish Environmental Protection Agency, 1998

Another important study used to underpin national policy decisions is Getränkeökobilanz II[289]. This study evaluated a wide range of drink, packaging and distribution scenarios. Its main conclusions were:

- "For mineral waters and carbonated soft drinks the existing refillable PET systems are superior from an environmental point of view if compared with the existing refillable glass bottles. This is particularly true regarding the environmentally important categories fossil resource consumption, global warming and acidification".

- "Based on the applied evaluation scheme for carbon-free beverages and wine there are no relevant environmental advantages and disadvantages between existing refillable glass bottles and the beverage carton systems"

- "One-way container systems from glass, aluminium and steel show significant environmental disadvantages when compared with refillable container systems. Again, the environmentally important categories fossil resource consumption, global warming and acidification are the decisive parameters.

As with many other studies, there are debates on the exact values used in the Getränkökobilanz II study and the dimension of differences. This is also reflected in the evaluation of the critical review panel to this study which nevertheless broadly confirmed the conclusions.

The Getränkeökobilanz II study, as stated in a presentation[290] at the DG Environment/Europen LCA workshop, also found that the "eco-profiles of reusables and non-reusables are substantially different". In the case of reusables, distribution and bottle rinsing cause the main impacts, whereas for non-reusables, production of packaging and packaging material dominates the ecological impacts. For all packaging systems, the results were found to correlate well with cumulated energy demand. In other words, the energy use of a packaging system was found to define much of its environmental performance.

An overview and critical analysis of LCA studies is also given in a review of LCA studies commissioned by EUROPEN[291]. This study concludes that it is difficult to give a single answer to the question of whether reuse or recycling are preferable.

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[289] Getränkeökobilanz II (Part 1), Umweltbundesamt Berlin, Report 2000. UBA-Texte 37/00. Prognos (Basel), IFEU (Heidelberg), UBA (Berlin); and Getränkeökobilanz II (Part 2), Umweltbundesamt Berlin, Report 2002. UBA-Texte 51/02. Prognos (Basel), IFEU (Heidelberg), UBA (Berlin).

[290] UmweltBundesamt, LCA for Drinks Packaging, DG Environment / EUROPEN LCA Workshop 20 June 02i

[291] A review of LCA studies, Dr. Neil Kirkpatrick, URS Corporation Ltd. London, May 2004.

The studies reviewed reveal situations where each type of packaging performed better than the other. No study found that either type of packaging was clearly always better or worse for the environment irrespective of the assumptions used. Most studies found reusable packaging to be best in relatively common situations with generally low transport distances and high return rates, and single-trip packaging to be best in specific situations with generally high transport distances and low return rates. Many studies found that for a medium range of parameters the environmental advantage of reusable systems was limited. All studies were sensitive to a wide variety of assumptions used, such as those concerning collection and recovery (for example, regions that have deposit systems for both reusable and single-trip packaging tend to achieve higher collection and recycling rates, so studies tend to be rather region-specific and case-specific) and the energy generation used (for example, an aluminium can will have a very different environmental impact depending on whether the electricity used to manufacture it was generated by hydro-electricity or coal). Therefore, there are rather ranges of possible results than single values. These ranges are often bigger than the differences between packaging options[292]. However, this should also not be overestimated. Very often variations in the underlying assumptions are reflected in a similar way in all compared packaging options (i.e. if a high value is assumed for electricity related emissions, this is likely to impact both on the re-usable and the one-way option in a similar way and the ranking between options often does not change). For all these reasons, precise conclusions are not possible, but some broad generalisations are possible. One of the most significant parameters for which generalisation is possible, to some degree at least, is that of distribution distances.

One industrial stakeholder who generally questions the use of LCA for justifying policy measures in favour of reuse has commented that "the shorter the transport distances between production/consumption and the greater the trippage number of re-usable packaging, the more re-use may be ecologically/economically an interesting option. This should be recognised and adequate policy conclusions be drawn, considering that reuse encouragement shall not hamper the proper functioning of the EU Internal Market nor distort competition."[293] This inevitably leads to debates on the proper balance between Internal Market and environmental objectives, to which there is no simple answer.

Drawing on the existing studies, estimations can be made of the ranges for which reusable packaging may be environmentally superior, one-trip packaging may be environmentally superior, or the picture is mixed. The 'mixed' range cannot be defined precisely based on current data but it is within the order of magnitude of 100 to 1000 km. Around the 100km order of magnitude, the majority of LCA studies show reusable packaging to be environmentally advantageous (for example, LCAs show that many northern European localised reuse systems achieve environmental benefit, such as the German beer bottles travelling 94km on average). Around the 1000km order of magnitude, virtually all LCA studies show single-trip packaging to be environmentally equal or advantageous. Within the 100-1000km range different studies produce differing results depending on the particular packaging systems investigated. This is because reuse systems are variable, and different systems have different maximum feasible distances. For example:

- A reusable transit tray that folds flat for space-saving reverse distribution, and returns in container loads that primarily contain other products and so does not incur extra reverse distribution transport, is likely to have a maximum feasible distance towards the 1000km or more end of the range.
- A reusable PET bottle that is relatively light and volumetrically efficient (compared to a reusable glass bottle) will incur lower transport impacts and even though it cannot be collapsed for reverse distribution (and so incurs heavier transport impacts in that stage than a collapsible transit tray) is

[292] Eco-balances for policy-making in the domain of packaging and packaging waste, RDC/Coopers&Lybrand for the European Commission 1997.

[293] BCME, 2004, document in preparation

still likely to have a maximum feasible distance in the middle of the range (studies that have found reusable PET bottles to be environmentally preferable have looked at average transport distances of 150-350km[294]).

- A reusable glass bottle, being of greater mass and volume than single-trip packaging, increases the number of trucks required per unit of beverage and incurs greater transport impacts in both distribution and reverse distribution, so is likely to have a maximum feasible distance towards the bottom of the range.

Stakeholders have commented that if a narrower range could be determined this would be more useful than the 100 to 1000km range, but currently there are not enough data to support a narrowing of the range, and it is likely that even if more studies were undertaken the range would remain wide since that is the reality of the variability of reusable packaging systems.

As the EEB has commented[295], "There is no general break-even point for transport distances. The break even point for distances depends on the material (eg glass or PET), the chosen ecological parameter (eg CO_2, greenhouse gas, energy etc) and the outline of the logistics, and can only be analysed case by case."

As long as the *average* distribution distance is less than the maximum feasible distance for any given reuse system, environmental benefit will be achieved. For example, if most of the bottles in a refillable bottle system travel only 50km, but a few travel 1000km, overall environmental benefit is achieved, even though the bottles that have travelled 1000km, when considered individually, may be poor environmental performers. Therefore the existence of individual examples of unfeasibly long transport distances does not necessarily prove that a reusable system is inappropriate. For example, if a localised German refillable bottle system for beer has a few members transporting from the Czech Republic, the system as a whole may be a sensible environmental option even though the Czech bottles themselves could be shown to be an undesirable environmental option in LCA terms.

It should also be pointed out that transport scenarios for particular companies are not necessarily fixed but will vary depending on the choice of packaging system. In particular, big soft drinks and beer producers can adapt to a more local distribution scenario as required for reusable packaging by using local filling installations.

3.2.4 Non-consumer reusable packaging

Over the last decade reuse has increased (from a level that was already higher than the public probably realised) in industrial and transit packaging[296]. There are undoubtedly more reusable packaging systems in existence than many consumers realise, because the societal and distributional features that suit reusable packaging exist more often within industrial and commercial operations than in consumer situations. For example, bread, vegetables and beverages are distributed in refillable transport packaging relatively often (mainly plastic trays and crates). Goods are often shipped on reusable wooden or plastic pallets. Industrial chemicals are often transported in reusable bulk crates and tanks. Car parts and similar engineering products are frequently shipped in specialised reusable packaging (for example Ford Australia reported that changing from four litre cardboard cases to reusable injection moulded plastic bins saved the disposal of approximately 500 corrugated cases per day equivalent to around 30 tonnes per

[294] German Refill Alliance, 2004, stakeholder submission

[295] EEB, 2004, stakeholder submission

[296] EUROPEN and members of the ACP task force on reusable packaging, 2004, *pers comm*

year[297]). Some medicines are delivered to hospitals and doctors' surgeries in reusable, foldable plastic crates[298]. TIMCON gives further examples of reusable wooden packaging: pallets (Europallet, Rental Pools, Chemical industry 9 sizes, Electronic worldwide), pallet collars, cable reels and drums, potato and apple one tonne boxes, vegetable crates, beer keg pallets and ammunition boxes.

These reuse systems are successful environmentally and financially for a wide variety of reasons. For example they are part of a tightly controlled closed loop and return rates are often exceptionally high, transport distances are often relatively short and the appearance of the packaging tends to be unimportant. Kunskapspartner, in discussing why reusable transit packaging is more common in Britain than Sweden, highlights population density and distribution differences, and says: "The English system consists of completely integrated companies, in which decisions are made centrally, and stores take delivery from their own wholesalers … there is a high degree of control over the flow of crates."[299] For example the UK supermarket chain Tesco used 170 million reusable tray trips in 2003, an increase of 5.4% over the previous year. Tesco has its own distribution system and manages supplier relationships closely, so all parts of the supply chain work well together to make the reusable system efficient and successful. The system was awarded the Queen's Award for the Environment in 2000[300]. There are many other examples of growing reusable transit packaging systems in the UK, such as 2-litre PET soft drink bottle trays, crates for eggs, crates for mobile telephones and bulk containers for liquids and powders.

Many studies demonstrate the importance of such organisational, logistical and societal aspects. A Dutch study found that the 'eco-costs' of single-trip, rigid reusable and foldable reusable transit were very similar when transport distances were under about 500km, after which the single-trip transit packaging gradually became more and more clearly the lowest eco-cost option as distances rose[301]. A study undertaken by FEFCO, however, showed that if applied in an inappropriate logistical context reusable systems can be worse for the environment at any distance, using 66% more road transport and costing 33% more[302]. A study of eight Swedish food distribution systems produced a similar result: all the systems cost more with returnable transit packaging[303]. A project performed by Ecobilan comparing the environmental performance of reusable plastic trays versus one-way corrugated trays for the transportation of yoghurt[304] emphasised the importance of the following parameters: weight, trip rate, transport distance, backloading of empty crates (reverse distribution), end of life treatment.

The results indicate that, as with reusable consumer packaging, reusable transit packaging and one-way transit packaging each has a role depending on the distribution logistics involved.

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297 Monash Centre for Environmental Management, 1999, Economic and environmental benefits of reusable transport packaging: Case studies and implementation guidelines

298 GlaxoSmithKline, 2000, *pers comm*

299 Kunskapspartner, 2000, Transport of Perishable Goods

300 Members of the ACP task force on reusable packaging, 2004

301 Vogtlander, J G, 2004, Corrugated Board Boxes and Plastic Container Systems: an analysis of costs and eco-costs, FEFCO

302 ONDEF/FEFCO, 2004, Fruit and Vegetables Corrugated Tray and Logistics Optimisation

303 Kunskapspartner, 2000, Transport Packaging for Perishable Goods

304 Teulon H, Life Cycle Assessment of Returnable versus Non Returnable Transport Packaging Systems, Ecobilan

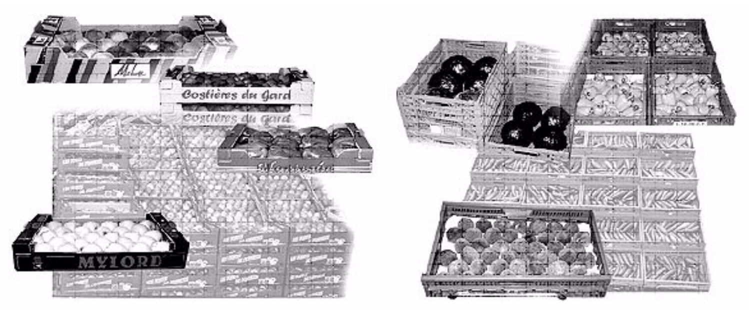

Figure 113: Single-trip and reusable trays for fruit and vegetables

3.2.5 Trip rates

The collection rates and number of trips achieved by refill systems can vary widely depending on how successfully closed the refill loop is. Industrial systems by their nature achieve the highest return rates. For example, reusable wooden pallet pool systems (such as the widely-used CHEP system) last for well over 100 trips (although wooden parts are replaced as they break, making it somewhat difficult to define when a pallet is still the original pallet)[305]. Plastic trays used for supermarket distribution of produce and suchlike are similarly estimated to last for approximately 100 trips (there are seven million of these reusable trays in use in Britain alone, so the importance of non-consumer reuse systems should not be underestimated).

Some of the best examples of well controlled consumer refill systems exist in Germany and Scandinavia, where return rates range are over 90% according to the German Refill Alliance. In Finland a study found trip rates for beer and soft drinks to be between 25 and 32 (96 to 97 per cent). Another study investigated reuse rates for a variety of European beverage containers and found trip rates of 10 to 42 (90 to 98 per cent)[306].

Trip rates for consumer refill systems are sometimes lower in less well controlled systems, since it is more difficult to control consumer behaviour and ensure that refillable packaging is returned without fail in the absence of regulatory measures such as deposits, eco-taxes, material bans and so on. For example, refillable glass bottles may be broken or used for storing paint by consumers, reusable plastic shopping bins used by a leading British supermarket are all too often reused in an unintended way as toyboxes and toolboxes, and the 'bag for life' reusable plastic shopping bags offered by UK supermarkets are reported to suffer a remarkably low reuse rate because customers tend to treat them as single-use bags[307]. Careful control of the loop is necessary to ensure that refill systems perform to their best potential.

The environmental impact of reusable packaging decreases in an inverse-square relationship with the number of trips. This means that a pack that completes 6 trips has a far lower environmental impact than a pack that completes 3, whereas a pack that completes 60 trips only achieves a very slightly lower impact than a pack than completes 30. The number of trips required is to be considered environmentally

[305] CHEP, 2000, *pers comm*

[306] Andreas Golding, 2000, Reuse of Primary Packaging

[307] Waitrose and Sainsbury supermarkets, 2003, *pers comm*

successful is generally around 10 (stakeholders varied in their opinions concerning how many trips could be considered satisfactory, with the figures varying from 6 to 20, but 10 seems a workable figure).

It should be noted that return rates are not easy to measure (a CEN standard discusses this issue in detail). Usually, the number of bottles that producers have to add into their system is used to calculate return rates. However, if the market is growing when they do this, the measured return rate would be lower than the real rate, and if the market is shrinking, the measured return rate would be higher than the real rate.

3.2.6 Pool Systems

Pool systems (different producers sharing interchangeable standardised bottles) have the potential to increase the efficiency of reuse systems. For example the German mineral water pool system enables 230 producers to share two billion bottles and minimise transport since bottles do not necessarily need to return to the original bottler but can return to the bottler closest to the point of collection. Similarly the UK milk bottle pool system enables the many local milk producers to share bottles. Often pool systems help SMEs by enabling them to benefit from efficiencies of scale.

3.2.7 Recycling

When reusable packaging reaches the end of its life it is usually recycled. Recycling of such waste is particularly successful because the waste is clean, uncontaminated and already accumulated in one location. LCA studies seldom make allowance for the fact that the end-of-life processing of reusable packaging tends to be more efficient than that of post-consumer one-trip packaging (for example, in Germany the DSD has reported contamination rates of 40% in the materials it collects, which significantly reduces the efficiency of recycling[308]). LCA studies often use the same recycling data for reusable and single-trip packaging, although in reality, the recycling of reusable packaging is likely to be more efficient (using less energy and causing less waste). The energy saving might be only 1-2% of the entire life cycle energy use, but nevertheless it means that refillables might be 1-2% better in reality than is shown by some LCA studies.

3.2.8 Float

Many of the LCAs reviewed appear to ignore the issue of the float required by reusable systems. Refillable bottle systems need extra bottles to allow for the bottles held at each point in the distribution and reverse distribution system. Extra bottles are also required to cope with peaks or cycles in demand (for example a system for soft drinks must have enough bottles to cater for summer peaks in consumption). There appear to be little data available on how big this float needs to be, but what data there are suggests that it is significant: in a USA study for beer and soft drinks, the float was 37 per cent. In other words, for every 1000 bottles being used, a bottling company would have purchased 1370 bottles, with the extra stock being stored until required.

Because LCAs often fail to explicitly deal with this issue it is unclear how such extra bottles could be accounted for in an LCA study. The German Refill Alliance has pointed out that float bottles do not incur full life cycle impacts since they are not used unless required: they incur manufacturing impacts but avoid most transport and reprocessing impacts unless actually used. Another stakeholder has similarly commented that the float has to be related to the operational life of the system[309], suggesting that

[308] German Refill Alliance, 2004, stakeholder submission

[309] EEB, 2004, stakeholder submission

bottles that are not used do not have the same environmental impact. Only a more detailed study could identify the most accurate way of dealing with the issue of float bottles in LCAs, but it seems clear that since float bottles must be manufactured, they must contribute some additional environmental impact, however small.

3.2.9 Capital impacts

LCAs generally do not include capital costs. So the environmental impact of building extra warehousing at retailers and fillers to store and process empty refillable bottles is not accounted for. This is not a criticism of LCA system boundaries; clearly it is appropriate that capital issues are considered to be beyond the scope of LCAs in most cases. However since the purpose of this study is to investigate the impact of increasing the use of reusable packaging systems in Europe, in the real world rebuilding retailer and filler premises will have an environmental impact and so this issue merits brief discussion.

As with many issues associated with reusable packaging, the key issues are societal ones rather than anything directly associated with the physical nature of the packaging itself. In members states such as Germany, soft drinks and beer are often, though not always, purchased by consumers in crate lots: 12 units (or for small bottle sizes 20 units) are bought in a (reusable) plastic crate, sometimes at drive-in retail outlets so that consumers can drive their cars straight into the point of collection and avoid having to carry the heavy crates. This situation differs from many member states, where consumers tend to buy bottles singly, for a variety of reasons. In some member states, consumers may not always have had the disposable incomes to buy 12-20 bottles at once. In others, high population density has led to a greater incidence of shopping on foot and carrying purchases home on foot. Increasingly, consumers buy drinks in single-serve sizes for consumption soon after purchase rather than at home. These and other societal reasons may make it more difficult to apply the crate purchasing model across Europe.

Retailers in high population density areas claim that they would find it difficult to have enough space to cater for refillables in some member states. For example in the south-east of England, where population density, land values and construction costs are all considerably higher than the EU average, retailers have been particularly vocal in their opposition to any requirement to build extra warehousing to cater for refillable bottles. However, modern technology has the potential to help: for example, space-efficient reverse vending machines automatically accept bottles and dispense deposit refunds (although these are most space-efficient when collecting and crushing cans for recycling: reusable bottles take up as much space in a reverse vending machine as in a warehouse).

Another capital issue is that of reusable bottles themselves: the cost of acquiring a stock of refillable bottles is significant. The capital costs associated with refill systems can lead to entrenched positions: companies that have a refillable bottle stock, warehousing, washing facilities and the necessary logistics tend to want to keep using them to protect their investment, and those that have not invested in such infrastructure tend to resist the suggestion that they should invest in it.

The British Soft Drinks Association has calculated that moving all UK soft drinks to reusable bottle systems would involve capital costs of between approximately 6 and 10 billion Euros, or at least 80 Euros per capita. However, UK costs are likely to be higher than most European countries for a variety of reasons. Assuming that the cost of moving centralised soft drink production and distribution systems to localised systems in regions covering 100 million Europeans would require expenditure of 40 Euros per capita, and in regions covering 100 million Europeans would require 20 Euros per capita, and in the remaining regions would cost nothing because the localised infrastructure was already in place, the cost of localising Europe to suit refillable soft drink packaging would be some 6 billion Euros. (Currently approximately 50% of the overall European beer market is in refillable packaging and approximately 25%

of the overall European soft drink market is in refillable packaging[310], so this is a optimistic scenario which assumes than some systems that currently use single-trip packaging could switch to reusable packaging at no cost).

Single-trip bottles have capital cost implications as well: the cost of building recycling facilities[311]. The capital costs of recycling are less directly borne by fillers, but they do exist for society as a whole.

3.2.10 Financial issues: internal costs, external costs and total social costs

Most stakeholders agreed with the idea that, in theory at least, it is desirable to internalise external costs. For example the cost of packaging should reflect its total costs to society, the cost of fuel should reflect its total costs, and so on. The more accurately total costs (including environmental costs) are reflected in the financial cost of materials, the more successfully free market economics will foster environmental protection. In practice, it is not easy to calculate total costs accurately or built them into financial costs fairly.

More studies have been identified which have found that single-trip packaging is the lowest (internal) cost solution than which have found the opposite, although there is a significant minority of studies which have found that reusable packaging systems can produce the lowest cost solution in appropriate circumstances. The 2003 RDC-Pira study for the Commission[312] studied reusable and single trip glass and PET systems. It found that for beverage packaging single-trip PET bottles offered the lowest total social cost (the total social cost measure used included internal financial costs as a key component, making up 63-94% of the total social cost). However this was not a simple result. The individual variables affecting the packaging systems were higher than the benefit found for the single-trip packaging, which meant that in certain situations reusable packaging offered the lowest total social cost. The table below attempts to summarise the RDC-Pira study's findings in more detail:

IN WHICH SITUATION DOES EACH PACKAGING TYPE OFFER THE LOWEST TOTAL SOCIAL COSTS?		
	Reusable Packaging	*Single-trip Packaging*
Total Social Cost	Lowest under 100km	Lowest over 300km
Internal Cost	Higher	Lower
External Cost	Lowest under 100km	Lowest over 300km

In other words, in terms of total social cost (including internal and external financial costs, social costs and environmental costs) reusable packaging is best for short distribution distances, reusable packaging and single-trip packaging are equal for medium distribution distances, and single-trip packaging is best for long transport distances. The results are the same when considering external cost alone (the social, environmental and other external costs that companies do not pay for but that society generally does pay for in some form). In terms of internal cost alone – the financial cost companies pay – single-trip packaging is always cheapest.

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310 INCPEN member company analysis, 2004.

311 German Refill Alliance, 2004, stakeholder submission

312 RDC-Pira, 2003, Evaluation of Costs and Benefits for the Achievement of Reuse and Recycling Targets for the Different Packaging Materials in the Frame of the Packaging and Packaging Waste Directive 94/62/EC

The fact that the lowest costs are often achieved by single trip packaging is an almost inevitable result given the realities of the modern economic system, since financial costs are largely *internalised* costs. Externalised costs (such as the cost of increased pollution borne by health services or the cost of lower employment borne by unemployment funds) are all but ignored in the direct financial costs faced by specifiers of packaging. (Some external costs are internalised however; for example the recycling levies paid by companies to recovery organisations such as the DSD or Eco-Emballage are in effect simple internalisations of the previously externalised costs of waste processing.) Most stakeholders accept that *internal* costs can be higher for reusable systems (while also pointing out that reusable packaging systems can be financially cheaper in some situations: for example in Latin America, where labour is cheaper, reusable packaging continues to be used because it is the most cost-effective option[313]).

If any general conclusion was to be drawn from the RDC-Pira work on reusable packaging, it would be that for *society as a whole* single-trip packaging fares best in some situations and reusable packaging fares best in some situations, whereas for *manufacturers* single-trip packaging is often cheapest. Therefore it would seem to be in the interests of society to identify the specific situations in which reusable packaging is best for society, and provide some sort of support for reusable packaging in those specific situations. Along similar lines, RDC-Pira commented that there should be no general rule to encourage refillables, but that a policy favouring refillables, if applied, should be restricted to the cases where the key parameters are such that refillables offer genuine benefit.

A study undertaken by GUA in 2001 reached similar conclusions: the study found that single-trip packaging caused environmental costs but these were, in all scenarios, considerably smaller than the internal financial cost advantages of single-trip packaging, so single-trip packaging was the lowest total cost option[314]. The Andreas Golding study for the Commission[315] found that reusable packaging was the most profitable for fillers (as long as capital costs were ignored) whereas single-trip packaging was the most profitable for retailers. The capital costs of reusable packaging systems were found to be up to five times higher than for single-trip packaging, which meant that reusable packaging was most feasible in stable markets with stable regulatory frameworks.

Total social costings vary greatly depending on the particular situation, but to give one actual example, in Holland it has been calculated that if a bottle of soft drink were to pay its total social cost, 3 to 6 cents would need to be added to its financial cost[316]. (The study was undertaken as part of an initiative looking into deposits; most of the 3-6 cents was for waste and litter collection costs, and not all of the more remote social costs were considered).

3.2.11 Further social issues

Social issues are included in the total social costs discussed above, but since total social costs tend to be rather dominated by financial costs, and some social costs cannot be fully described numerically, it is worth discussing certain social issues further.

Littering can be a significant social issue in terms of public perception. It could be argued that littering is not a function of packaging but of society: packaging does not create litter, people do. However, reusable

[313] German Refill Alliance, 2004, stakeholder submission

[314] GUA, 2001, Comparison on One-Way and Refillable Beverage Packaging in Austria by Analysis of Costs, Ecological Effects, Employment and Valued Added.

[315] Andreas Golding, 2000, Reuse of Primary Packaging

[316] CE Delft and Bureau B&G, 2004, Breed Inzamelplan Drankverpakkingen

packaging tends to be less visible in litter than one-trip packaging and this is an environmental advantage valued by many stakeholders (for example the German Refill Alliance reports that "in more than 40 difference articles, describing the spring-cleaning activities in the towns, it is stated that beverage containers (covered under the deposit) are no longer part of the littering problem"[317]). In Germany, where reusable packaging is associated with deposits on both reusable and single-trip packaging, littering is said to have been strongly reduced as a result. However, this may be more of a deposit issue than a reusable packaging issue. There are also different views on whether and to what extent such a reduction in littering has taken place. The litter reduction issue is a social aspect that is very highly valued by some stakeholders and so it merits further discussion, but there appear to be little hard data comparing littering in reusable and non-reusable markets which would enable the impact of reusable packaging (rather than regulatory aspects such as deposits) on littering to be assessed quantitatively.

Employment is an issue of major importance to some stakeholders. Production and recycling of single-trip packaging clearly creates jobs (for instance DSD is said to have created 17,000 jobs, Eco-Emballage 16,000, and Fost-Plus 2400[318]), and reusable packaging systems clearly create jobs (it is claimed that 53,000 jobs would be lost if reusable packaging systems disappeared from Germany[319]). The most relevant aspect to measure is any net difference in the amount of employment created. There appears to be no firm data in this respect. Jobs have been lost in the packaging manufacturing industries as a result of reusable packaging systems (for example beverage can makers have claimed that 25,000 jobs will be lost by the end of 2004[320]), and jobs have been generated in the reusable packaging industries, but the evidence tends to be anecdotal or qualitative rather than quantitative. Further complicating the issue is the fact that job creation and loss are often in difference regions. Users of reusable packaging systems believe that their creation of employment is greater than the loss of employment elsewhere (in other words reusable packaging helps employment). This may well be true, since the processing of reusable packaging tends to be quite labour-intensive whereas packaging production tends to be more mechanised. The jobs created by reusable packaging systems are of key importance in certain areas. For example, the employment generated by reusable packaging systems is highly valued in Germany, where unemployment is relatively high especially in the East where unskilled jobs are strongly needed. Whereas the job losses tend to be in other areas, for example in Scandinavia where metal cans are manufactured or in France where the largest brands of mineral water are bottled. So the issue of employment is sensitive, complex and poorly researched, but it seems likely that reusable packaging offers social advantages in terms of employment, although not without cost elsewhere.

Waste disposal is an issue that is taken into account in LCAs, but some stakeholders value waste prevention – and specifically landfill avoidance – as perhaps the most important environmental issue of all, overriding other parameters that are often quite dominant in LCA valuations such as climate change. If landfill avoidance is valued beyond the scientific valuation accorded to disposal in LCA, landfill avoidance could be considered to have extra value as a social issue. In such cases reusable packaging systems would usually offer greater benefit than LCA results would suggest[321].

Another social advantage offered by reusable packaging is that it has the potential to encourage environmentally-responsible consumer behaviour. Because reusable packaging requires a little more

[317] German Refill Alliance, 2004, stakeholder submission

[318] CIAA, 2004, submission to study

[319] German Refill Alliance, 2004, stakeholder submission

[320] EUROPEN, 2004, Mandatory Deposits on Non-Refillable Beverage Containers in Germany: The Economic, Environmental and Social Effects

[321] EEB, 2004, stakeholder submission

effort (for example in carrying, washing, storing and returning it) than single-trip packaging it has the potential to encourage consumers to be more conscious of their consumption. It may have the potential to make them think about their choices and about buying local products. However, this should be kept in perspective because there are of course other forms of encouragement that may more directly support better environmental behaviour, such as higher taxes on low-fuel-efficiency cars or on fuel itself. (Some industry stakeholders have requested that it be stated that they dispute the idea that reusable packaging encourages environmentally-responsible behaviour: they are unconvinced that refillable packaging is environmentally beneficial and so they take the view that consumers should not be misled by 'green tokenism'.)

Reusable packaging systems also have a related social benefit in terms of maintaining a social structure that people appreciate and are familiar with[322]. For instance in Germany many consumers value the traditional features of reusable packaging systems, enjoying the perception of tradition and careful frugality implied by such systems. This is another social dimension that is not quantifiable, but that has undeniable power in the markets where such attitudes exist. It is also the sort of social aspect that the public in markets where such traditions have been lost finds difficult to understand.

3.2.12 Measures to support reusable packaging

It is clear from the many studies that have been undertaken and the views of stakeholders and experts that reusable packaging and single-trip each offer environmental advantages depending on the societal and logistical context in which they exist.

Whether support measures are appropriate for reusable packaging is an issue hotly contested by stakeholders. Some stakeholders are of the opinion that such measures are essential because reuse systems are in decline yet they are self-evidently worth preserving. Others have suggested that it is all but impossible to support systems that cannot compete in the open market, and it is probably better to let systems grow or decline naturally; in other words, it is unwise to attempt to oppose the harsh realities of free market economics.

Both these views have some truth to them; it is all a matter of degree. In specific situations reusable packaging systems appear to offer environmental and social benefit yet they are in decline. Therefore it seems appropriate to have reasonable mechanisms to support reusable packaging where it is genuinely suitable and environmentally and socially effective.

However, there is the issue of proportionality to consider; any support measures should be proportionate to the environmental and social benefit of reusable systems. We also have received many comments that measures should strike an appropriate balance between environmental and social benefits and effects on the Internal Market. Any choice in favour or against any of the below measures is a matter for political decisions that should of course also take these effects into account. However, the assessment of Internal Market effects goes beyond the scope of this study and is addressed in a parallel study by Perchards/FFact.

Subsidies and state aid

A very simple support mechanism would involve making reusable packaging exempt from the recycling requirements of the Packaging and Packaging Waste Directive and specifically exempt from paying recovery levies as imposed by member state recovery organisations. In many member states it is already the case that reusable packaging does not pay recycling fees (such as with DSD in Germany) but ideally a consistent policy should apply in all European countries. This simple mechanism would aid existing

[322] EEB, 2004, stakeholder submission

reusable packaging systems, but in most cases not enough to halt or reverse their decline. Also, some producer responsibility organisations find the idea contentious because reusable packaging is recycled eventually and so it is felt that the fees should apply to reusable packaging when put in circulation for the first time.

Being exempt from recovery levies means that the financial size of the support is dependent on the costs of recovery of (mainly single-trip) packaging. In other words, the size of the support is not directly related to the financial requirements of reusable packaging systems. So another next step could be to provide support to reusable systems that is more proportionate to their financial needs. The total social cost work discussed earlier suggested there is a case for a mechanism that brings the internal financial costs of reusable systems into line with the internal costs of single-trip systems. Provided that the size of the subsidy is appropriate, this could create a 'level playing field' in which packaging could compete more closely on external cost grounds rather than internal cost grounds. This would necessitate reusable packaging being given a financial credit in some way. The amount could be adjusted each year depending on whether the market share of reusable systems had declined, remained stable or increased in the past year. Clearly there are many logistical difficulties which could arise, and such a system would probably need an in-depth economic study to be undertaken. Even relatively simple economic instruments have the potential to produce unpredictable and undesirable results in practice, as many recovery organisations discovered in their early years of operation.

A measure that has the potential to target the heart of the issue is that of providing state aid to smaller businesses selling localised products in reusable packaging. Applying state aid to appropriate users of reusable packaging has the advantage of directly targeting the most deserving reuse systems and efficiently applying support on a case by case basis where it is most needed, without having undesirable effects on other businesses or packaging systems. This measure would seem appropriate for some of the highly localised SME producers of beer, mineral water and soft drinks in countries such as Germany, because these producers tend to meet the requirements for genuinely environmentally beneficial use of refillable bottles as well as being most in need of financial support if they are to survive to operate reuse systems. State aid rules also exist that are designed to minimise the effect of such aid on competition.

Eco Taxes and Deposits

Eco-taxes or deposits on single-trip packaging may serve to discourage the use of single-trip packaging. Deposit systems for single-trip beverage containers are currently implemented in Denmark, Estonia, Finland, Germany and Sweden (as well as Norway and Iceland)[323]. In Scandinavian countries, the original intention for deposits on single-trip packaging was to ensure high return and recycling rates rather than to specifically encourage reuse systems. Users of refillable systems say that the deposit systems for single-trip packaging are highly effective to support refillable systems. In cases where reusable and single-trip packaging both bear deposits (ie Germany), proponents say that this gives equal footing to both packaging types since both face deposits and both achieve high recovery and recycling rates[324]. However opponents say that in practice this has led to discriminatory effects[325]. Further details of deposit and eco-tax systems are given in Appendix 17.

Careful and fair design of the system is necessary if situations are to be avoided whereby, for example, foreign competitors may be all but prevented from entering a market, protecting local businesses from

[323] German Refill Alliance, 2004, stakeholder submission

[324] German Refill Alliance, 2004, stakeholder submission

[325] BCME, 2004, stakeholder submission

competition[326]. Foreign competitors may, of course, localise their operations and build smaller local filling plants so that they can utilise refillable packaging effectively. Major soft drinks producers have done this in Germany. However the costs of such fundamental production and distribution changes are significant[327].

Tax Incentives

Other than discouraging single-trip packaging, it is possible to encourage reusable packaging, for example through tax breaks such as a lower rate of value added taxation (VAT or similar), as has already been given to energy efficient or environmentally preferable products in some markets. Another example is the subsidy for bottle washing provided by the Dutch government[328]. The net effect of providing financial encouragement for reusable packaging would be much the same as that of penalising single-trip packaging, but certain potential distortions of the system would be avoided and competitors using single-trip packaging might be less likely to feel shut out of a market.

To encourage the capital investment that is required to set up new reusable packaging stocks, companies could be offered 100% depreciation allowances on reusable packaging capital expenditure. This accounting practice is a significant incentive for companies because it would allow them to claim their whole expenditure on reusable packaging, filling lines and cleaning lines to be claimed back in one year, potentially cutting their tax bill. This practice has already been used successfully to help Dutch companies buy products considered to be environmentally preferable and to encourage UK companies to invest in information technology.

Tax breaks could be given to manufacturers wishing to decentralise their production facilities and open local filling plants. Such tax breaks are already given for other reasons, for example to encourage pharmaceutical manufacturers to produce medicines locally, and to aid employment in high-unemployment areas. In other words, incentives may be applied not just on reusable packaging itself but also on the infrastructure that supports such packaging.

Tradeable Permits

Tradeable permits offer possibly the most sophisticated approach. For example, if a member state desired 40% of its beverage packaging to be refillable in any particular year, it could issue single-trip permits sufficient for 60% of the beverage packaging on the market. The permits could be traded freely so that companies could either buy more permits or use more reusable packaging as they wished. Free market economics would, in theory at least, cause the price of the permits to approximate the additional cost of operating reusable packaging systems. The member state could slightly reduce the number of permits each year if it wished to see the market share of reusable packaging grow, in which case the cost of the permits would gradually rise and reusable packaging would be an increasingly compelling option economically for companies.

The free-market tradable permit solution offers theoretical advantages, but in practice the complexities and difficulties are likely to be substantial. The cost of the bureaucracy could very possibly exceed the benefit, and the potential for abuse or unpredicted effects would be large. For example, what would happen if the market grew unexpectedly: would products be rationed because there was no packaging available? What would happen if permits were forged? Who would oversee and control them? How could a member state obtain market information accurate enough to predict the amount to be issued? If the

[326] EUROPEN, 2004

[327] BSDA, 2003

[328] EUROPEN, 2004

permit supply was imperfect large swings in price could occur and the whole market could destabilise (and reusable packaging systems succeed best in stable markets). How would international trade work? A tradable permit system would be, in effect, a microcosm of a free-market economy, with all the complexity and potential instability that implies, and so it is probable that it is too complex a system to be successfully managed in practice. However, perhaps further research could identify ways to simplify the approach, creating a manageable semi-free-market system. The UK system of tradable recycling certificates (PRNs), while not perfect, may provide valuable lessons in developing such a system.

To provide another perspective on these issues, below is a table adapted from one provided by the German Refill Alliance outlining support mechanisms. Details of existing support mechanisms were also provided by the Alliance, and these are included in Appendix 17.

POTENTIAL REUSABLE PACKAGING SUPPORT MECHANISMS			
Support Mechanism	**Description**	**Advantages**	**Disadvantages**
Regulations			
Quotas	Require that a given share of specific beverages be sold in refillable containers, as in Germany	Effective in protecting refillables	Control can be demanding and costly; provides no incentive for consumers to buy and retailers to sell refillables
Compulsory supply of beverages in refillable and one-ways	Retailers are obliged to give the consumers the choice of buying beverages in one-way and refillable containers, as in Portugal	Potential for consumer choice	Easily distorted by retailers (they can put high prices on refillables to avoid selling them and avoid having to have a convenient take back structure)
Bans	Require specific beverages to be sold only in refillable containers, as in Prince Edward Island, Canada	Effective in protecting refillables; very simple to control	Consumers are not given the option to choose: disliked by industry
Deposit return systems	Mandatory deposit return system for one-way containers, as in Germany, with punishment if quota is not achieved	Levels the playing field between refillables and one-ways; effective measure to promote refillables; achieves high recycling of one-ways	Sometimes disliked by industry
High recycling targets	Setting up ambitious recycling targets for one-way containers, as in Sweden	Effective measure to protect refillables; no need to control refillable share; high recycling of one-ways	High levels of recycling can cause environmental disbenefit and cause minimal packaging to be replaced with heavier but more recyclable packaging
Economic instruments			
Packaging taxes	Give refillables a price advantage via taxes that affect one-way containers negatively, as in Finland	Motivates (not forces) consumers, industry and trade to opt for refillables; internalizes costs	Sometimes disliked by industry
State Aid	Provide state aid to appropriate businesses that use reusable packaging	Directly focuses support where it is most needed; Avoids undesirable effects in the wider packaging context; avoids creating barriers to trade	May need to be applied on a case-by-case basis which could be resource-intensive
Tradable permits	Issue of permits for one-way packaging (no existing systems known)	Free market characteristics	May favour large companies over SMEs; complex and difficult to control

Where deposits or similar support mechanisms are used, there may be a practical upper limit to the size of the deposit, because if it becomes too much larger than the cost of manufacturing the packaging, producers might find that they could make more money by producing and immediately claiming a deposit on packaging than by producing it for its proper purpose. Where any system generates income than is disproportionate with the economics of the product supply system, abuse of the system is possible. Where a packaging system is very significantly infeasible within the context of the modern free market economic system, any support mechanisms are unlikely to be totally successful.

It seems of the utmost importance that any support mechanisms be perceived to be for environmental benefit, and not for any other hidden purpose such as regional or national protectionism or the market benefit of particular material sectors. "Instruments could only be justified if they have a positive environmental effect and guarantee a level playing field for businesses", as the Dutch Secretary of State for the Environment Mr Pieter van Geel has said[329]. Therefore the utmost care needs to be taken to ensure, for example, that no packaging material is in effect banned from a market and no importers are in effect prevented from competing with local products. As Andreas Golding pointed out in his report for the Commission[330], "The success or failure of the instruments is often determined not by the instrument itself but by the detail of the regulations [and] the way in which an instrument is handled by public authorities in reality."

In contrast to this view, some stakeholders are of the opinion that some forms of packaging should be banned irrespective of their effect on the internal market[331]. There are also some environmentalists who believe that society should be encouraging localism and discouraging internationalism if a sustainable society is to be achieved. It is true that there are far more significant actions that need to be taken than those focused on packaging and it is also possible that a sustainable society will be a less globalised one[332]. If regulators were to decide to pursue a policy of encouraging localisation, ideally it would be undertaken openly and directly; for example road fuel might be taxed to a greater extent, manufacturers might be offered incentives to operate local plants, and local production and consumption might be encouraged in a wide variety of ways[333]. This is, however, beyond the scope of packaging, which is why any measures to support reusable packaging systems should be carefully designed to avoid causing wider, unwarranted effects.

3.2.13 Further research

The reuse section of this study has generated more stakeholder interest than any other part of the report despite not being intended initially to be a major part of the study (ten days' work was assigned to it.) Therefore further work may be justified in future.

The interest in this section has highlighted the lack of data in some areas.

LCAs receive a lot of discussion and criticism, and so it may seem natural to devote more work to further LCAs. However, it is not clear that this would be the most effective use of resource. Most of the lessons that LCAs can provide may have already been revealed by existing LCAs, and the amount of controversy

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329 P van Geel, 2004, as reported by EUROPEN

330 Andreas Golding, 2000, Reuse of Primary Packaging

331 EEB, 2004, stakeholder submission

332 Transport 2000, 2002, Wise Moves report

333 Transport 2000, 2002, Wise Moves report

they generate may be more due to various stakeholders' discomfort with the various findings than due to any flaws in the LCAs themselves. It seems that LCAs will always be controversial irrespective of how many are carried out.

Perhaps social research deserves more attention in order to better understand issues that are resistant to quantification, such as litter, landfill avoidance, employment and quality of life issues associated with packaging.

However, the most directly relevant issue that requires further research is that of support measures for reusable packaging. Are such measures justified at all? Which measures would best meet environmental and social requirements with least undesirable effects? Which measures meet proportionality requirements? How can measures be harmonised across Europe if requirements are region-specific or case-specific? How can measures help to reconcile environment and development in the field of packaging? These are not easy questions to answer.

In many ways the decisions that are required are not scientific but political decisions, since different viewpoints are valid:

- In scientific terms there is often a case for support measures (there is disagreement on the exact dimension to which this applies).
- In social terms reuse systems are highly valued in certain member states and their survival is important to many stakeholders in those member states.
- In sustainable development terms some stakeholders believe that moving towards a more localised society will be necessary for sustainability, and reuse systems may have a greater role in such a society.
- In economic theory terms it can be challenging to measure external costs accurately and internalise them fairly.
- In investment terms it may be more appropriate to invest in other environmental measures that may produce a better environmental return on investment.
- In logistical terms the cost would be high of changing existing long-distance product supply systems to be more localised in order to suit reusable packaging.
- In market theory terms it may be difficult to maintain certain reuse systems if these are naturally being out-competed due to economic reality and consumer choice.

4. TASK 4: STAKEHOLDER CONSULTATION AND PRESENTATION OF VIEWS

4.1 INTRODUCTION

Previous studies conducted by the consultants have demonstrated the benefits of involving stakeholders throughout the study. In this case, an interim report was published on the Commission's website on which stakeholders were invited to offer written comments. All comments received were subsequently posted onto the website.

Alongside this, a stakeholder workshop was held at which views and opinions were able to be expressed verbally during an open discussion forum. The list of attendees at this workshop is provided in Table 83.

Table 83: Stakeholder workshop attendees

Organisation represented	Representatives
• EC – DG Environment	Mr. Otto Linher
• Waste Topic Center – partner of the EC	Mr. Herik Jacobsen Mrs Mette Skovgaard
Consultants	
• Ecolas	Mr. Arnoud Lust Mrs. Eva Goossens Mrs. Veronique Van Hoof
• Pira	Mr. Gary Parker Mrs. Carolynn Royce Ms. Jonna Meyhoff Brink
Stakeholders / experts	
• EUPC	Mr.Jürgen Bruder
• ACE	Mrs. Erika Mink
• INCPEN	Mrs. Jane Bickerstaffe
• EUROPEN	Mr. Steve Anderson
• ICVIE	Mrs. Caroline Auriel
• CIAA	Mr. Claude Thevenot
• Deutsche Umwelthilfe	Mr. Jürgen Resch
• FEVE	Mr. Andrew Somogyi
• EEB	Mrs. Susanne Hempen
• CEPI	Mr. Esa Hyvarinen
• ACRR/IBGE	Mr. Jean-Pierre Hannequart
• Association of small and independent breweries in Europe	Mr. Roland Demleitner
• Pro-Europe/FOST Plus	Mr. Johan Goossens
• Consultancy B&G	Mr. Robbert van Duin
• Genossenschaft Deutscher Brunnen	Mr. Thomas Hilche
• APEAL	Mr. Jean-Pierre Taverne
• EAA	Mr. Prubost

A second stakeholder workshop was also held in order to more fully discuss issues relating to re-use. Again an interim report relating to this issue was provided prior to the workshop. The attendees at this workshop are outlined in Table 84.

Table 84: Attendees at re-use workshop

Organisation Represented	Representative
• EC – DG Environment	Mr. Otto Linher
• Waste Topic Center – partner of the EC	Mrs Mette Skovgaard
• EC – DG Enterprise	Ms Camilla Wilander
Consultants	
• Ecolas	Mr. Arnoud Lust
• Pira	Mr. Gary Parker
	Mrs. Carolynn Royce
Stakeholders / experts	
• EUPC	Mr. Paolo Bochicchio
• ACE	Mrs. Erika Mink
• INCPEN	Mrs. Jane Bickerstaffe
• EUROPEN	Mr. Steve Anderson
• ICVIE	Mrs. Caroline Auriel
• CIAA	Ms Nadia Six
• Deutsche Umwelthilfe	Mr. Jürgen Resch
• FEVE	Mr. Andrew Somogyi
• EEB	Mrs. Susanne Hempen
• CEPI	Mr. John Swift
• ACRR/IBGE	Mr. Jean-Pierre Hannequart
• Association of small and independent breweries in Europe	Mr. Roland Demleitner
• Pro-Europe/FOST Plus	Mr. Johan Goossens
• Consultancy B&G	Mr. Robbert van Duin
• Genossenschaft Deutscher Brunnen	Mr. Thomas Hilche
• APEAL	Mr. Renaud Batier
• Beverage Can Makers Europe	Mr. Bob Schmitz

All written and verbal comments received were assessed in order to determine their importance, considering their potential to influence the results achieved and conclusions drawn in the study. In many cases comments concerning methodology and data have been incorporated within this final report.

LITERATURE

Legend:

Scen :	Scenarios (task 1)	EcI :	Economic Impact (task 1)	EnI :	Environmental Impact (task 1)
SoI :	Social Impact (task 1)	PEI :	Packaging Environment Indicator	PrPl :	Prevention Plans
EsR :	Essential Requirements	HM :	Hazardous Materials	PrR :	Producer Responsibility
Targ :	Prevention Targets	Re-:	Reuse	StH :	Stakeholders

Task	T1				T2						T3	T4
Document	**scen**	**EcI**	**EnI**	**SoI**	**PEI**	**PrPl**	**EsR**	**HM**	**PrR**	**Targ**	**Re-**	**StH**
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Task	T1				T2						T3	T4
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ANNEXES

Annex 1: Background data for calculation of environmental impact assumptions

Annex 2: Baseline scenario (= Scenario 2)

Annex 3: Metal packaging generated recovery and recycling

Annex 4: Packaging Waste in the Context of Packaging

Annex 5: Background information on Packaging Prevention Plans

Annex 6: Legal context of the Essential requirements

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Annex 9: Conformity assessment procedures: current situation

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Annex 16: Landfill bans or progressive landfill taxes in the EU Member States

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Annex 19 : Examples of Reprocessor Investment in the UK from PRN Revenue

Annex 20 : Art. 21 Committee working paper on data collection methods

Annex 21 : Data Sources for the environmental assessment of the PPWD