Annex 8 : Current performance of Member States

1 METHODOLOGY FOR THE DATA COLLECTION:

- Classification of the data per year
- Classification of the data (total (MSW + non-MSW)) into production (packaging brought on the market) and recycling summary tables for individual Member States and for the whole of Europe
- Data were collected for the material classes as detailed as possible (as much sub-divisions according to material applications as possible)
  - glass,
  - plastics,
  - paper & cardboard,
  - metals,
  - composites[1] ,
  - wood,
  - other packaging materials

This gives the tables shown in Annex 8 bis (for 1997, 1998 and 1999).

1.1 Data of 1997

1.1.1 Introduction

For 1997 a lot of data has been published (by Compliance Scheme) besides the official reporting from the Member States to the European Commission.

The data reported to the European Commission concern total data per material (quantities brought on the market, reuse, recycling and recovery data), but not detailed data per material application and no distinction between household and industrial packaging.
However, Member States are asked to report their data in the official data format, established by the European Commission. This data format encourages the Member States to fill in data within divisions of the main material groups (i.e. for PET, PP, PVC,... within the plastics group), nevertheless on a voluntary basis. The total amounts per material group are obligatory to report. This means generally that Member States have only reported the obligatory data, meaning data for glass, plastics, paper & cardboard and metals. Also

[1] composite means packaging made of different materials and which can not be separated by hand. [Commission Decision 97/138/EC]

obligatory is to report total data for quantities on the market, total recycling and total recovery (the division in organic recycling, incineration, etc. is voluntary and thus generally not reported).

Member States are asked to report within 18 months of the end of the relevant year (this means July 1999 was the end date for reporting the data of 1997, and the results of 1998 can be expected in July 2000).

1.1.2 Results

11 countries officially reported to the European Commission (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Spain, Sweden, the Netherlands and the United Kingdom).

No global data were reported from Luxembourg, Portugal, Greece, Ireland.

Comparable data for these countries were found in other sources, especially in references [2]and [3]. Those two reports already analysed the 1997 data on packaging and packaging waste and provided ERRA with summary tables with specific data of household, industrial and total data for the Member States.

The conclusions of these studies [2], [3] by Price Waterhouse Coopers were:

- Exact data on the amount of waste, packaging waste and recycling is hard to get and ambitious;
- Data on the amount of waste, packaging waste and recycling is not comparable; due to the fact that :
- the definitions of packaging and other terms used are interpreted differently and the methods of data collection and analysis differ
- e.g. for some countries the only information available concerns packaging processed by the packaging organisations, those amounts have not been corrected to a national level, because of insufficient information, so it is clear that total amounts of packaging for these countries are higher (the same is true for recycling amounts)
- e.g. MSW sometimes includes packaging from small businesses, sometimes not
- a potential cause of inaccuracy of data is the inclusion of quantities exported for recycling in the final recycling results (some countries reported these quantities separately, other not)

- methodologies for recycling and recovery assessment are not reported
- it is plausible that national factors influence the amount of packaging placed on the market and the extent to which it is recycled (factors like Gross Domestic Product, geographical position, reuse promotion, type of valorisation scheme have to be analysed in more detail to be able to draw some conclusions)

Other specific data (for 1997) were found in various reports of packaging recovery organisations and available study reports (see Bibliography).

1.2 Data of 1998 and following years

For some countries global data can be found in (annual) reports from packaging recovery organisations (Duales System Deutschland for Germany, Altstoff Recycling Austria for Austria, Sociedade Ponto Verde for Portugal, Valorlux for Luxembourg, …). Also material recycling organisations publish data on collected and recycled amounts (e.g. Svensk Glasåtervinning for Sweden, PYR for Finland,…).

Important to notice is that the results reported by the packaging recovery organisations do not include full country coverage and are sometimes specific for MSW.
Generally, more specific information and data were found through the national (and European) material federations.

The official data (of 1998) from the Member States available at the European Commission are also included.

1.3 Summary of the results of the data compilation

- Most data were found for 1997 and 1998
- Exact data on the amount of waste, packaging waste and recycling are hard to get;
- Data on the amount of waste, packaging waste and recycling are not comparable;
- More reliable data are/will be available for 1998 and especially 1999 thanks to the experiment and the improvement of the calculation methods.

1.4 Sources :

[1], [2], [3], [4], [5], [6], [7], [8], [9], [10]

Total HH + industrial										
Material	Glass	Plastic	Paper and board	Metals	Al	Steel	composites	Wood	Other	Total
Application										
1997										
Waste										
AUT	260	180	666	85			28	50		1269
BE	310	208	529.6	120.5			17.2	142	28.8	1356.1
DK	202.306	183.43	463.021	58.035				60.782	3.639	971.213
FI	52	90	243.5	31						416.5
FR	3296	1571	3611	622			290	1679		11069
DE	3750.3	1502.1	5447.8	1121.4	87.2	1034.2		1892.2	16.9	13730.7
GK										1456
IE										452
IT	2248	1777	3246	487				1802		9560
LU	17.3	7	11.3	2.8			0.68		0.92	80
NL	469	611	1449	216				0		2745
PO										1050
SP	1398.1	1215	2255	340					670.7	5878.8
SE	177.4	150	526.5	70						923.9
UK	1787.265	1356.019	3034.893	809.093	112.258	696.835		749.476	17.769	7754.515
EU										
Recycled										
AUT	199	36	500	29			8	7		779
BE	217.3	52.7	410.6	84.7			5.2	75		845.5
DK	124.122	11.249	219	2.17						356.541
FI	24.4	9.2	135.6	1.5						170.7
FR	1388	102	2276	331				300		4397
DE	2797.3	675.3	3193.1	914.9				1040		8620.6
GK										180
IE										80
IT	750	164	1170	25				700		2809
LU										
NL	354	76	941	145						1516
PO										32
SP	521.5	64.95	1242.4	76.4					60.4	1965.6
SE	134.2	21	348	31.8						535
UK	441	100	1609	211	27	184				2361
EU										

Legend:

data EC -MS reports 1997

data report PWC review data MS 1997

data valorlux : chiffres cléfs only HH

data PWC The facts a European cost/benefit analysis 1998

Total HH + industrial										
Material	Glass	Plastic	Paper and board	Metals	Al	Steel	composites	Wood	Other	Total
Application										
1998										
Waste										
AUT	230	190	510	85			40	60		1115
BE										
DK	176	172	435	55						838
FI	55	90	246	33						424
FR	3513	1628	4123	681				1696		11641
DE										6215.416
GK										
IE										
IT	2200	1800	4023	511	57	454		2050		10584
LU	21	9	28	5					12	77
NL	459	491	1633	227				379		3189
PO										
SP										
SE	171	140	570	75						955
UK	1889	1316	3015	808				123		7169
EU										
Recycled										
AUT	193.944	40.898	286.55	28.246				7.794		723
BE										
DK										268
FI	34.6	9.2	140.4	5						189
FR	1576	131	2515	308				305		4835
DE	2704.859	600.015	1415.502	418.216	43.343	374.873	344.962			5483.554
GK										
IE										
IT	810	192	1489	34	7	27		400		2925
LU										32
NL	385	49	775	176				86		1471
PO										
SP										
SE	143.1									583
UK	434.306	115.169	1894.086	161.738	14.517	147.221		170		2775.299
EU										
Legend:										

data EC -MS reports 1998
data DSD : annual report 1998, only HH?
data ARA: annual report 1998
data DSD: press information mass flow verification 1999, only HH?
data Swedish Glass recycling Facts 1998
data PYR: Finnisch statistics for 1998
data Ministery VROM: jaarverslag 1998
data Conai: source : European Packaging and waste Law, N°79, July 2000, p.33, 34

(1998)

Total HH + industrial										
Material	Glass	Plastic	Paper and board	Metals	Al	Steel	composites	Wood	Other	Total
Application										
1999										
Waste										
AUT										
BE										
DK										
FI										
FR										
DE										6382
GK										
IE										
IT	2249	1850	4105	526	59	467		2404		11134
LU										
NL										
PO	261.027	108.9	207.776	44.204	5.574	38.63		2.677	3.536	
SP										
SE										
UK										
EU										
Recycled										
AUT		48.597								
BE										
DK										
FI										
FR										
DE	2710	610	1480	359	37	322	391			5909
GK										
IE										
IT	890	243	1600	57	13	44		910		3700
LU										
NL										
PO										
SP										
SE										
UK										
EU										

Legend:

data ÖKK Austria: verwertung kunststoff verpackungen 1999

data DSD: press information mass flow verification 1999, only HH?

data Sociedade Ponto verde : resultados Globais 1999

data Conai: source : European Packaging and waste Law, N°79, July 2000, p.33, 34

Annex 9 : Critical factors limiting recycling and reuse

1 RECYCLING DIFFICULTIES

The critical factors identified in this section are taken into account in the calculations and the hypothesis taken for packaging applications when no CBA is performed.

Recycling difficulties can be classified according to technical, economic and marketing constraints. Marketing constraints can be avoided by specific marketing actions: they mainly depend on the willingness of the industries.
On the other hand technical and economical constraints are more difficult – or impossible up to now - to overcome. Technical constraints require R&D investments or increase of collecting, sorting and/or treatment capacities. Economic constraints are very difficult to control: e.g.: market prices, internal market barriers.

This paragraph provides a brief description of recycling difficulties and a summary of them. Reuse recycling difficulties are also described.

1.1 Glass[11], [12], [13]

Especially for glass packaging the consultant identifies factors which are reasonable reasons to limit recycling from factors which may be valid points but are not really a reason to limit recycling.
"Reasonable" factors are mainly technical and economic limits:

(1) Contamination : the stream quality must be free of contamination (e. g. no china cups), otherwise the whole load may be rejected by the glass recycler.

(2) Imbalance in colour: the national glass production has to be in agreement with the national glass consumption. This constraint could be avoided through the development of alternative end-uses for recycled green glass.

(3) Market price: the low price value of glass hampers international trading and long transport distance.

Factors which may be valid points recycling limitations but are not really a reason to limit recycling mainly concern:

- Noise when disposal : it can lead to problems with the disturbance of neighbouring residential areas

- Human wound : glass is dangerous once broken
- Insufficient maintenance : bottle banks may not be emptied frequently enough
- Consumers participation : put green glass in clear glass reduces the value of the load or may cause it to be rejected. In countries where households are charged and recyclables taken away free of charge, less care is taken to include only recyclable material in recycling collection containers. Therefore automated processing of waste glass to remove colour and foreign objects contamination has been more rapidly developed. On the other hand permitted contaminant levels are set lower than in countries without direct waste disposal charges. This represents one possibility to avoid this recycling limit.

The consultant concludes that recycling limits exists but could be avoided thanks to communication, improved maintenance and custom changes.

1.2 Plastics[14], [15], [16]

Plastic applications constitute a very important issue as stakeholders point of view on their recyclability diverge. The following critical factors were identified:

Technical limits

(a) Contamination

According to the nature of the impurities (surface or embedded contamination, e.g.) washing can be considered to avoid this difficulty.

Bags containing raw materials may present sufficiently low contamination to be recycled without difficulties. Contamination of pallet covers (plastic films) depends on the content and the stock conditions. Recycling is therefore possible according to the contamination level.

(b) Insufficient amount (profitability aspect): throughput of recycling plants must be sufficient in order to be profitable. The throughout will be dependent on a number of factors, including available supply and market demand.

(c) Too thin plastic films : the thicker the film, the easier to recycle. This difficulty is linked to contamination. It is only feasible to remove contamination if the thickness is sufficient.

(d) Nature of the plastics : due to the different molecular construction, practical recycling depends on the ability to separate them from each other. Moreover, the output market is different for each plastic type. Generally recycling is only possible if packaging is previously sorted by material.

(e) (Main) Technical performance and processing difficulties : specific comments on these subjects, if any, where integrated in the CBA.

Market acceptance

(f) Image : Can also be positive. Can be reversed if there are investments to convince the consumers. Investments can only start if there are enough.

(g) Risk : failures in material performance are more frequent. A severe quality control could partly overcome this problem, but would increase the cost of recycling.

(h) Minor characteristics (odour, touch and look) : current treatment techniques do not overcome these problems. If guarantees are offered to consumers concerning the main technical performance and if the image is improved, this might be overcome. This kind of difficulty could also be reduced by marketing actions if marketers are convinced they have to help the market to accept different colours.

(i) Legislative barriers : [[14], p.31]

EU food contact legislation (Pira to provide full reference) prevent the use of recycled plastics for applications in direct contact with food. This limits the market potential of plastics recyclate to non-food grade applications However there exist recycling techniques which allow PET recycling into PET food grade.

(j) Polymer prices – polymer prices are very volatile and it is important it is recognised that the virgin price can – and does - fall below the total costs associated with the recovery and recycling of used plastic materials. The demise of many recycling companies is evidence of this.

The cause of polymer price volatility is:

- Inequality in capacity and demand, which is difficult to rectify due to the fact that each new production unit must be so large
- Stock building during a low price situation and stock use during high price situations exacerbates the situation
- Price of virgin is also linked to oil price

However, the cost of collecting and recycling used film remains constant.

Economical reasons

(k) Recycling costs: high collection costs in Europe hinder general introduction of plastics recycling. Development of sorting machines should reduce collecting and sorting costs and increase the plastic streams quality.

1.3 Paper and board[17], [18]

Paper and board are widely recycled and not only as packaging waste. The critical factors are the same for packaging and non packaging applications. They are described hereafter.

(1) Recycling close loop lifetime: paper cannot be continuously recycled (max ~4 times) because the fibres will gradually degrade during the repeated pulping process

(2) Technical properties of the fibre – fibres from different sources (both virgin and recycled) provide different technical properties. The demands of the end use product and the properties of the fibres must be compatible. In effect, the end-use application determines the recycled content that can be incorporated.

(3) Waste packaging composition (intrinsic contamination): paper to be recycled must be pulpable ⇒ not laminated with plastics, no synthetic glues (⇒ sticky residues), no ink (formulated to resist dispersion in water) ⇒ design new product for easier recycling

(4) Food contact legislation – food contact laws limit the use of recycled fibre for applications in direct contact with food.

(5) Contamination : contamination such as fat or organic coming from the packaged product should be avoided.

(6) Price volatilty and the balance of supply and demand :

Fibre is a global commodity, and the economic feasibility of particular paper and board recycling activities may be dependent on the price of virgin fibre. Fibre prices are volatile:

- Inequality in capacity and demand, which is difficult to rectify due to the fact that each new production unit is expensive and introduces significant new capacity
- Stock building during a low price situation and stock use during high price situations exacerbates the situation

  When the price of virgin fibre is low, then it can be cheaper than the cost of producing recycled fibre.

1.4 Metals (steel and aluminium)

Identified limits to recycling are technical limits :

(1) Insufficient amount : there is very little aluminium in household waste stream (less than 1%). Selective collection have to be adapted to local conditions

(2) Contamination : aluminium foils can be contaminated with food.

For both aluminium and steel recycling there is no output markets limits : fluctuating end-use markets do not limit recycling as for paper. Whatever the price variation, it remains higher than for other materials.

The consultant concludes that there is no technical, economical or marketing limits to recycling for steel and aluminium packaging which can't be avoided, except for contaminated aluminium foils.

1.5 Composites[2]

Packaging made of different material can be found at three different levels:

- compound packaging, where materials are put together with or without mechanical connections or glue
- complex packaging, where materials are put together with glue or in a more durable manner
- composite packaging, where materials merge together in order to constitute a new material

Compound packaging are favourable to material recycling, while material recycling of complex packaging can depend on technical and economic constraints. Energy recovery could be encouraged due to the high calorific value of this latest packaging. [19]

Composite packaging contributes to a small extent to the packaging consumption (and waste). For composite packaging waste other than liquid beverage cartons, the main difficulty is therefore the low amount of waste. There are two main recycling route :

- they could be recycled with the main material stream, taking into account the same recycling difficulties as for the main material recycling scheme

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[2] "Composite" means packaging made of different materials, and which cannot be separated by hand, none exceeding a given percent by weight, which shall be established in accordance with the procedure laid down in Article 21 of Directive 94/62/EC. (source: Commission Decision 97/138/EC)

- Energy recovery or chemical recycling are recommended by the author (Sarens).[19].

Different publications [20] of the Alliance for Beverage Cartons and the Environment (ACE) mentioned the composition of composites and suggest waste management options. No recycling difficulties such as material separation are mentioned.

The composite beverage carton is made out of 89% paper and 11% PE or can consist of 70% paper, 25% PE and 5% Al.. Composite beverage carton is potentially suitable for different waste management options:

- recycling: repulping enables the high quality fibre to be recycled, plastic and aluminium are recovered separately
- energy recovery: high calorific value due to the content of paperboard and PE
- composting/biomethanisation: due to the high organic content of the paper

The consultant concludes that there are no technical constraints to recycle liquid beverage cartons. Other recycling limits are the same as for the paper and board packaging waste recycling.

2 SUMMARY OF RECYCLING DIFFICULTIES

The above mentioned critical factors are considered in the definition of the range of recycling rates considered in the cost benefit analysis. Table 1 shows the identified recycling constraints per material. They are classified in factors, which are reasonable reasons to limit recycling, and factors, which may be valid points but are not really a reason to limit recycling.

Table 1 : Summary of the recycling difficulties

Recycling difficulties	Glass	Plastics	Paper/board	Metals	Composites
Capacity	X		(X)		
Output market / market price	X	X			
contamination	X	X	X	(X)	
imbalance supply-demand	X		X		
Insufficient amount of waste		X		(X)	X
Recycling lifetime			X		
Nature of waste (too thin,…)		X	X	X	X
Recycling costs		X			
Factors which are not really a reason to limit recycling					
Noise	X				
Human wound	X				
Insufficient maintenance	X				
Disposers participation	X	X	X	X	X
Colour, odour		X			
Resistance to the use of recyclate		X			

The critical factors identified in this section are taken into account in the calculations and the hypothesis taken for packaging applications when no CBA is performed.

3 REUSE DIFFICULTIES[21], [22]

Reuse was one of the issue of this study. It is not a priority of the revision but it has to be taken into account. Therefore a good understanding of its critical factors is essential to tackle the question. As for recycling it is possible to distinguish between technical and economical constraints. The third kind of constraints concern consumer convenience.

Economical constraints mainly concern the initial capital investment of re-usable packaging much higher than for the disposable packaging[3] and the on-cost burden of reverse logistics (e.g. transport costs) of returning the empty packaging to its point of origin. The latest constraint can be reduced by the development of European standard such as Europallets. Reuse can in this case happen in the same geographical area as the use.

Maintenance (washing,…) and repairs can also can be costly and time consuming.

Consumer convenience can influence the reuse rate :

- by the choice between 1-way and reuse and
- by the level of return (the end-user may not return the packaging after use)

While the second point does not seem to be a limit to reuse rate, the first one has to be managed by the way of communication and design.

Finally, technical limits mainly relate to the quality of reuse packaging and the necessity of an effective control.

4 SECONDARY EFFECTS OF HIGHER RECYCLING TARGETS

Industry globally accepts efforts as long as they are the same for all competitors in all countries. But they are opposed to :

- ✓ very expensive systems (control becomes difficult and **free riders** get a sensible economic advantage above honest competitors)

[3] this is exacerbated if the reusable packaging line replaces a single trip line which has not yet reached the end of its lifetime

- ✓ **market decrease** for packed products and/or for packaging materials

So the Industry's basic arguments/reasons are :

Reuse targets

- ✓ "Reusable packaging is often less convenient for the consumer : heavier, no volume reduction for storage at home (it may not be crushed), immobilised assets (deposit)… ➔ the market (of packed products) decreases.
- ✓ Reuse system might be more expensive (mainly due to management cost of deposit and returned packaging) ➔ the market (of packed products) decreases."

Recycling targets

- ✓ "Recycled materials compete with virgin materials ➔ market prices and volume of virgin materials decrease.
- ✓ High cost *encourages fraud* ➔ *infringers get a competitive advantage* ➔ *market share decreases for honest industry*"

So, the only basic concern of the industry is, by definition in an open market economy, to maintain/increase the sales and benefits. So Industry's basic arguments/reasons to resist high targets need to be investigated seriously.

As industry seeks to reduce their waste management cost, they are inclined to favour energy recovery (whose cost is supported by the public authorities). This means industry won't try to do better than the mandatory targets. If industry had to finance all waste management operations (i.e. also incineration and landfilling), recycling would appear relatively more attractive at their eyes. This would motivate industry to do more than mandatory, give more confidence in the recycling chain and so favour investments.

Annex 10: Presentation of the CBA results and the optimum systems

Table of content

1 Explanation on internal costs calculations

Internal costs are calculated by tonne of packaging waste respectively incinerated, landfilled and recycled, in low and high population density areas. Internal costs for a specific recycling rate are calculated as balanced sum of recycling costs and incineration/landfilling costs.

In fact there is a **really comprehensive assessment** of the relationship between recycling rates and costs, as we have analysed separately the different packaging materials and applications, the different situations concerning population density, cost of incineration… The situation presented in the report concerns only the "optimum" system as being the sum op many individual optimum systems

2 Steel from household sources

2.1 Scenarios considered

Table 1 summarises the parameters considered for the baseline scenarios modelled.

Table 1 : Scenarios considered for steel

	Population density	Selective collection scheme	Recycling rate achieved	MSW waste management option
Scenario 1	Low	None	0%	Landfill
Scenario 2	Low	None	0%	Incineration
Scenario 3	Low	None	80%	Incineration with slag recovery
Scenario 4	Low	Separate kerbside collection	40-60%	Landfill
Scenario 5	Low	Separate kerbside collection	40-60%	Incineration
Scenario 6	Low	Separate kerbside collection	88-92%	Incineration with slag recovery
Scenario 7	Low	Bring scheme	15-21%	Landfill
Scenario 8	Low	Bring scheme	15-21%	Incineration
Scenario 9	Low	Bring scheme	83-84%	Incineration with slag recovery
Scenario 10	High	None	0%	Landfill
Scenario 11	High	None	0%	Incineration
Scenario 12	High	None	80%	Incineration with slag recovery
Scenario 13	High	Separate kerbside collection	40-60%	Landfill
Scenario 14	High	Separate kerbside collection	40-60%	Incineration
Scenario 15	High	Separate kerbside collection	88-92%	Incineration with slag recovery
Scenario 16	High	Bring scheme	15-21%	Landfill
Scenario 17	High	Bring scheme	15-21%	Incineration
Scenario 18	High	Bring scheme	83-84%	Incineration with slag recovery

2.2 Results of the cost benefit analysis of steel

Table 2 :Steel – low population density: Internal costs, external costs and total social costs A remplacer !!!

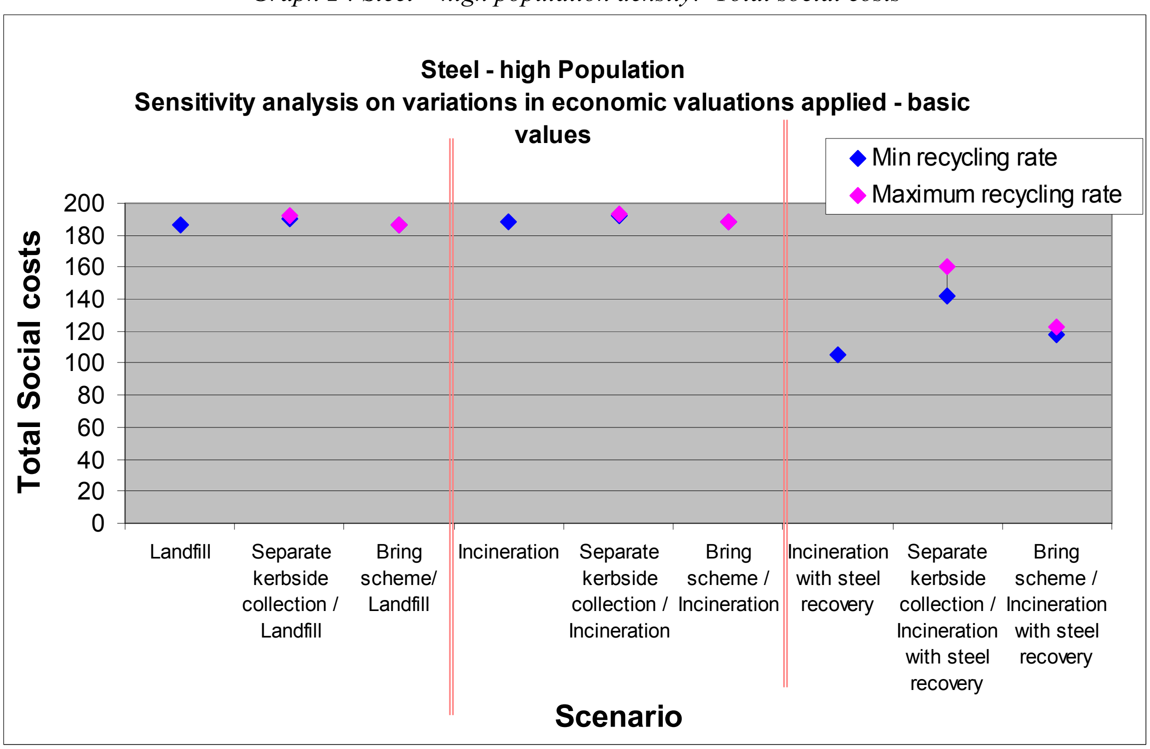
Collection method	**N/A**	**N/A**	**N/A**	**Separate Kerbside**	**Separate kerbside**	**Separate kerbside**	**Bring scheme**	**Bring scheme**	**Bring scheme**
Recycling rate	**0%**	**0%**	**80%**	**40-60%**	**40-60**	**88-92%**	**15-21%**	**15-21**	**83-84%**
Residual waste management option	**Landfill**	**Incineration**	**Incineration with recovery of steel from slags**	**Landfill**	**Incineration**	**Incineration with recovery of steel from slags**	**Landfill**	**Incineration**	**Incineration with recovery of steel from slags**
Externalities									
GWP (kg CO2 eq.)	0.4	0.6	-14.0	-6.5 to -9.9	-6.3 to -9.8	-15.1 to -15.6	-2.2 to -3.2	-2.0 to -3.0	-14.4 to -14.6
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Acidification (Acid equiv.)	0.0	0.1	-0.2	-0.1 to -0.1	0.0 to -0.1	-0.2 to -0.2	0.0 to 0.0	0.0 to 0.0	-0.2 to -0.2
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Toxicity Gaseous (SO2 equiv.)	0.1	0.2	-6.5	-3.1 to -4.7	-3.1 to -4.7	-7.1 to -7.4	-0.9 to -1.3	-0.9 to -1.3	-6.6 to -6.6
Toxicity Metals non carcinogens (Pb equiv.)	0.1	0.0	0.5	0.3 to 0.4	0.3 to 0.4	0.5 to 0.5	0.2 to 0.2	0.1 to 0.2	0.5 to 0.5
Toxicity Particulates & aerosols (PM10 equiv)	9.2	8.8	13.0	15.9 to 19.3	15.7 to 19.1	18.2 to 20.8	9.3 to 9.3	8.9 to 9.0	12.4 to 12.2
Toxicity Smog (ethylene equiv.)	0.3	0.2	-0.4	0.2 to 0.1	0.1 to 0.1	-0.2 to -0.1	0.2 to 0.2	0.2 to 0.2	-0.3 to -0.3
Black smoke (kg dust eq.)	0.2	0.3	-0.7	-0.2 to -0.4	-0.2 to -0.4	-0.8 to -0.8	0.1 to 0.0	0.1 to 0.1	-0.7 to -0.7
Fertilisation	-0.1	-0.1	0.5	0.1 to 0.2	0.1 to 0.2	0.5 to 0.5	0.0 to 0.0	0.0 to 0.0	0.5 to 0.5
Traffic accidents (risk equiv.)	0.1	0.1	0.6	0.5 to 0.7	0.5 to 0.7	0.8 to 0.9	1.1 to 1.4	1.1 to 1.4	1.5 to 1.8
Traffic Congestion (car km equiv.)	0.1	0.1	11.1	1.6 to 2.4	1.6 to 2.4	8.2 to 6.7	0.7 to 0.9	0.7 to 0.9	10.0 to 9.6
Traffic Noise (car km equiv.)	0.4	0.4	1.1	1.7 to 2.3	1.7 to 2.3	2.1 to 2.6	0.7 to 0.9	0.7 to 0.9	1.4 to 1.5
Water Quality Eutrophication (P equiv.)	0.0	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Disaminity (kg LF waste equiv.)	37.0	10.1	10.1	22.2 to 14.8	6.1 to 4.1	6.1 to 4.1	31.5 to 29.2	8.6 to 8.0	8.6 to 8.0
TOTAL EXTERNALITIES	**47.8**	**21.0**	**15.1**	**32.6 to 25.0**	**16.5 to 14.3**	**13.0 to 11.9**	**40.6 to 37.6**	**17.7 to 16.4**	**12.8 to 11.8**
INTERNAL COSTS	**112.2**	**141.4**	**93.4**	**133.2 to 143.8**	**150.8 to 155.4**	**122.0 to 136.2**	**116.9 to 118.8**	**141.7 to 141.8**	**100.9 to 103.9**
TOTAL SOCIAL COSTS	**160.0**	**162.4**	**108.5**	**165.9 to 168.8**	**167.3 to 169.7**	**135.0 to 148.2**	**157.5 to 156.4**	**159.4 to 158.3**	**113.7 to 115.7**

Table 3 : Steel – high population density: Internal costs, external costs and total social costs

Collection method	**N/A**	**N/A**	**N/A**	**Separate Kerbside collection**	**Separate kerbside collection**	**Separate kerbside collection**	**Bring scheme**	**Bring scheme**	**Bring scheme**
Recycling rate	**0%**	**0%**	**80%**	**40-60%**	**40-60%**	**88-92%**	**15-21%**	**15-21%**	**83-84%**
Residual waste management option	**Landfill**	**Incineration**	**Incineration with recovery of steel from slags**	**Landfill**	**Incineration**	**Incineration with recovery of steel from slags**	**Landfill**	**Incineration**	**Incineration with recovery of steel from slags**
Exeternalities									
GWP (kg CO2 eq.)	0.3	0.5	-14.8	-5.6 to -8.5	-5.4 to -8.4	-14.6 to -14.5	-2.5 to -3.6	-2.3 to -3.4	-15.2 to -15.4
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Acidification (Acid equiv.)	0.0	0.1	-0.2	-0.1 to -0.1	0.0 to -0.1	-0.2 to -0.2	0.0 to 0.0	0.0 to 0.0	-0.2 to -0.2
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Toxicity Gaseous (SO2 equiv.)	0.1	0.2	-6.7	-2.6 to -3.9	-2.5 to -3.9	-6.6 to -6.6	-1.1 to -1.5	-1.0 to -1.5	-6.8 to -6.9
Toxicity Metals non carcinogens (Pb equiv.)	0.1	0.0	0.5	0.2 to 0.3	0.2 to 0.3	0.5 to 0.5	0.2 to 0.2	0.1 to 0.2	0.5 to 0.5
Toxicity Particulates & aerosols (PM10 equiv)	8.0	7.5	-7.3	9.3 to 9.9	9.0 to 9.7	0.1 to 3.8	6.4 to 5.7	6.0 to 5.4	-6.6 to -6.3
Toxicity Smog (ethylene equiv.)	0.2	0.2	-0.7	-0.1 to -0.2	-0.1 to -0.2	-0.6 to -0.6	0.1 to 0.0	0.0 to 0.0	-0.7 to -0.7
Black smoke (kg dust eq.)	0.2	0.2	-0.9	-0.2 to -0.5	-0.2 to -0.4	-0.9 to -0.9	0.0 to -0.1	0.0 to 0.0	-0.9 to -0.9
Fertilisation	-0.1	-0.1	0.7	0.2 to 0.3	0.2 to 0.3	0.6 to 0.6	0.0 to 0.1	0.0 to 0.1	0.7 to 0.7
Traffic accidents (risk equiv.)	0.2	0.2	0.3	0.6 to 0.8	0.6 to 0.8	0.6 to 0.8	0.6 to 0.7	0.6 to 0.7	0.7 to 0.8
Traffic Congestion (car km equiv.)	8.2	8.2	10.6	27.5 to 37.2	27.5 to 37.2	29.0 to 38.2	19.5 to 24.0	19.5 to 24.0	21.5 to 25.9
Traffic Noise (car km equiv.)	0.2	0.2	0.3	0.6 to 0.9	0.6 to 0.9	0.7 to 0.9	0.3 to 0.4	0.3 to 0.4	0.5 to 0.5
Water Quality Eutrophication (P equiv.)	0.0	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Disaminity (kg LF waste equiv.)	37.0	10.1	10.1	22.2 to 14.8	6.1 to 4.1	6.1 to 4.1	31.5 to 29.2	8.6 to 8.0	8.6 to 8.0
TOTAL EXTERNALITIES	**54.2**	**27.3**	**-8.1**	**52.1 to 51.1**	**36.0 to 40.3**	**14.7 to 26.1**	**54.9 to 55.1**	**32.0 to 33.9**	**1.9 to 5.9**
INTERNAL COSTS	**132.0**	**161.2**	**113.2**	**138.3 to 141.5**	**155.8 to 153.2**	**127.0 to 134.0**	**131.5 to 131.3**	**156.3 to 154.4**	**115.5 to 116.5**
TOTAL SOCIAL COSTS	**186.2**	**188.5**	**105.1**	**190.4 to 192.5**	**191.8 to 193.5**	**141.8 to 160.1**	**186.4 to 186.4**	**188.4 to 188.3**	**117.5 to 122.4**

Graph 1 : Steel – low population density: Total social costs

Graph 2 : Steel – high population density: Total social costs



2.3 Main findings:

For low population density:

- From total social cost perspective, where landfilling is the MSW option, a bring scheme achieving a recycling rate of 7-17% is the optimum system from the scenarios considered. (Although the difference between all scenarios is very small).
- From total social cost perspective, where incineration with energy recovery but no slag recovery is the MSW option, a bring scheme achieving a recycling rate of 7-17% is the optimum system from the scenarios considered.
- From total social cost perspective, where incineration with energy recovery and slag recovery is the MSW option, 100% incineration with recycling of steel recovered from slags is the optimum system for the scenarios considered.

For high population density:

- From total social cost perspective, where landfilling is the MSW option, 100% landfilling is the optimum system (although the difference between the systems is very small)
- From total social cost perspective, where incineration with energy recovery but no slag recovery is the MSW option, there is no distinction between 100% incineration and a bring scheme achieving a recycling rate of 5-10% as the optimum system from the scenarios considered.
- From total social cost perspective, where incineration with energy recovery and slag recovery is the MSW option, 100% incineration with recycling of steel recovered from slags is the optimum system for the scenarios considered.

2.4 Sensitivity analysis

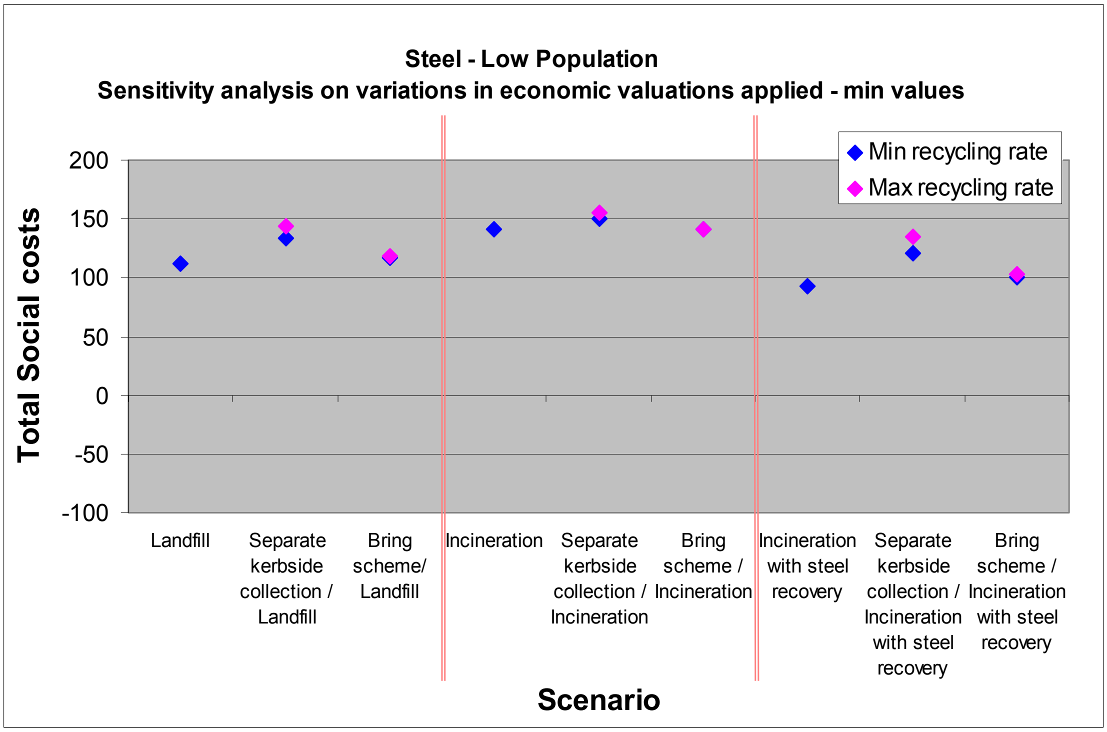
2.4.1 Methodological choices

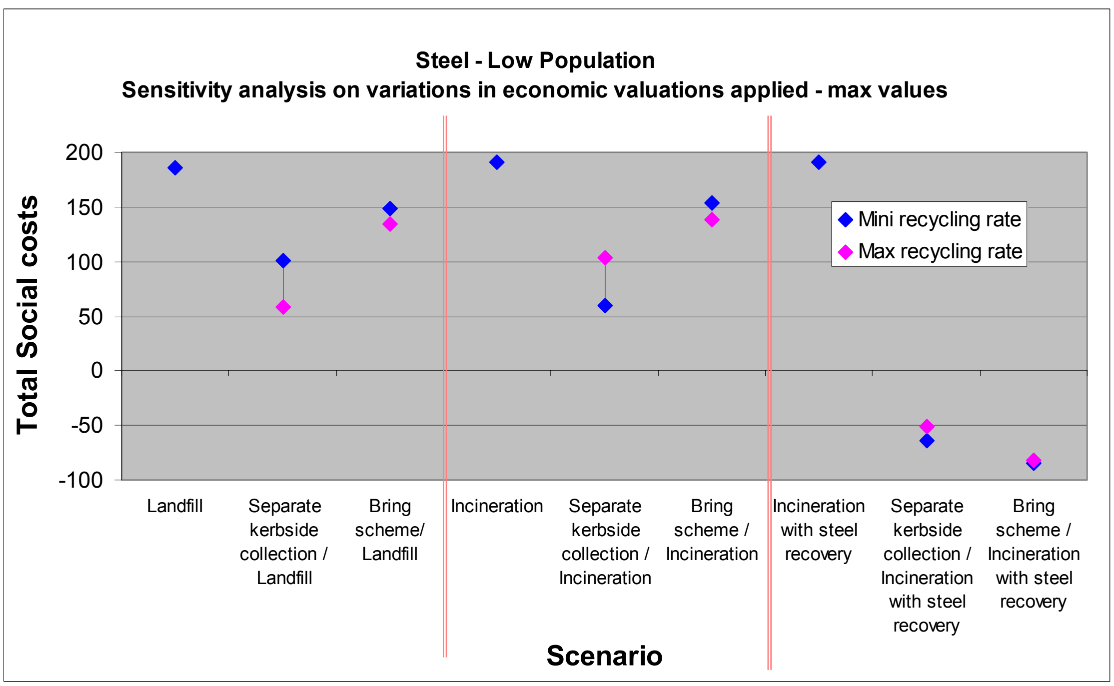
2.4.1.1 Choice of external valuations

Graph 3 & Graph 4 show the sensitivity of the analysis to the economic valuations applied to the defined environmental impacts. The graphs have been produced by considering the same environmental impact results, but applying different impact assessment valuations (see Annex 4 for a list of maximum and minimum valuations applied).

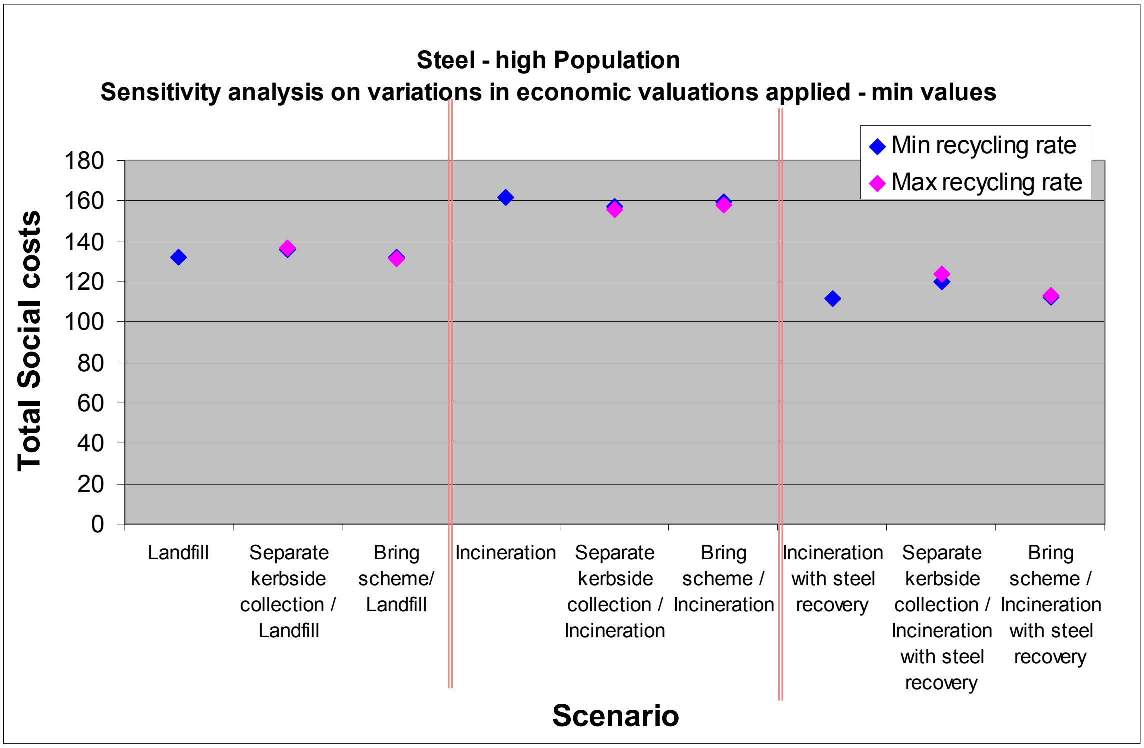
Table 4 show that the achieved results.

Graph 3 : Steel – low population density: Sensitivity of the results to the external economic valuations applied





Graph 4 : Steel – high population density: Sensitivity of the results to the external economic valuations applied



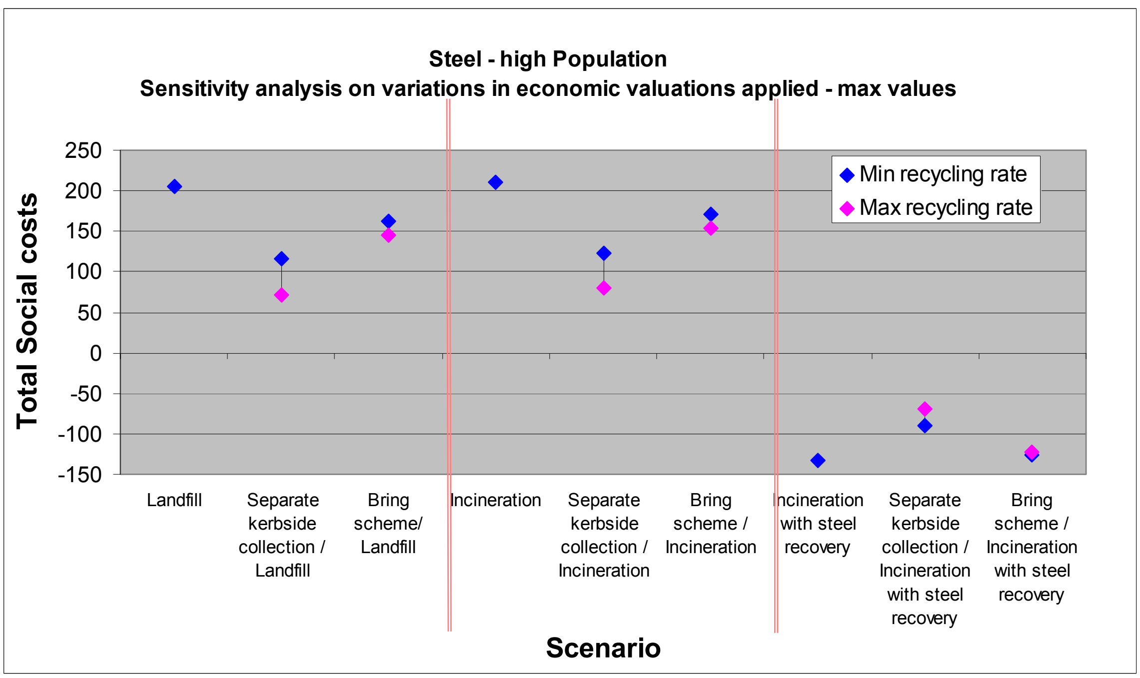


Table 4: Summary of the sensitivity analysis to economic valuations

Low population density			
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Bring	No SC	Kerbside
Incineration with energy recovery but no slag recovery	Bring	Bring	Kerbside
Incineration with energy recovery and slag recovery	No SC[1]	No SC	Bring
High population density			
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	No SC	No SC (Bring)	Kerbside
Incineration with energy recovery but no slag recovery	No SC or Bring	Kerbside	Kerbside
Incineration with energy recovery and slag recovery	No SC	No SC	No SC

Conclusions drawn :

- where landfill is the residual waste management option are mainly dependent upon the max economic valuations applied to the environmental impacts.,
- where incineration with energy recovery and slag recovery is the residual waste management option are not or slightly dependent upon the economic valuations applied to the environmental impacts.,

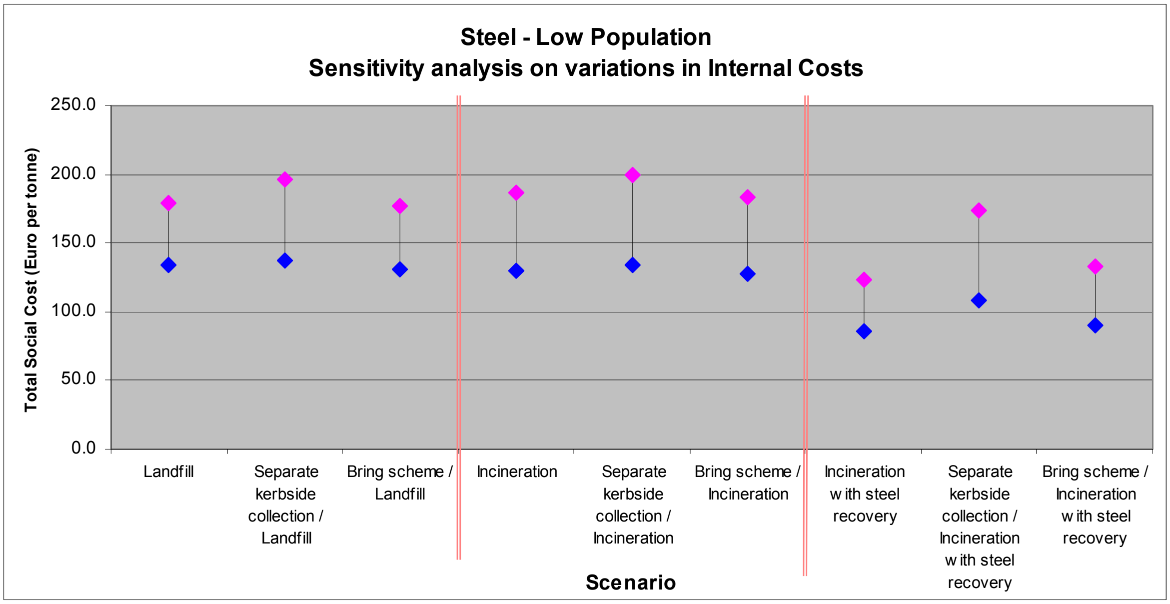
2.4.1.2 Internal costs

The internal costs applied in this study have been sourced mostly from the UK, France and Belgium. Even where equivalent waste management practices are compared internal costs can vary considerably between Member States, depending on a range of factors such as cost of living and geographical considerations (mountainous regions, island populations, etc.). In this part of the sensitivity analysis, the effect on the results of considering a +/-20% variation in internal costs is investigated. The results are presented in Graph 5 & Graph 6.

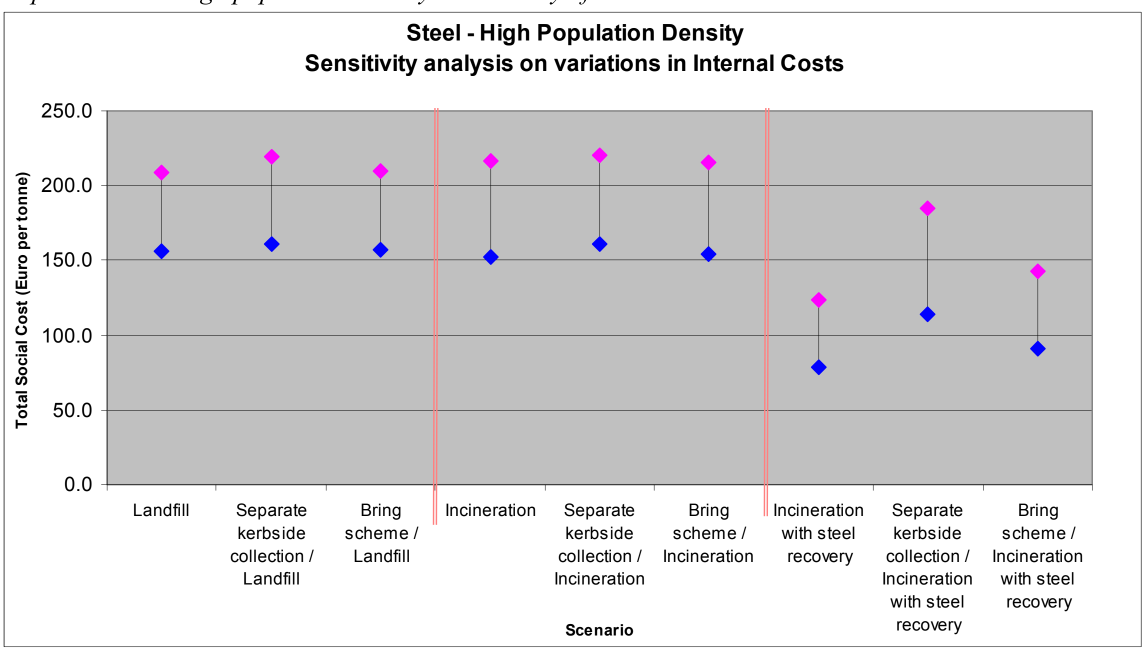
The graphs show that the results achieved and conclusions drawn are highly dependent upon the internal costs applied. Applying a range of +/-20% to the internal costs makes it impossible (or very difficult) to distinguish an optimum system from the scenarios studied.

[1] SC : Selective Collection

Graph 5 : Steel – low population density: Sensitivity of the results to the internal economic costs considered



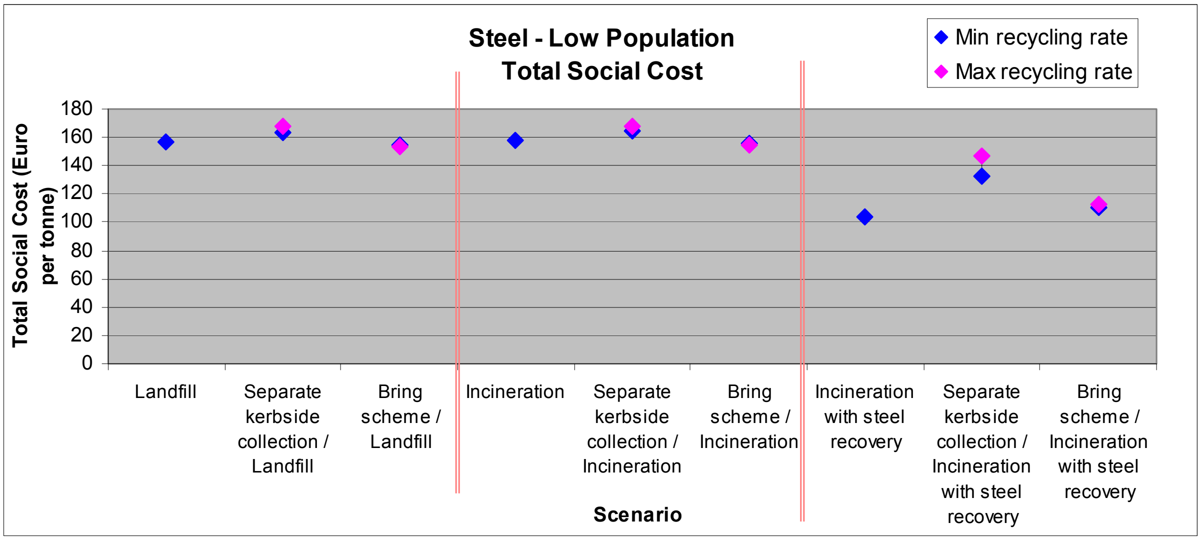
Graph 6 : Steel – high population density: Sensitivity of the results to the internal economic costs considered



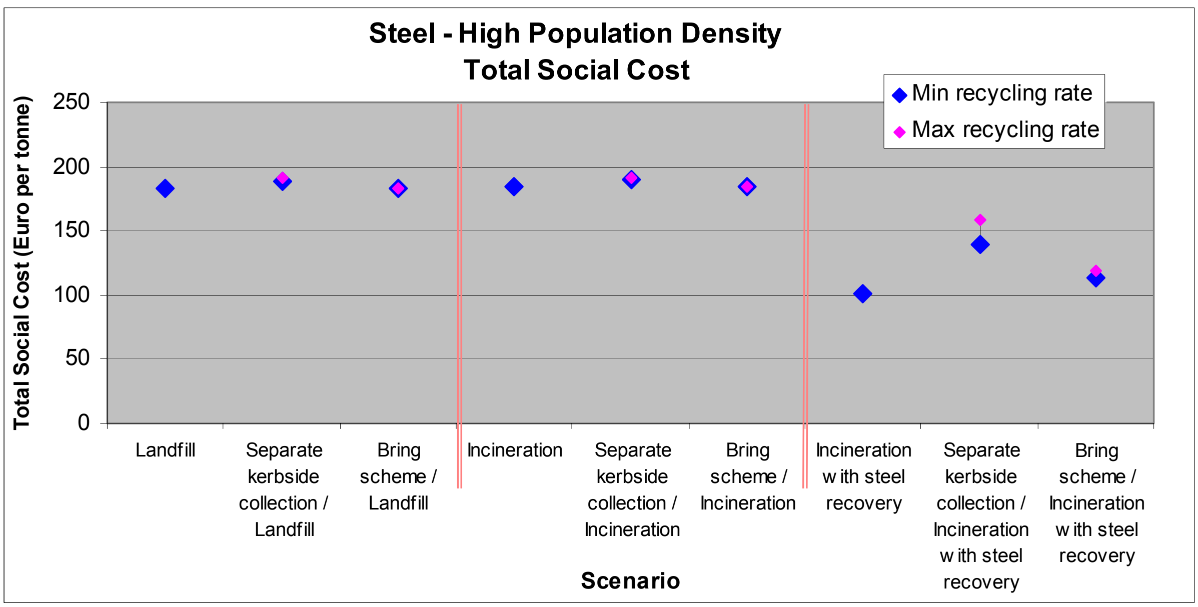
2.4.1.3 Inclusion of employment as an impact category

Graph 7 & Graph 8 show the sensitivity of the analysis to the inclusion of employment as an impact category. The graphs have been produced by including employment along with the other environmental impacts used in the baseline analysis.

Graph 7 : Steel – low pop. density: Sensitivity of the results to the addition of employment as an impact category



Graph 8 : Steel – high pop. density: Sensitivity of the results to the addition of employment as an impact category



The following implications of including employment should be considered:

For low population density:

- From total social cost perspective, where landfill is the MSW option it is no longer possible to distinguish between the scenarios
- From total social cost perspective, where incineration with energy recovery but no slag recovery is the MSW option it is no longer possible to distinguish between the scenarios
- From total social cost perspective, where incineration with energy recovery and slag recovery is the MSW option, 100% incineration with recycling of steel recovered from slags is the optimum system for the scenarios considered.

For high population density:

- From total social cost perspective, where landfilling is the MSW option, it is no longer possible to distinguish between the scenarios
- From total social cost perspective, where incineration with energy recovery but no slag recovery is the MSW option it is no longer possible to distinguish between the scenarios
- From total social cost perspective, where incineration with energy recovery and slag recovery is the MSW option, 100% incineration with recycling of steel recovered from slags is the optimum system for the scenarios considered.

2.4.2 Scenario and modelling choices

Findings from the sensitivity analysis of scenario and modelling choices are summarised in Table 5.

Table 5 : Summary of sensitivity analysis of scenario and modelling choices for steel

Parameter investigated	Influence on CBA results	Influence on conclusions drawn
Incineration model Combined heat and power	No significant effect on scale of CBA results	No effect on choice of optimum scenario
Incineration model Offset electricity	No significant effect on scale of CBA results	No effect on choice of optimum scenario
Transport distances MSW collection round Kerbside collection round Collection from bring bank Transport from sorting plant to reprocessor	Transport assumptions made can have significant influence on the relative standing of results.	Considering best and worst cases for each scenario makes it impossible to determine an optimum system for each set of conditions
Transport distance Consumer transport to bring bank	Consumer transport assumptions critical to relative standing of the bring scheme scenario	Alternative assumptions would affect the choice of optimum scenario

3 Aluminium cans

3.1 Scenarios considered

The table below summarises the parameters considered for the baseline scenarios modelled.

Table 6 : Scenarios considered for aluminium cans

	Population density	Selective collection scheme	Recycling rate achieved	MSW waste management option
Scenario 1	Low	None	0%	Landfill
Scenario 2	Low	None	0%	Incineration
Scenario 3	Low	None	76%	Incineration with slag recovery
Scenario 4	Low	Separate kerbside collection	45-55%	Landfill
Scenario 5	Low	Separate kerbside collection	45-55%	Incineration
Scenario 6	Low	Separate kerbside collection	87-89%	Incineration with slag recovery
Scenario 7	Low	Bring scheme	31-41%	Landfill
Scenario 8	Low	Bring scheme	31-41%	Incineration
Scenario 9	Low	Bring scheme	83-86%	Incineration with slag recovery
Scenario 10	High	None	0%	Landfill
Scenario 11	High	None	0%	Incineration
Scenario 12	High	None	76%	Incineration with slag recovery
Scenario 13	High	Separate kerbside collection	45-55%	Landfill
Scenario 14	High	Separate kerbside collection	45-55%	Incineration
Scenario 15	High	Separate kerbside collection	87-89%	Incineration with slag recovery
Scenario 16	High	Bring scheme	31-41%	Landfill
Scenario 17	High	Bring scheme	31-41%	Incineration
Scenario 18	High	Bring scheme	83-86%	Incineration with slag recovery

3.2 Results of the cost benefit analysis for aluminium cans

This section presents and discusses the results of the cost benefit analysis for aluminium cans.

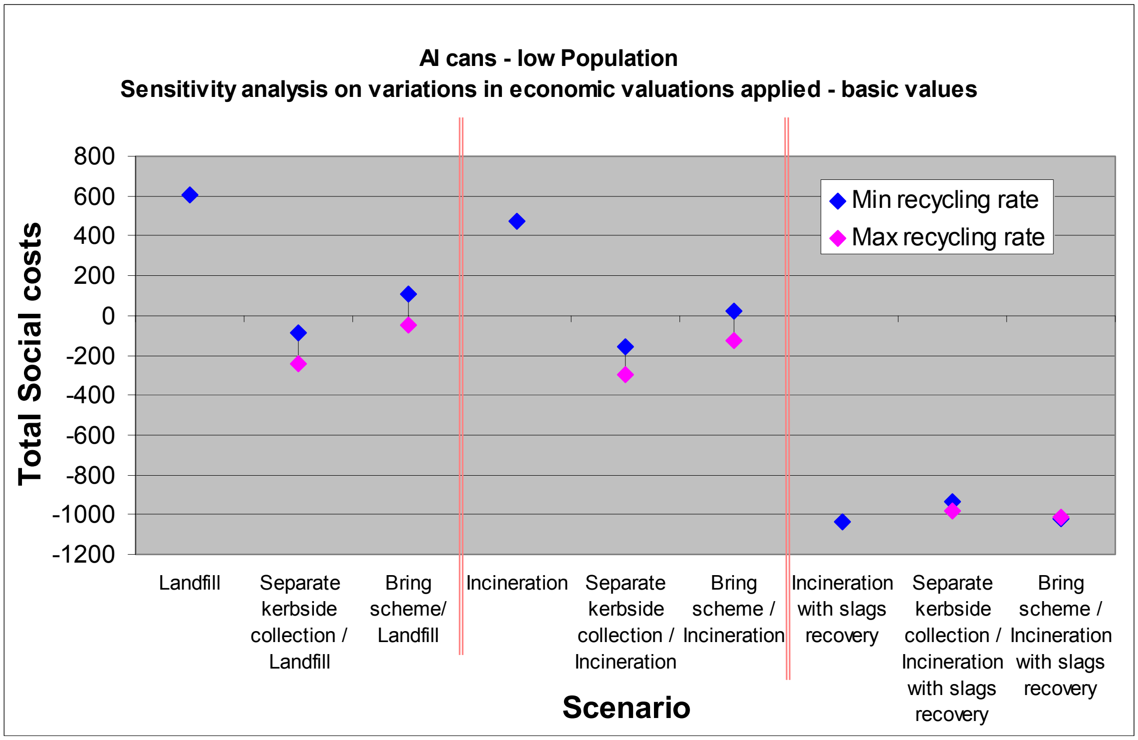
Table 7 : Aluminium cans - low population density: Internal costs, external costs and total social costs

Collection method	**N/A**	**N/A**	**N/A**	**Separate Kerbside collection**			**Separate kerbside collection**			**Separate kerbside collection**			**Bring scheme**			**Bring scheme**			**Bring scheme**		
Recycling rate	**0,0**	**0,0**	**80%**	**45-55%**			**45-55%**			**87-89%**			**31-41%**			**31-41%**			**83-86%**		
Residual waste management option	**Landfill**	**Incineration**	**Incineration with nodule recovery**	**Landfill**			**Incineration**			**Incineration with nodule recovery**			**Landfill**			**Incineration**			**Incineration with nodule recovery**		
Exeternalities																					
GWP (kg CO2 eq.)	0,4	1,0	-95,5	-55,9	to	-68,4	-55,5	to	-68,1	-108,6	to	-111,5	-38,4	to	-50,9	-37,9	to	-50,5	-104,5	to	-107,5
Ozone depletion (kg CFC 11 eq.)	0,0	0,0	0,0	0,0	to	0,0	0,0	to	0,0	0,0	to	0,0	0,0	to	0,0	0,0	to	0,0	0,0	to	0,0
Acidification (Acid equiv.)	0,0	0,1	-13,1	-7,7	to	-9,4	-7,7	to	-9,4	-14,9	to	-15,4	-5,3	to	-7,0	-5,2	to	-7,0	-14,3	to	-14,8
Toxicity Carcinogens (Cd equiv)	0,0	0,0	-19,3	-11,4	to	-13,9	-11,4	to	-13,9	-22,0	to	-22,6	-7,9	to	-10,4	-7,9	to	-10,4	-21,2	to	-21,8
Toxicity Gaseous (SO2 equiv.)	0,1	0,3	-79,6	-47,0	to	-57,5	-46,9	to	-57,4	-90,8	to	-93,3	-32,0	to	-42,3	-31,9	to	-42,2	-87,0	to	-89,4
Toxicity Metals non carcinogens (Pb equiv.)	0,1	0,1	-337,7	-199.9	to	-244,4	-199,9	to	-244,4	-385,7	to	-396,4	-137,6	to	-182,1	-137,7	to	-182,1	-370,7	to	-381,4
Toxicity Particulates & aerosols (PM10 equiv)	9,7	10,5	-550,4	-306.7	to	-377,0	-306,2	to	-376,6	-614,7	to	-629,0	-213,4	to	-285,3	-212,8	to	-284,8	-599,8	to	-615,8
Toxicity Smog (ethylene equiv.)	0,3	0,3	-18,0	-10,2	to	-12,5	-10,2	to	-12,5	-20,2	to	-20,7	-6,9	to	-9,2	-6,9	to	-9,2	-19,5	to	-20,0
Black smoke (kg dust eq.)	0,2	0,4	-43,0	-25,3	to	-31,0	-25,2	to	-30,9	-49,1	to	-50,5	-17,3	to	-23,0	-17,2	to	-22,9	-47,2	to	-48,5
Fertilisation	-0,1	-0,2	10,6	6,1	to	7,4	6,0	to	7,4	11,9	to	12,2	4,1	to	5,5	4,1	to	5,5	11,5	to	11,8
Traffic accidents (risk equiv.)	0,1	0,1	0,6	0,8	to	0,9	0,8	to	0,9	1,0	to	1,1	2,2	to	2,9	2,2	to	2,9	2,5	to	3,2
Traffic Congestion (car km equiv.)	0,1	0,1	10,8	6,8	to	8,3	6,8	to	8,3	12,7	to	13,1	4,8	to	6,3	4,8	to	6,3	12,1	to	12,6
Traffic Noise (car km equiv.)	0,4	0,4	1,1	2,2	to	2,6	2,2	to	2,6	2,6	to	2,9	1,3	to	1,6	1,3	to	1,6	1,8	to	2,1
Water Quality Eutrophication (P equiv.)	0,0	0,0	-1,0	-0,6	to	-0,7	-0,6	to	-0,7	-1,1	to	-1,1	-0,4	to	-0,5	-0,4	to	-0,5	-1,1	to	-1,1
Disaminity (kg LF waste equiv.)	37,0	10,1	10,1	20,4	to	16,7	5,6	to	4,6	5,6	to	4,6	25,5	to	21,8	7,0	to	6,0	7,0	to	6,0
TOTAL EXTERNALITIES	**48,3**	**23,4**	**-1124,4**	**-628,5**	**to**	**-778,9**	**-642,3**	**to**	**-790,2**	**-1273,5**	**to**	**-1306,6**	**-421,2**	**to**	**-572,7**	**-438,4**	**to**	**-587,4**	**-1230,3**	**to**	**-1264,5**
INTERNAL COSTS	**555,0**	**453,0**	**88,0**	**541,0**	**to**	**537,9**	**484,9**	**to**	**492,0**	**336,5**	**to**	**327,7**	**531,3**	**to**	**523,6**	**460,9**	**to**	**463,4**	**209,0**	**to**	**248,1**
TOTAL SOCIAL COSTS	**603,3**	**476,4**	**-1036,4**	**-87,5**	**to**	**-241,0**	**-157,3**	**to**	**-298,2**	**-937,0**	**to**	**-978,9**	**110,1**	**to**	**-49,1**	**22,5**	**to**	**-124,0**	**-1021,3**	**to**	**-1016,5**

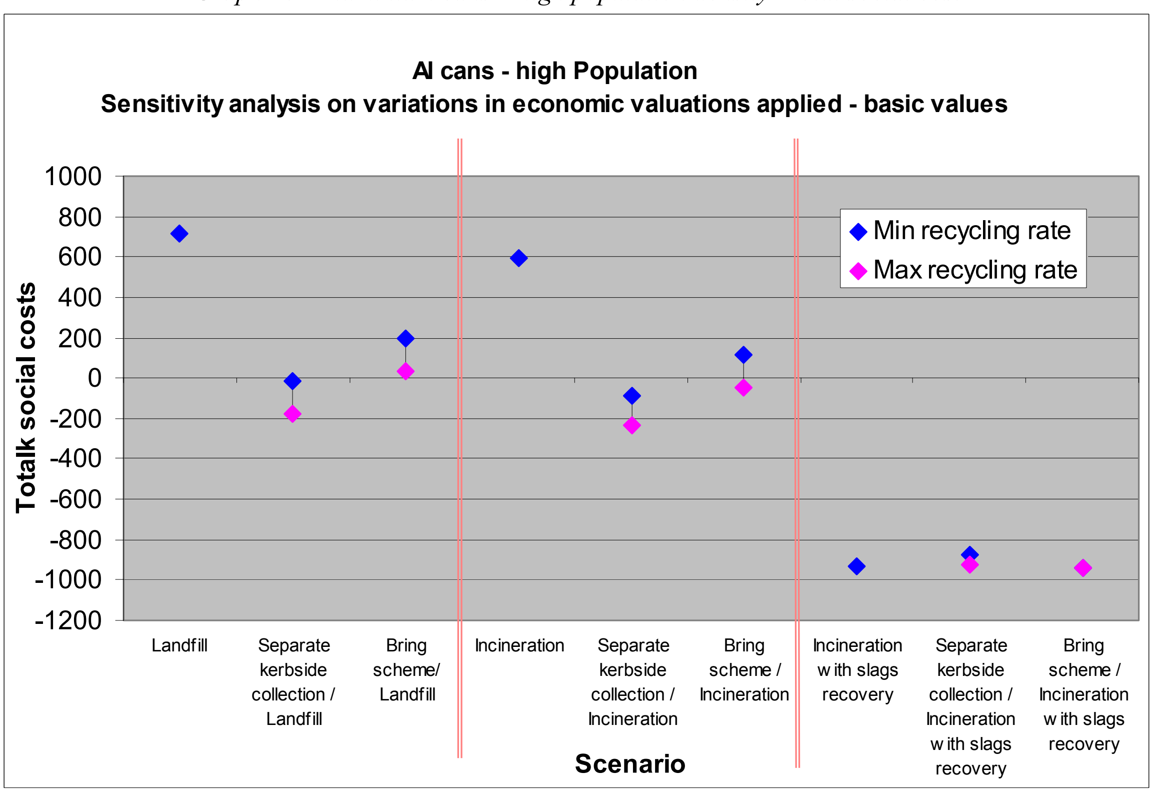
Table 8 : Aluminium cans – high population density: Internal costs, external costs and total social costs

Collection method	N/A	N/A	N/A	Separate Kerbside collection			Separate kerbside collection			Separate kerbside collection			Bring scheme			Bring scheme			Bring scheme		
Recycling rate	**0,0**	**0,0**	**80%**	**45-55%**			**45-55%**			**87-89%**			**31-41%**			**31-41%**			**83-86%**		
Residual waste management option	**Landfill**	**Incineration**	**Incineration with nodule recovery**	**Landfill**			**Incineration**			**Incineration with nodule recovery**			**Landfill**			**Incineration**			**Incineration with nodule recovery**		
Externalities																					
GWP (kg CO2 eq.)	0,3	0,9	-95,9	-56,4	to	-69,0	-56,1	to	-68,8	-109,3	to	-112,3	-38,8	to	-51,4	-38,4	to	-51,1	-105,2	to	-108,2
Ozone depletion (kg CFC 11 eq.)	0,0	0,0	0,0	0,0	to	0,0	0,0	to	0,0	0,0	to	0,0	0,0	to	0,0	0,0	to	0,0	0,0	to	0,0
Acidification (Acid equiv.)	0,0	0,1	-13,1	-7,8	to	-9,5	-7,7	to	-9,5	-15,0	to	-15,4	-5,3	to	-7,1	-5,3	to	-7,0	-14,4	to	-14,8
Toxicity Carcinogens (Cd equiv)	0,0	0,0	-19,3	-11,4	to	-14,0	-11,4	to	-13,9	-22,0	to	-22,6	-7,9	to	-10,4	-7,9	to	-10,4	-21,2	to	-21,8
Toxicity Gaseous (SO2 equiv.)	0,1	0,3	-79,7	-47,1	to	-57,6	-47,0	to	-57,5	-91,0	to	-93,5	-32,3	to	-42,7	-32,1	to	-42,6	-87,3	to	-89,8
Toxicity Metals non carcinogens (Pb equiv.)	0,1	0,1	-337,7	-199,9	to	-244,4	-199,9	to	-244,4	-385,7	to	-396,4	-137,7	to	-182,1	-137,7	to	-182,1	-370,8	to	-381,4
Toxicity Particulates & aerosols (PM10 equiv)	8,4	9,2	-563,9	-312,8	to	-384,2	-312,3	to	-383,8	-627,5	to	-641,7	-218,1	to	-291,1	-217,5	to	-290,6	-612,9	to	-628,7
Toxicity Smog (ethylene equiv.)	0,2	0,2	-18,2	-10,5	to	-12,9	-10,5	to	-12,9	-20,6	to	-21,1	-7,2	to	-9,5	-7,2	to	-9,5	-19,9	to	-20,4
Black smoke (kg dust eq.)	0,2	0,4	-43,1	-25,5	to	-31,2	-25,4	to	-31,1	-49,3	to	-50,7	-17,5	to	-23,2	-17,3	to	-23,1	-47,4	to	-48,7
Fertilisation	-0,1	-0,1	10,7	6,2	to	7,6	6,2	to	7,6	12,1	to	12,4	4,2	to	5,6	4,2	to	5,6	11,7	to	12,0
Traffic accidents (risk equiv.)	0,2	0,2	0,6	1,0	to	1,2	1,0	to	1,2	1,2	to	1,4	1,1	to	1,5	1,1	to	1,5	1,5	to	1,7
Traffic Congestion (car km equiv.)	8,2	8,2	18,8	41,3	to	48,7	41,3	to	48,7	47,2	to	53,5	35,0	to	43,6	35,0	to	43,6	42,3	to	49,9
Traffic Noise (car km equiv.)	0,2	0,2	0,9	1,2	to	1,4	1,2	to	1,4	1,6	to	1,7	0,7	to	0,9	0,7	to	0,9	1,2	to	1,3
Water Quality Eutrophication (P equiv.)	0,0	0,0	-1,0	-0,6	to	-0,7	-0,6	to	-0,7	-1,1	to	-1,1	-0,4	to	-0,5	-0,4	to	-0,5	-1,1	to	-1,1
Disaminity (kg LF waste equiv.)	37,0	10,1	10,1	20,4	to	16,7	5,6	to	4,6	5,6	to	4,6	25,5	to	21,8	7,0	to	6,0	7,0	to	6,0
TOTAL EXTERNALITIES	**54,7**	**29,7**	**-1130,7**	**-601,9**	**to**	**-747,8**	**-615,6**	**to**	**-759,0**	**-1253,9**	**to**	**-1281,2**	**-398,4**	**to**	**-544,6**	**-415,6**	**to**	**-559,3**	**-1216,3**	**to**	**-1244,0**
INTERNAL COSTS	**665,0**	**563,0**	**198,0**	**585,2**	**to**	**567,4**	**529,1**	**to**	**521,5**	**377,1**	**to**	**357,3**	**597,3**	**to**	**575,5**	**526,9**	**to**	**515,3**	**275,1**	**to**	**300,0**
TOTAL SOCIAL COSTS	**719,7**	**592,7**	**-932,7**	**-16,7**	**to**	**-180,4**	**-86,6**	**to**	**-237,5**	**-876,8**	**to**	**-923,9**	**198,9**	**to**	**30,9**	**111,3**	**to**	**-44,0**	**-941,2**	**to**	**-944,0**

Graph 9 : Aluminium cans – low population density: Total social cost



Graph 10 : Aluminium cans – high population density: Total social cost



3.3 Main findings:

For low population density:

- From total social cost perspective, where landfilling is the MSW option, a separate kerbside collection scheme achieving a recycling rate of 45-55% is the optimum system from the scenarios considered.
- From total social cost perspective, where incineration with energy recovery but no slag recovery is the MSW option a separate kerbside collection scheme achieving a recycling rate of 45-55% is the optimum system from the scenarios considered.
- From total social cost perspective, where incineration with energy recovery and slag recovery is the MSW option, 100% incineration with recycling of aluminium recovered from slags is the optimum system for the scenarios considered.

For high population density:

- From total social cost perspective, where landfilling is the MSW option, a separate kerbside collection scheme achieving a recycling rate of 45-55% is the optimum system from the scenarios considered.
- From total social cost perspective, where incineration with energy recovery but no slag recovery is the MSW option a separate kerbside collection scheme achieving a recycling rate of 45-55% is the optimum system from the scenarios considered.
- From total social cost perspective, where incineration with energy recovery and slag recovery is the MSW option, a bring scheme achieving a recycling rate of 31-41% is the optimum system for the scenarios considered.

3.4 Sensitivity analysis

3.4.1 Methodological choices

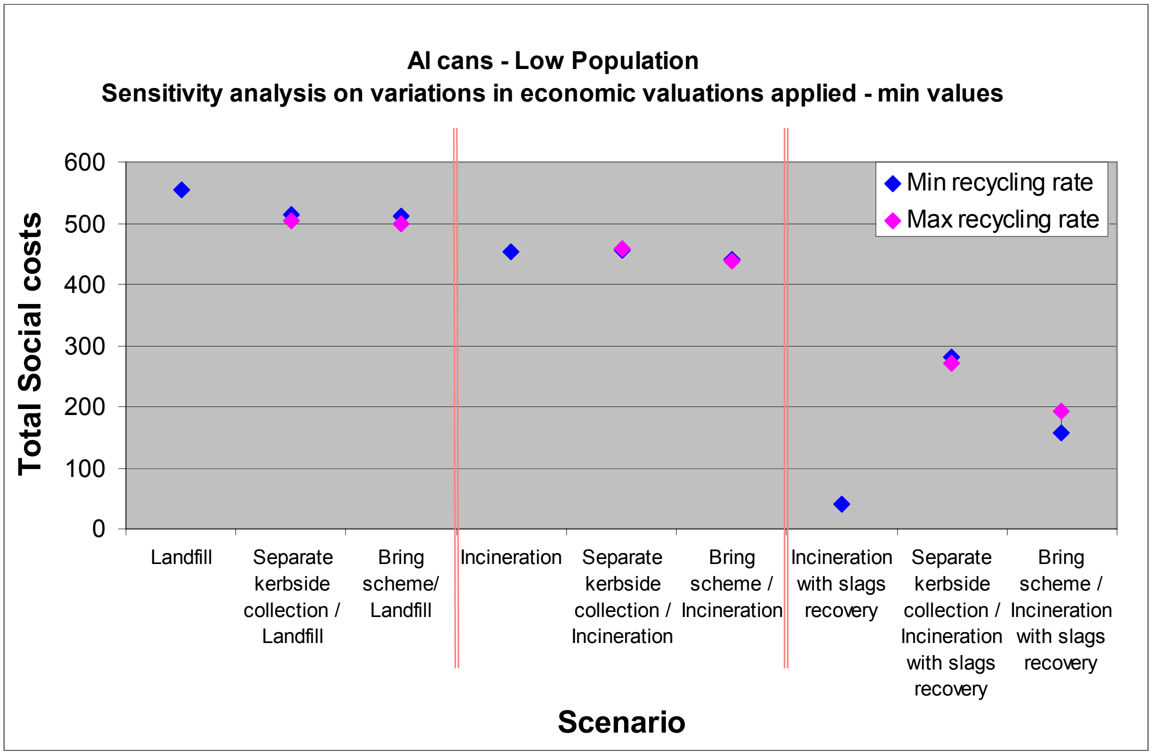
3.4.1.1 Choice of external valuations

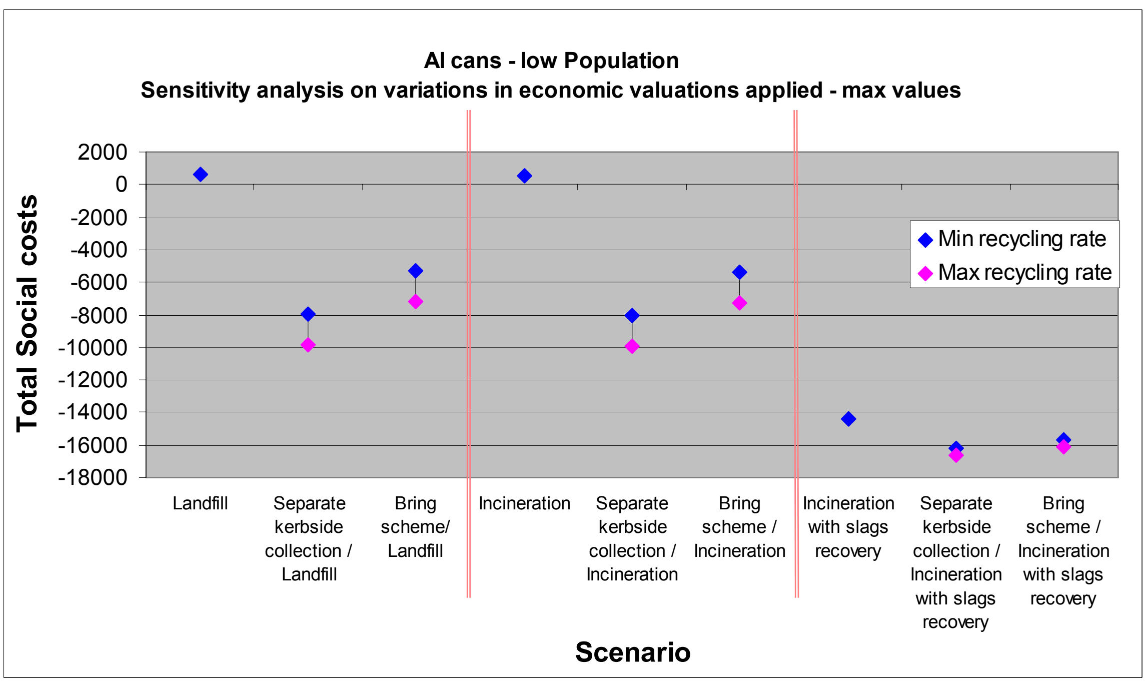
The graphs below show the sensitivity of the analysis to the economic valuations applied to the defined environmental impacts. The graphs have been produced by considering the same environmental impact results, but applying different impact assessment valuations (see Annex 4 for a list of maximum and minimum valuations applied).

Table 9: Summary of the sensitivity analysis to economic valuations

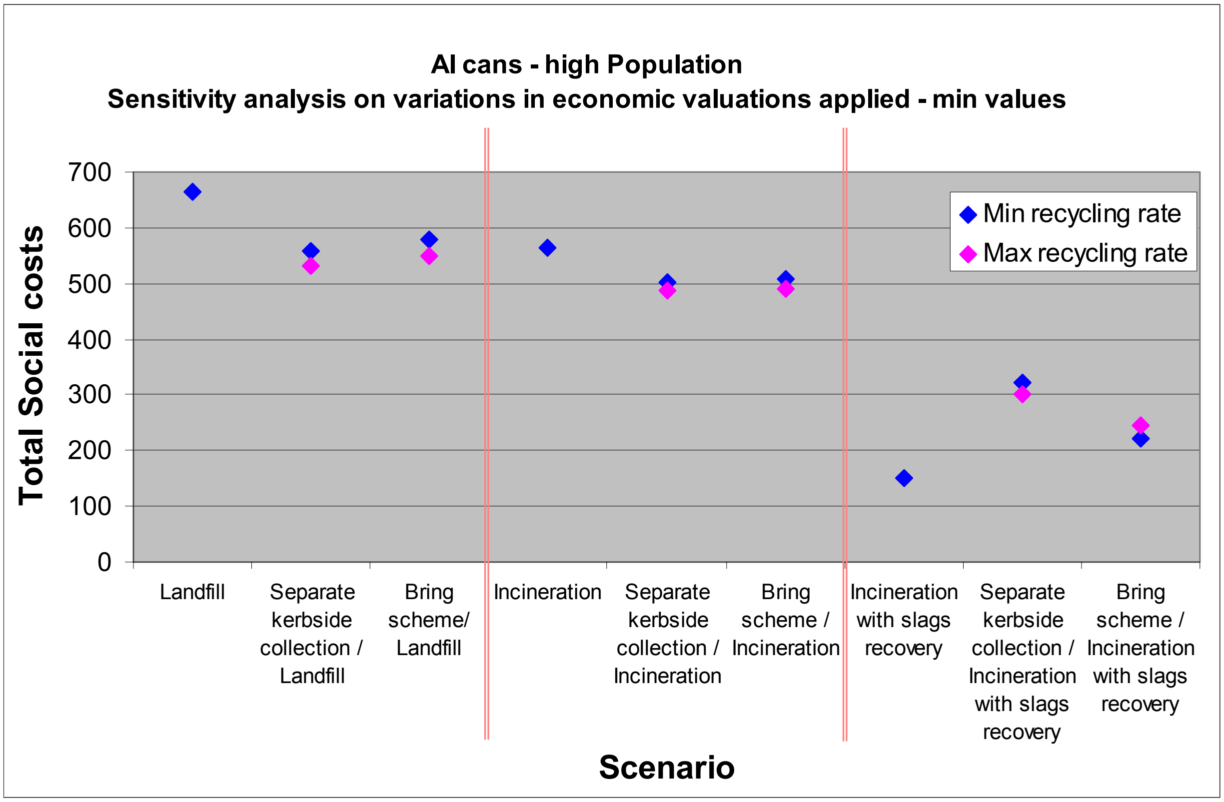
	Low population density		
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Kerbside	Kerbside - Bring	Kerbside
Incineration	Kerbside	Bring	Kerbside
Incineration with slag recovery	No SC	No SC	Kerbside
	High population density		
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Kerbside	Kerbside	Kerbside
Incineration	Kerbside	Kerbside – Bring	Kerbside
Incineration with slag recovery	Bring	No SC	Kerbside

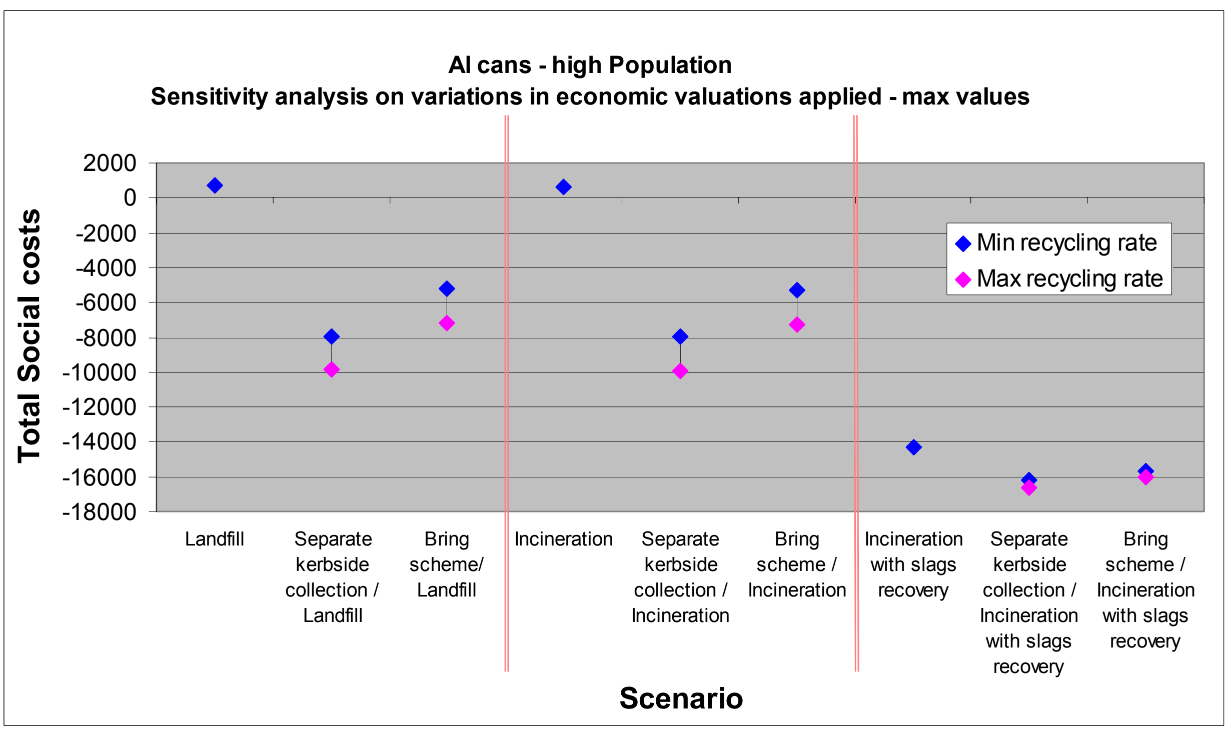
Graph 11 : Aluminium cans – low population density: Sensitivity of results to the external economic valuations applied





Graph 12 : Aluminium cans – high population density: Sensitivity of results to the external economic valuations applied





For low population density, the graphs show where landfill is the MSW option, separate kerbside collection achieving 45-55% recycling appears clearly as the optimal system from those considered.

Where incineration with energy recovery but no recovery of slags is the MSW option it is more difficult to distinguish between separate kerbside collection achieving 45-55% recycling and a bring scheme achieving 31-41% as the optimal system from those considered. However separate kerbside collection should have the preference.

Where incineration with slag recovery is the MSW option, it is not possible to distinguish between separate kerbside collection achieving 45-55% recycling and no selective collection as the optimal system from those considered.

For high population density, when the full range of economic valuations is applied where landfill is the MSW option separate kerbside collection achieving 45-55% recycling is clearly the optimal system from those considered.

Where incineration with energy recovery but no recovery of slags is the MSW option it is more difficult to distinguish between separate kerbside collection achieving 45-55% recycling and a bring scheme achieving 31-41% as the optimal system from those considered. However separate kerbside collection should have the preference.

Where incineration with slag recovery is the MSW option, it is not possible to distinguish between the options considered.

3.4.1.2 Internal costs

The internal costs applied in this study have been sourced mostly from the UK, France and Belgium. Even where equivalent waste management practices are compared internal costs can vary considerably between Member States, depending on a range of factors such as cost of living and geographical considerations (mountainous regions, island populations, etc.). In this part of the sensitivity analysis, the effect on the results of considering a +/-20% variation in internal costs is investigated. The results are presented in the graph below.

For low population density where landfill is the MSW option, it is no longer possible to distinguish between separate kerbside collection achieving 45-55% recycling and a bring scheme achieving 31-41% as the optimal system from those considered.

Where incineration with energy recovery but no slag recovery is the MSW option, the results are not sensitive to variations in the internal costs.

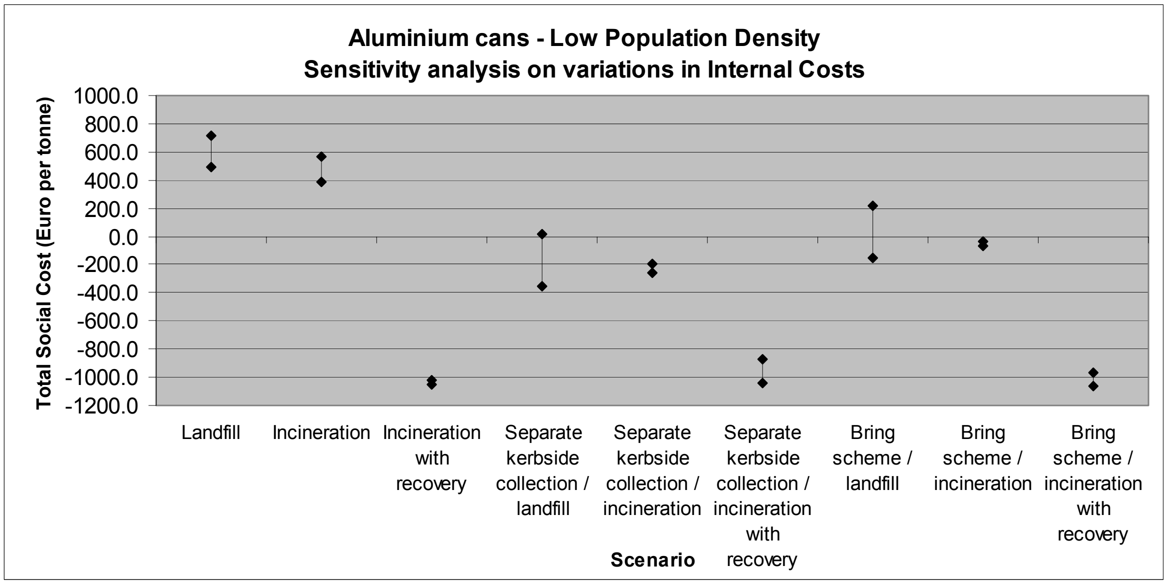
Where incineration with energy recovery and slag recovery is the MSW option it is not possible to distinguish between the options considered when variations in internal costs are taken into account.

For high population density, where landfill is the MSW option, it is no longer possible to distinguish between separate kerbside collection achieving 45-55% recycling and a bring scheme achieving 31-41% as the optimal system from those considered.

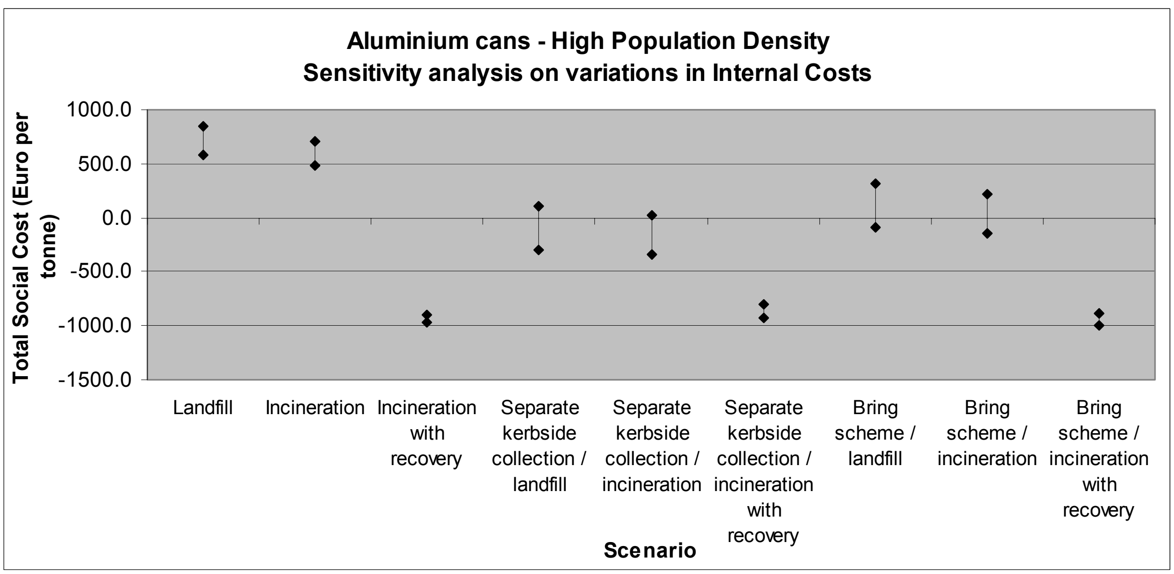
Where incineration with energy recovery but no slag recovery is the MSW option, the results are not sensitive to variations in the internal costs.

Where incineration with energy recovery and slag recovery is the MSW option it is not possible to distinguish between the options considered when variations in internal costs are taken into account.

Graph 13 : Aluminium cans – low population density: Sensitivity of the results to the internal economic costs considered



Graph 14 : Aluminium cans – high population density: Sensitivity of the results to the internal economic costs considered

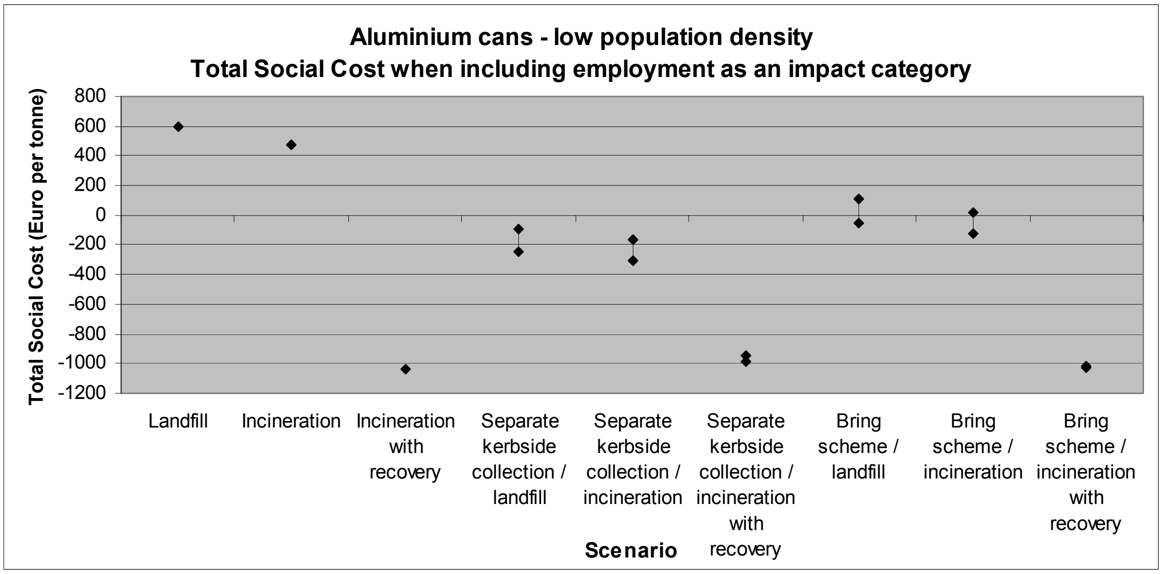


3.4.1.3 Inclusion of employment as an impact category

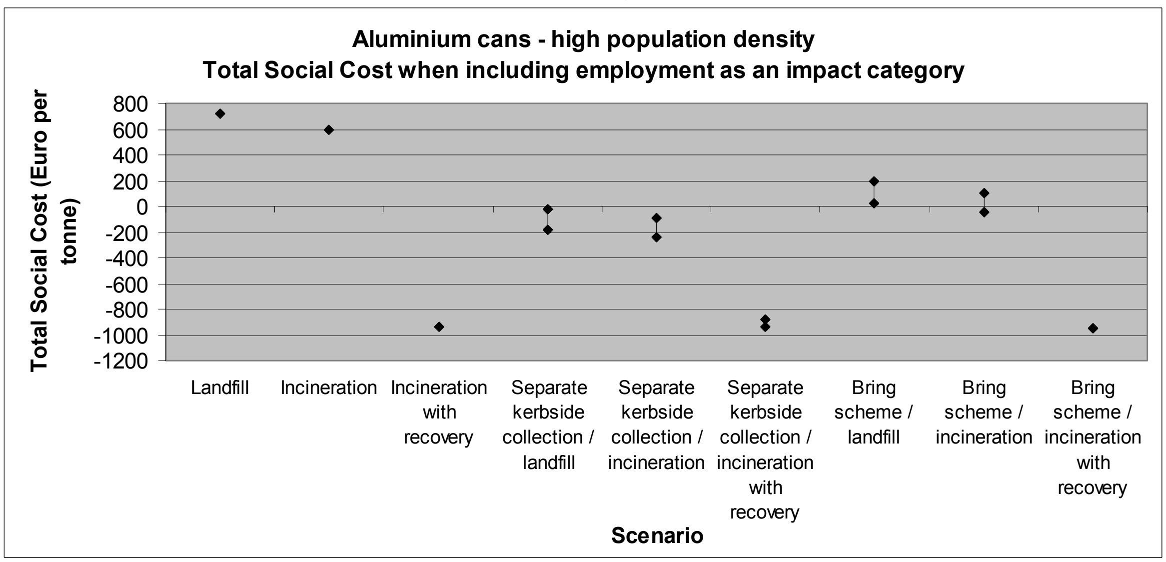
The graph below shows the sensitivity of the analysis to the inclusion of employment as an impact category. The graph has been produced by including employment along with the other environmental impacts used in the baseline analysis.

The graphs show that the results achieved and conclusions drawn are not sensitive to the inclusion of this parameter as an external impact category.

Graph 15 : Aluminium cans – low population density: Sensitivity of the results to the addition of employment as an impact category



Graph 16 : Aluminium cans – high population density: Sensitivity of the results to the addition of employment as an impact category



3.4.2 Scenario and modelling choices

Findings from the sensitivity analysis of scenario and modelling choices are summarised in the table below.

Table 10 : Summary of sensitivity analysis of scenario and modelling choices for aluminium cans

Parameter investigated	Influence on CBA results	Influence on conclusions drawn
Incineration model Combined heat and power	No significant effect on scale of CBA results	No influence on choice of optimal scenario
Incineration model Offset electricity	No significant effect on scale of CBA results	No influence on choice of optimal scenario
Transport distances MSW collection round Kerbside collection round Collection from bring bank Transport from sorting plant to reprocessor	No influence on the relative standing of options	No influence on choice of optimal scenario
Transport distance Consumer transport to bring bank	No influence on the relative standing of options	No influence on choice of optimal scenario

4 Aluminium (other rigid and semi-rigid aluminium packaging, excluding beverage cans)

4.1 Scenarios considered

The table below summarises the parameters considered for the baseline scenarios modelled.

Table 11 : Scenarios considered for aluminium (other rigid than beverage cans)

	Population density	Selective collection scheme	Recycling rate achieved	MSW waste management option
Scenario 1	Low	None	0%	Landfill
Scenario 2	Low	None	0%	Incineration
Scenario 3	Low	None	0%	Incineration with slag recovery
Scenario 4	Low	Separate kerbside collection	7-17%	Landfill
Scenario 5	Low	Separate kerbside collection	7-17%	Incineration
Scenario 6	Low	Separate kerbside collection	7-17%	Incineration with slag recovery
Scenario 7	Low	Bring scheme	3-10%	Landfill
Scenario 8	Low	Bring scheme	3-10%	Incineration
Scenario 9	Low	Bring scheme	3-10%	Incineration with slag recovery
Scenario 10	High	None	0%	Landfill
Scenario 11	High	None	0%	Incineration
Scenario 12	High	None	0%	Incineration with slag recovery
Scenario 13	High	Separate kerbside collection	6-16%	Landfill
Scenario 14	High	Separate kerbside collection	6-16%	Incineration
Scenario 15	High	Separate kerbside collection	6-16%	Incineration with slag recovery
Scenario 16	High	Bring scheme	3-8%	Landfill
Scenario 17	High	Bring scheme	3-8%	Incineration
Scenario 18	High	Bring scheme	3-8%	Incineration with slag recovery

4.2 Results of the cost benefit analysis for aluminium

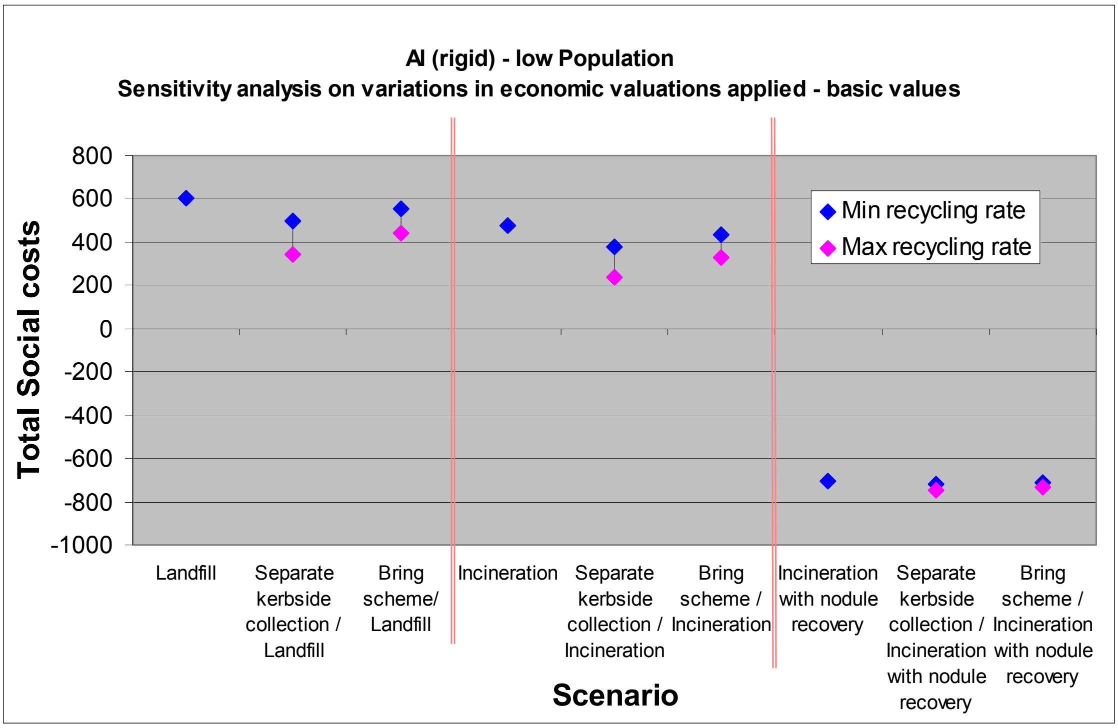
Table 12 : Aluminium – low population density: Internal costs, external costs and total social costs

Collection method	N/A	N/A	N/A	Separate Kerbside	Separate kerbside	Separate kerbside	Bring scheme	Bring scheme	Bring scheme
Recycling rate	**0,0**	**0,0**	**0,0**	**7-17%**	**7-17%**	**7-17%**	**3-10%**	**3-10%**	**3-10%**
Residual waste management option	**Landfill**	**Incineration**	**Incineration with slag recovery**	**Landfill**	**Incineration**	**Incineration with nodule recovery**	**Landfill**	**Incineration**	**Incineration with nodule recovery**
Exeternalities									
GWP (kg CO2 eq.)	0,4	1,0	-79,0	-8,3 to -20,8	-7,8 to -20,4	-82,2 to -86,8	-3,3 to -12,1	-2,8 to -11,6	-80,4 to -83,6
Ozone depletion (kg CFC 11 eq.)	0,0	0,0	0,0	0,0 to 0,0	0,0 to 0,0	0,0 to 0,0	0,0 to 0,0	0,0 to 0,0	0,0 to 0,0
Acidification (Acid equiv.)	0,0	0,1	-10,8	-1,2 to -2,9	-1,1 to -2,8	-11,3 to -11,9	-0,5 to -1,7	-0,4 to -1,6	-11,0 to -11,5
Toxicity Carcinogens (Cd equiv)	0,0	0,0	-16,0	-1,8 to -4,3	-1,8 to -4,3	-16,6 to -17,6	-0,8 to -2,5	-0,8 to -2,5	-16,3 to -16,9
Toxicity Gaseous (SO2 equiv.)	0,1	0,3	-65,9	-7,2 to -17,7	-7,0 to -17,5	-68,6 to -72,5	-3,0 to -10,2	-2,8 to -10,0	-67,0 to -69,7
Toxicity Metals non carcinogens (Pb equiv.)	0,1	0,1	-279,9	-31,0 to -75,5	-31,0 to -75,5	-291,4 to -307,9	-13,2 to -44,3	-13,3 to -44,4	-284,8 to -296,3
Toxicity Particulates & aerosols (PM10 equiv)	9,7	10,5	-454,4	-39,6 to -109,9	-38,7 to -109,1	-471,2 to -495,1	-11,9 to -62,3	-11,1 to -61,5	-462,1 to -480,0
Toxicity Smog (ethylene equiv.)	0,3	0,3	-14,9	-1,4 to -3,7	-1,3 to -3,7	-15,4 to -16,3	-0,4 to -2,1	-0,4 to -2,0	-15,1 to -15,7
Black smoke (kg dust eq.)	0,2	0,4	-35,6	-3,8 to -9,4	-3,6 to -9,3	-37,1 to -39,2	-1,5 to -5,5	-1,3 to -5,3	-36,2 to -37,7
Fertilisation	-0,1	-0,2	8,7	0,8 to 2,2	0,8 to 2,2	9,1 to 9,6	0,3 to 1,2	0,3 to 1,2	8,9 to 9,2
Traffic accidents (risk equiv.)	0,1	0,1	0,5	0,2 to 0,4	0,2 to 0,4	0,6 to 0,7	0,3 to 0,8	0,3 to 0,8	0,7 to 1,1
Traffic Congestion (car km equiv.)	0,1	0,1	9,0	1,2 to 2,6	1,2 to 2,7	9,4 to 10,0	0,6 to 1,6	0,6 to 1,6	9,1 to 9,6
Traffic Noise (car km equiv.)	0,4	0,4	1,0	0,7 to 1,1	0,7 to 1,1	1,2 to 1,6	0,5 to 0,7	0,5 to 0,7	1,1 to 1,2
Water Quality Eutrophication (P equiv.)	0,0	0,0	-0,8	-0,1 to -0,2	-0,1 to -0,2	-0,8 to -0,9	0,0 to -0,1	0,0 to -0,1	-0,8 to -0,8
Disaminity (kg LF waste equiv.)	37,0	10,1	10,1	34,4 to 30,7	9,4 to 8,4	9,4 to 8,4	35,9 to 33,3	9,8 to 9,1	9,8 to 9,1
TOTAL EXTERNALITIES	**48,3**	**23,4**	**-928,0**	**-57,0 to -207,4**	**-80,2 to -228,1**	**-965,0 to -1017,8**	**2,9 to -103,1**	**-21,3 to -125,6**	**-944,2 to -981,9**
INTERNAL COSTS	**555,0**	**453,0**	**222,0**	**552,8 to 549,7**	**458,0 to 465,1**	**243,1 to 273,3**	**552,7 to 547,3**	**453,8 to 455,5**	**229,7 to 247,6**
TOTAL SOCIAL COSTS	**603,3**	**476,4**	**-706,0**	**495,9 to 342,3**	**377,8 to 237,0**	**-721,8 to -744,4**	**555,6 to 444,2**	**432,4 to 329,9**	**-714,5 to -734,2**

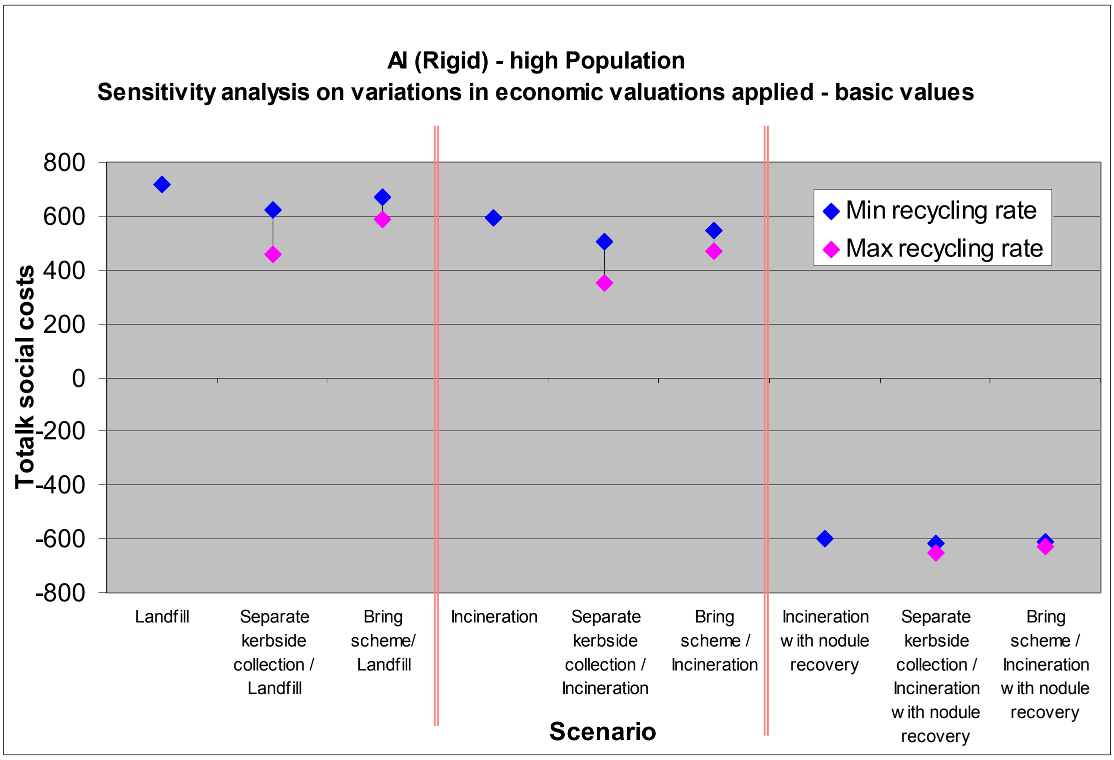
Table 13 : Aluminium – high population density: Internal costs, external costs and total social costs

Collection method	**N/A**	**N/A**	**N/A**	**Separate Kerbside collection**	**Separate kerbside collection**	**Separate kerbside collection**	**Bring scheme**	**Bring scheme**	**Bring scheme**
Recycling rate	**0,0**	**0,0**	**0,0**	**6-16%**	**6-16%**	**6-16%**	**3-8%**	**3-8%**	**3-8%**
Residual waste management option	**Landfill**	**Incineration**	**Incineration with slag recovery**	**Landfill**	**Incineration**	**Incineration with slag recovery**	**Landfill**	**Incineration**	**Incineration with slag recovery**
Exeternalities									
GWP (kg CO2 eq.)	0,3	0,9	-79,4	-7,3 to -19,9	-6,7 to -19,4	-82,1 to -86,8	-3,5 to -9,8	-2,9 to -9,3	-80,8 to -83,1
Ozone depletion (kg CFC 11 eq.)	0,0	0,0	0,0	0,0 to 0,0	0,0 to 0,0	0,0 to 0,0	0,0 to 0,0	0,0 to 0,0	0,0 to 0,0
Acidification (Acid equiv.)	0,0	0,1	-10,8	-1,0 to -2,7	-0,9 to -2,7	-11,2 to -11,9	-0,5 to -1,3	-0,4 to -1,3	-11,0 to -11,4
Toxicity Carcinogens (Cd equiv)	0,0	0,0	-16,0	-1,5 to -4,1	-1,5 to -4,1	-16,5 to -17,5	-0,8 to -2,0	-0,8 to -2,0	-16,3 to -16,7
Toxicity Gaseous (SO2 equiv.)	0,1	0,3	-66,0	-6,2 to -16,7	-6,0 to -16,5	-68,3 to -72,2	-3,0 to -8,2	-2,8 to -8,1	-67,1 to -69,1
Toxicity Metals non carcinogens (Pb equiv.)	0,1	0,1	-279,9	-26,6 to -71,0	-26,6 to -71,1	-289,8 to -306,2	-13,3 to -35,5	-13,3 to -35,5	-284,9 to -293,1
Toxicity Particulates & aerosols (PM10 equiv)	8,4	9,2	-465,8	-34,4 to -105,8	-33,6 to -105,1	-480,2 to -504,2	-13,5 to -50,1	-12,7 to -49,3	-473,5 to -486,3
Toxicity Smog (ethylene equiv.)	0,2	0,2	-15,1	-1,2 to -3,6	-1,2 to -3,6	-15,6 to -16,4	-0,5 to -1,7	-0,5 to -1,7	-15,3 to -15,7
Black smoke (kg dust eq.)	0,2	0,4	-35,7	-3,2 to -8,9	-3,1 to -8,8	-36,9 to -39,1	-1,5 to -4,4	-1,3 to -4,2	-36,3 to -37,4
Fertilisation	-0,1	-0,1	8,8	0,7 to 2,1	0,7 to 2,1	9,1 to 9,6	0,3 to 1,0	0,3 to 1,0	9,0 to 9,2
Traffic accidents (risk equiv.)	0,2	0,2	0,5	0,3 to 0,5	0,3 to 0,5	0,6 to 0,8	0,3 to 0,4	0,3 to 0,4	0,6 to 0,8
Traffic Congestion (car km equiv.)	8,2	8,2	17,0	12,6 to 20,0	12,6 to 20,0	20,9 to 27,4	10,8 to 15,1	10,8 to 15,1	19,4 to 23,2
Traffic Noise (car km equiv.)	0,2	0,2	0,8	0,3 to 0,5	0,3 to 0,5	0,9 to 1,0	0,2 to 0,3	0,2 to 0,3	0,8 to 0,9
Water Quality Eutrophication (P equiv.)	0,0	0,0	-0,8	-0,1 to -0,2	-0,1 to -0,2	-0,8 to -0,9	0,0 to -0,1	0,0 to -0,1	-0,8 to -0,8
Disaminity (kg LF waste equiv.)	37,0	10,1	10,1	34,8 to 31,1	9,5 to 8,5	9,5 to 8,5	35,9 to 34,0	9,8 to 9,3	9,8 to 9,3
TOTAL EXTERNALITIES	**54,7**	**29,7**	**-932,2**	**-32,8 to -178,7**	**-56,3 to -199,7**	**-960,5 to -1007,7**	**10,9 to -62,2**	**-13,4 to -85,2**	**-946,4 to -970,2**
INTERNAL COSTS	**665,0**	**563,0**	**332,0**	**654,4 to 636,6**	**558,5 to 550,9**	**341,3 to 356,9**	**658,5 to 647,5**	**559,5 to 553,7**	**335,4 to 341,2**
TOTAL SOCIAL COSTS	**719,7**	**592,7**	**-600,2**	**621,5 to 457,9**	**502,2 to 351,2**	**-619,2 to -650,8**	**669,3 to 585,3**	**546,1 to 468,5**	**-611,0 to -629,0**

Graph 17 : Aluminium – low population density: Total social costs



Graph 18 : Aluminium – high population density: Total social costs



4.3 Main findings:

For low population density:
Where landfill is the MSW option, for a total social cost perspective it is not possible to distinguish between separate kerbside collection achieving a recycling rate of 7-17% and a bring scheme achieving 3-10% as the optimum system from the scenarios modelled.

Where incineration with energy recovery but no slag recovery is the MSW option, for a total social cost perspective it is not possible to distinguish between separate kerbside collection achieving a recycling rate of 7-17% and a bring scheme achieving 3-10% as the optimum system from the scenarios modelled.

Where incineration with nodule recovery is the MSW option, for a total social cost perspective it is not possible to distinguish between separate kerbside collection achieving a recycling rate of 7-17% and a bring scheme achieving 3-10% as the optimum system from the scenarios modelled.

For high population density
Where landfill is the MSW option, for a total social cost perspective it is not possible to distinguish between separate kerbside collection achieving a recycling rate of 6-16% and a bring scheme achieving 3-8% as the optimum system from the scenarios modelled.

Where incineration with energy recovery but no slag recovery is the MSW option, for a total social cost perspective it is not possible to distinguish between separate kerbside collection achieving a recycling rate of 6-16% and a bring scheme achieving 3-8% as the optimum system from the scenarios modelled.

Where incineration with nodule recovery is the MSW option, for a total social cost perspective it is not possible to distinguish between separate kerbside collection achieving a recycling rate of 6-16% and a bring scheme achieving 3-8% as the optimum system from the scenarios modelled.

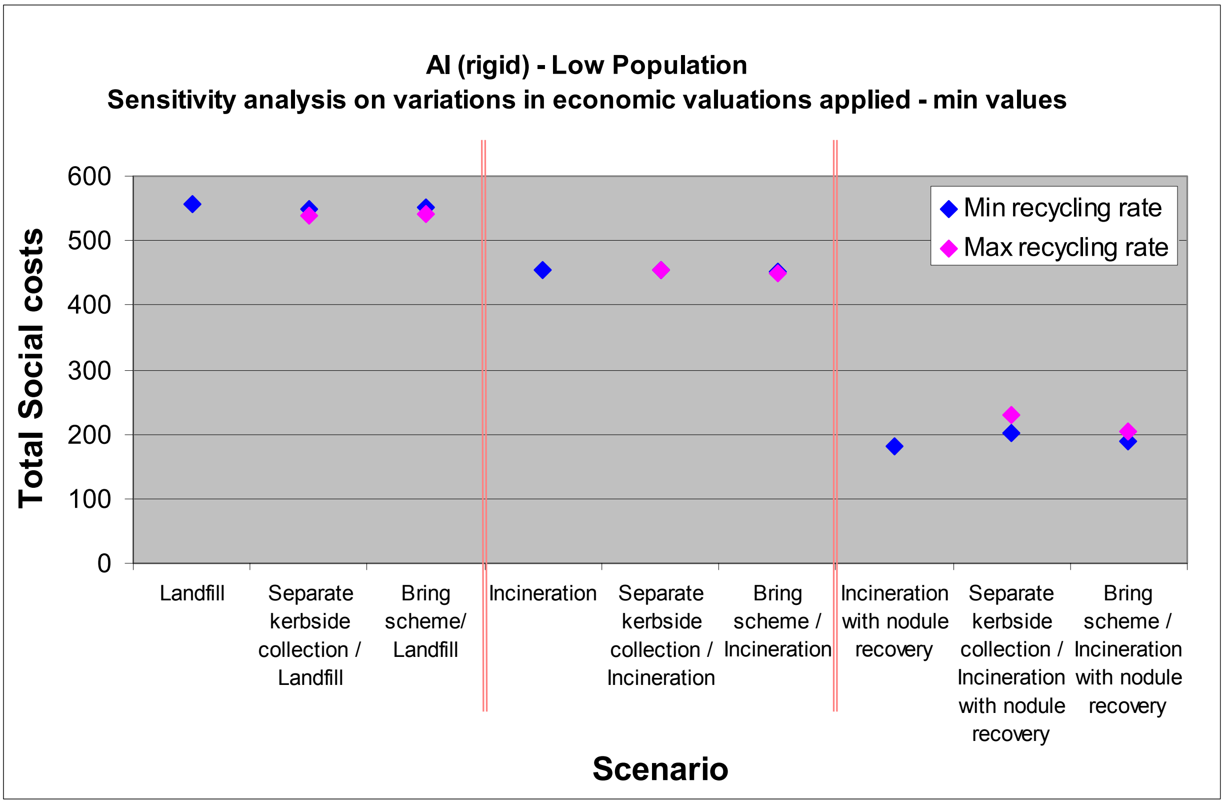
4.4 Sensitivity analysis

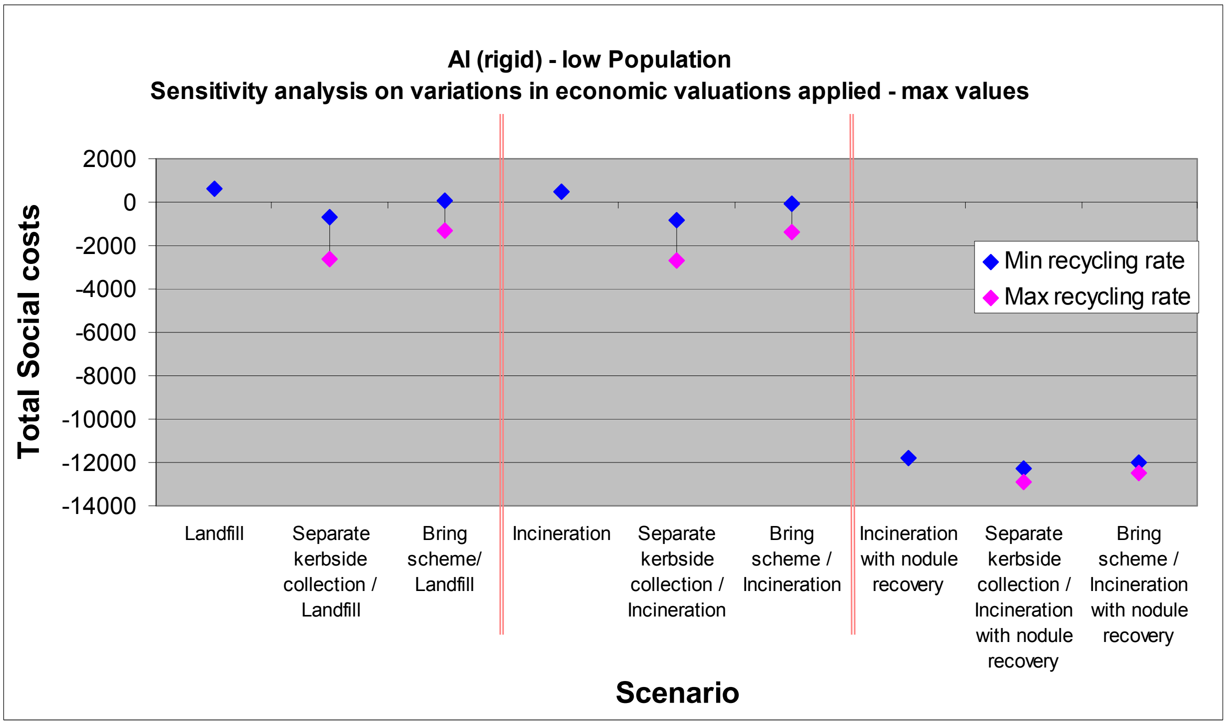
4.4.1 Methodological choices

4.4.1.1 Choice of external valuations

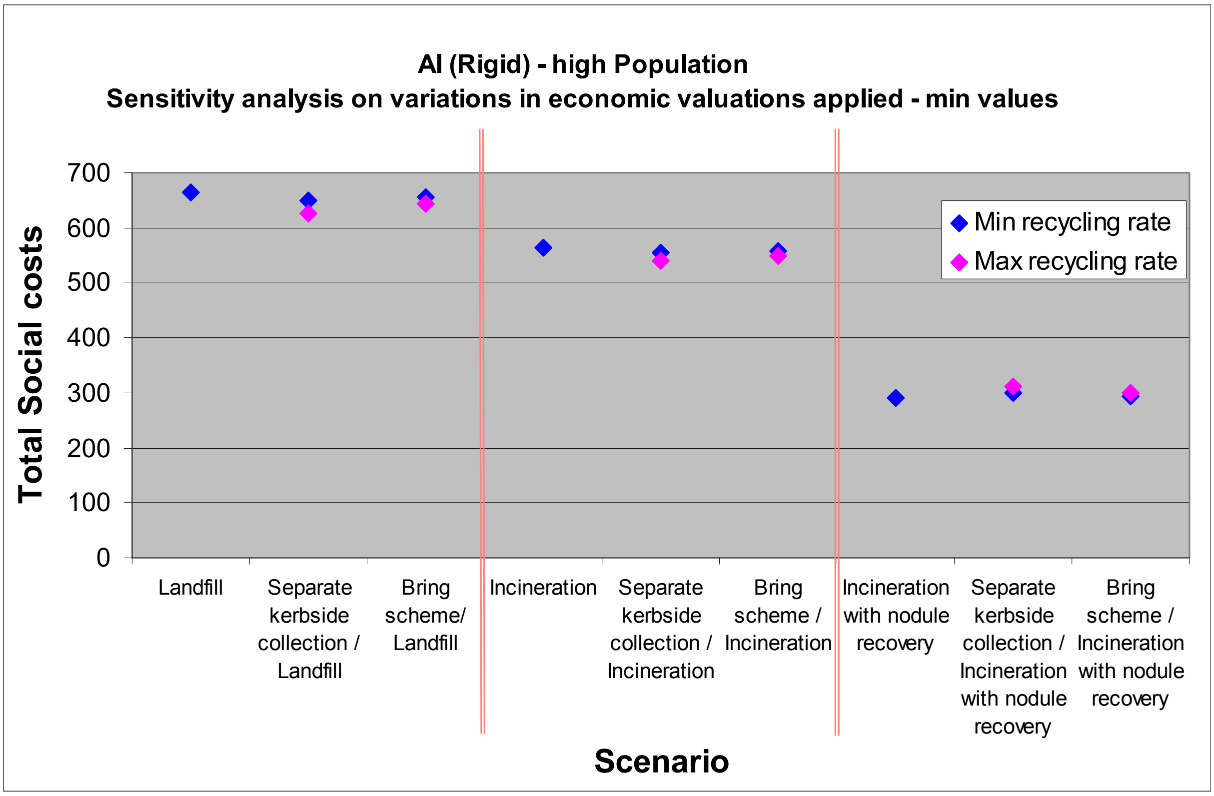
The graphs below show the sensitivity of the analysis to the economic valuations applied to the defined environmental impacts. The graphs have been produced by considering the same environmental impact results, but applying different impact assessment valuations (see Annex 4 for a list of maximum and minimum valuations applied).

Graph 19 : Aluminium – low population density: Sensitivity of the results to the external economic valuations applied





Graph 20 : Aluminium – high population density: Sensitivity of the results to the external economic valuations applied



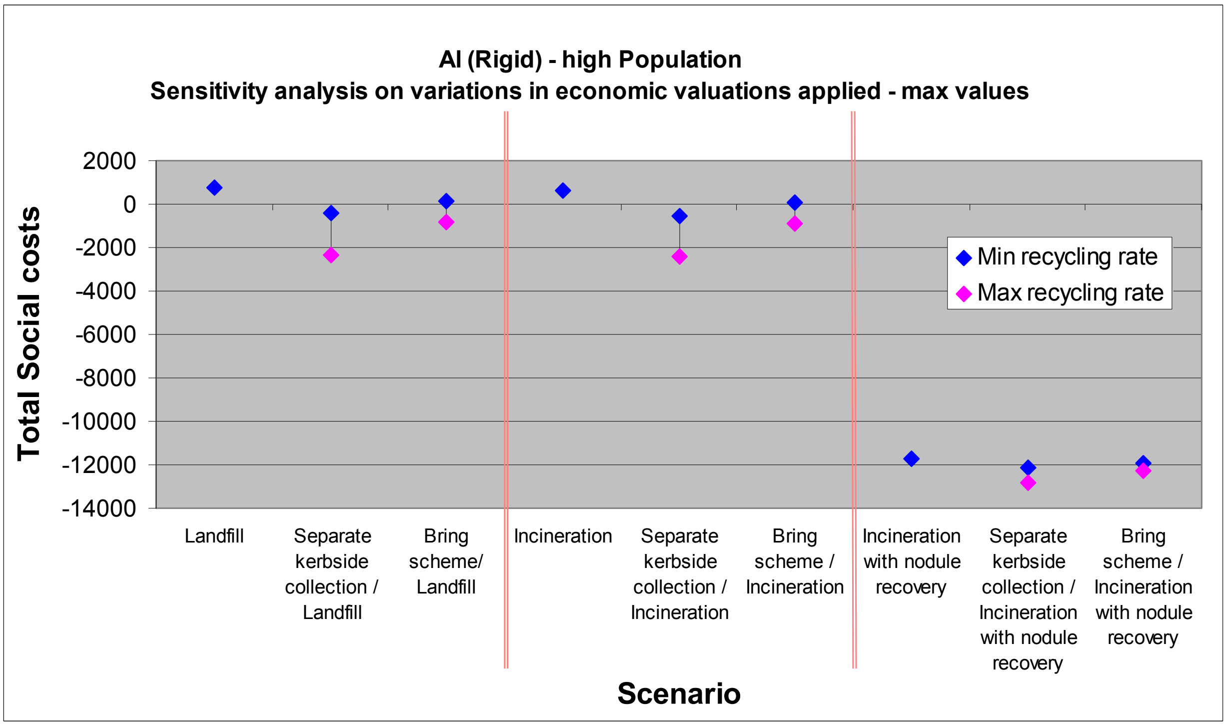


Table 14 : Summary of the sensitivity analysis to economic valuations

Low population density			
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Kerbside – Bring	No optimum	Kerbside – Bring
Incineration	Kerbside (Bring)	No optimum	Kerbside (Bring)
Incineration with slag recovery	Kerbside (Bring)	No SC	Kerbside (Bring)
High population density			
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Kerbside (Bring)	Kerbside (Bring)	Kerbside (Bring)
Incineration	Kerbside (Bring)	Kerbside (Bring)	Kerbside (Bring)
Incineration with slag recovery	Kerbside (Bring)	No SC	Kerbside (Bring)

For low population density
Regardless of the residual waste management option, there is no or very limited influence of the economic values on the results achieved or conclusions drawn.

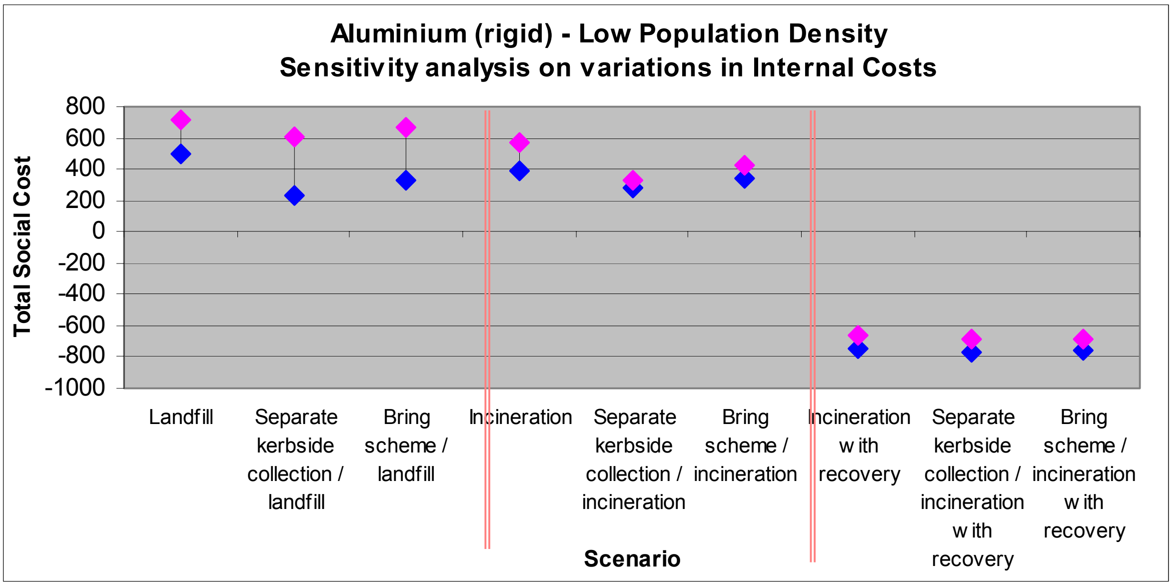
For high population density:
Regardless of the residual waste management option, there is no or very limited influence of the economic values on the results achieved or conclusions drawn.

4.4.1.2 Internal costs

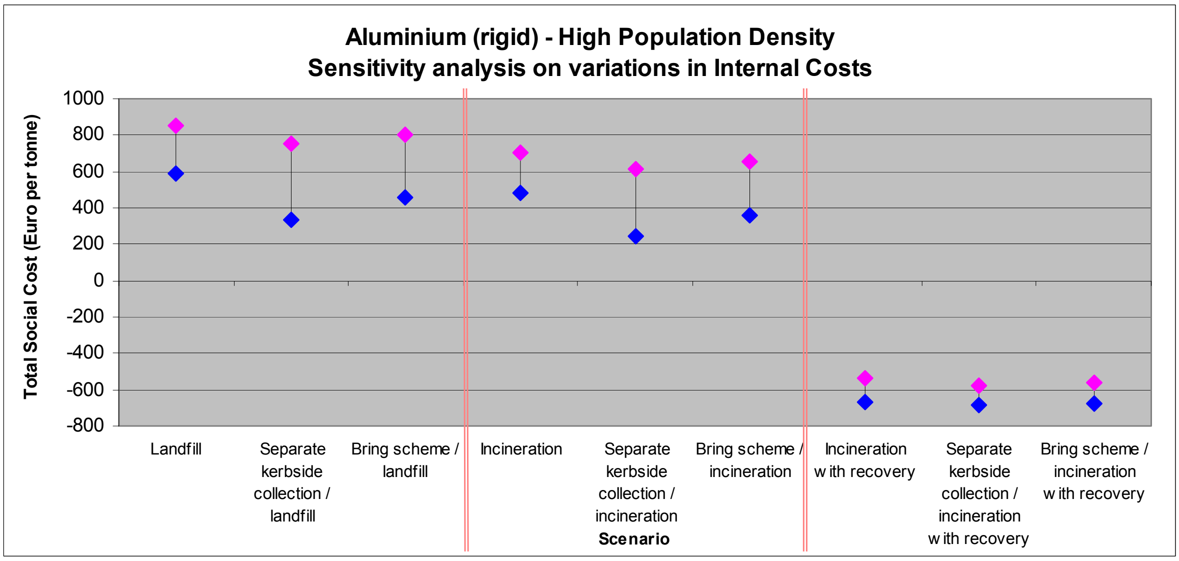
The internal costs applied in this study have been sourced mostly from the UK, France and Belgium. Even where equivalent waste management practices are compared internal costs can vary considerably between Member States, depending on a range of factors such as cost of living and geographical considerations (mountainous regions, island populations, etc.). In this part of the sensitivity analysis, the effect on the results of considering a +/-20% variation in internal costs is investigated. The results are presented in the graph below.

When potential variations in internal costs are taken into account it is no longer possible to distinguish between the alternative systems modelled.

Graph 21 : Aluminium – low population density: Sensitivity of the results to the internal economic costs considered



Graph 22 : Aluminium – high population density: Sensitivity of the results to the internal economic costs considered

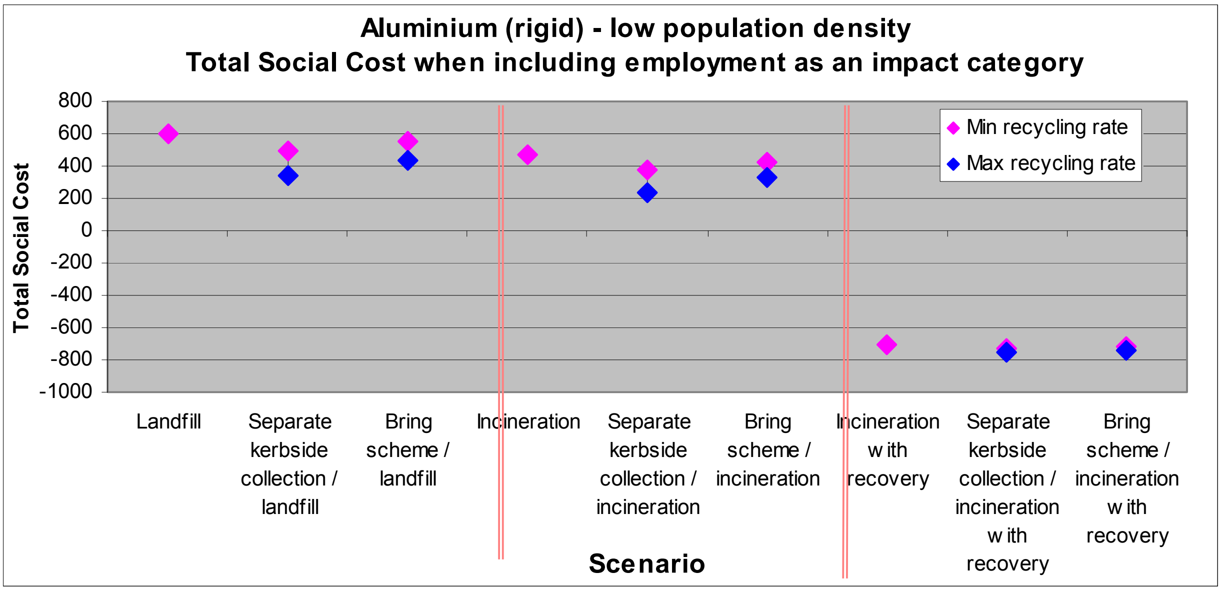


4.4.1.3 Inclusion of employment as an impact category

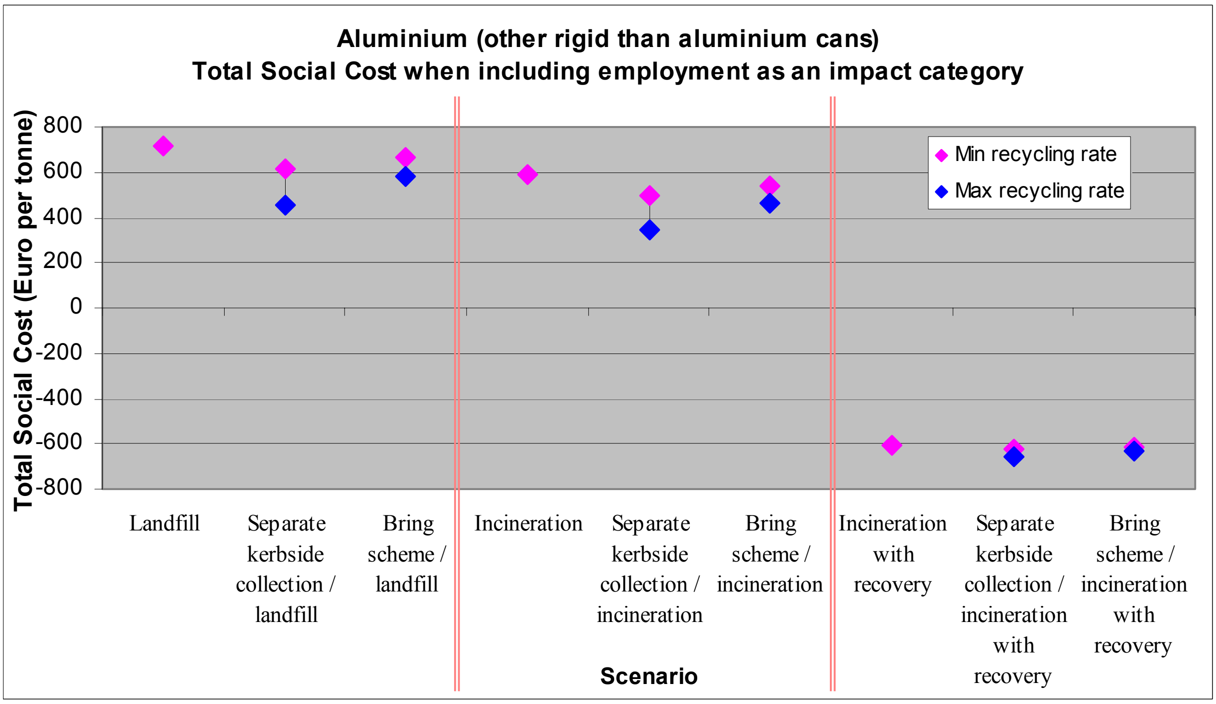
The graph below shows the sensitivity of the analysis to the inclusion of employment as an impact category. The graph has been produced by including employment along with the other environmental impacts used in the baseline analysis.

The results show that the results achieved and conclusions drawn are slightly sensitive to the inclusion of this parameter as an external impact.

Graph 23 : Aluminium – low population density: Sensitivity of the results to the addition of employment as an impact category



Graph 24 : Aluminium – high population density: Sensitivity of the results to the addition of employment as an impact category



4.4.2 Scenario and modelling choices

Findings from the sensitivity analysis of scenario and modelling choices are summarised in the table below.

Table 15 : Summary of sensitivity analysis of scenario and modelling choices for aluminium

Parameter investigated	Influence on CBA results	Influence on conclusions drawn
Incineration model Combined heat and power	No influence on the relative standing of options	No influence on choice of optimal scenario
Incineration model Offset electricity	No influence on the relative standing of options	No influence on choice of optimal scenario
Transport distances MSW collection round Kerbside collection round Collection from bring bank Transport from sorting plant to reprocessor	No influence on the relative standing of options	No influence on choice of optimal scenario
Transport distance Consumer transport to bring bank	No influence on the relative standing of options	No influence on choice of optimal scenario

5 Paper from household sources

5.1 Scenarios considered

The table below summarises the parameters considered for the baseline scenarios modelled.

Table 16 : Scenarios considered for paper

	Population density	Selective collection scheme	Recycling rate achieved	MSW waste management option
Scenario 1	Low	None	0%	Landfill
Scenario 2	Low	None	0%	Incineration
Scenario 3	Low	Separate kerbside collection	61-71%	Landfill
Scenario 4	Low	Separate kerbside collection	61-71%	Incineration
Scenario 5	Low	Bring scheme	25-35%	Landfill
Scenario 6	Low	Bring scheme	25-35%	Incineration
Scenario 7	High	None	0%	Landfill
Scenario 8	High	None	0%	Incineration
Scenario 9	High	Separate kerbside collection	55-65%	Landfill
Scenario 10	High	Separate kerbside collection	55-65%	Incineration
Scenario 11	High	Bring scheme	19-29%	Landfill
Scenario 12	High	Bring scheme	19-29%	Incineration

5.2 Results of the cost benefit analysis for paper

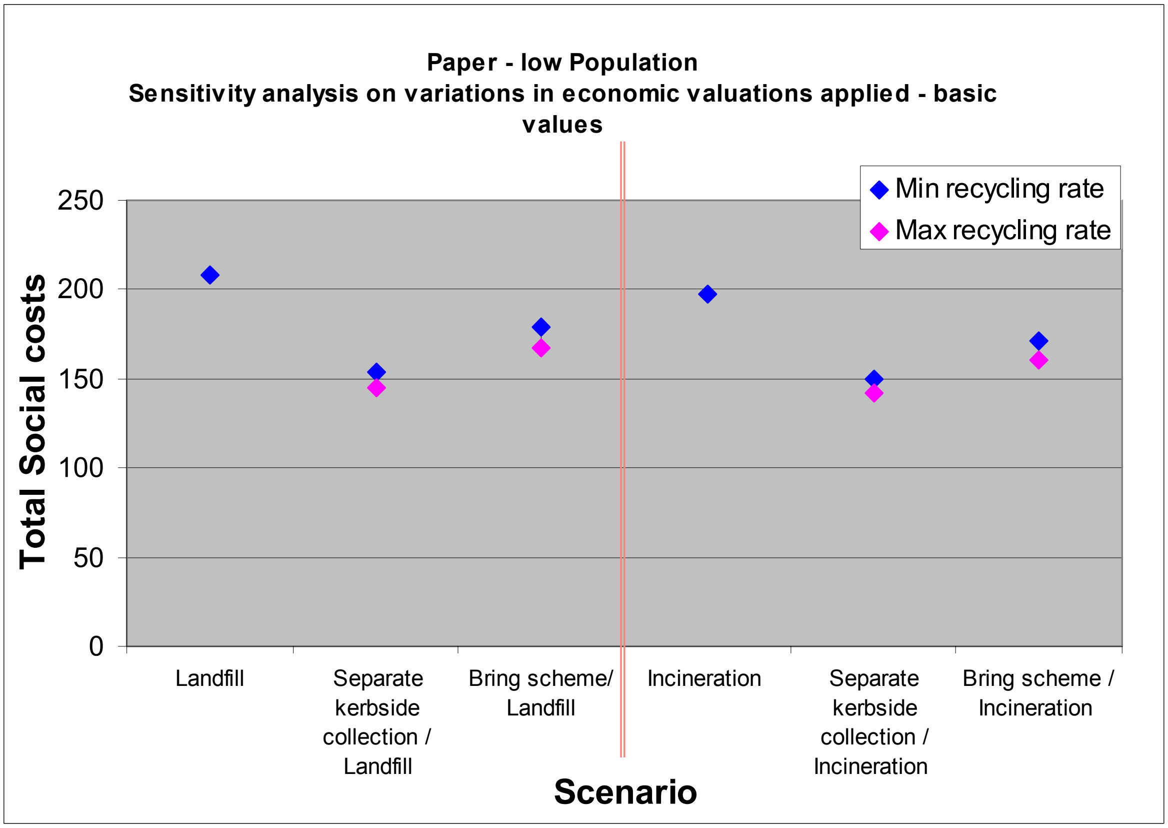
Table 17 : Paper – low population density: Internal costs, external costs and total social costs

Collection method	N/A	N/A	Separate Kerbside collection			Separate kerbside collection			Bring scheme			Bring scheme		
Recycling rate	**0.0**	**0.0**	**61-71%**			**61-71%**			**25-35%**			**25-35%**		
Residual waste management option	**Landfill**	**Incineration**	**Landfill**			**Incineration**			**Landfill**			**Incineration**		
Exeternalities														
GWP (kg CO2 eq.)	32.5	17.0	26.5	to	25.5	20.5	to	21.0	29.9	to	28.9	18.3	to	18.8
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0	to	0.0	0.0	to	0.0	0.0	to	0.0	0.0	to	0.0
Acidification (Acid equiv.)	-0.1	-0.4	-0.3	to	-0.4	-0.4	to	-0.4	-0.2	to	-0.2	-0.4	to	-0.4
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0	to	0.0	0.0	to	0.0	0.0	to	0.0	0.0	to	0.0
Toxicity Gaseous (SO2 equiv.)	-0.6	-1.5	-0.9	to	-1.0	-1.3	to	-1.3	-0.5	to	-0.5	-1.2	to	-1.0
Toxicity Metals non carcinogens (Pb equiv.)	0.0	-0.2	-0.1	to	-0.1	-0.2	to	-0.2	0.0	to	0.0	-0.1	to	-0.1
Toxicity Particulates & aerosols (PM10 equiv)	6.3	-11.9	2.4	to	1.8	-4.7	to	-3.5	-2.3	to	-5.7	-15.9	to	-17.5
Toxicity Smog (ethylene equiv.)	1.8	0.0	0.6	to	0.4	-0.1	to	-0.1	1.3	to	1.1	-0.1	to	-0.1
Black smoke (kg dust eq.)	-0.3	-1.4	-1.4	to	-1.6	-1.8	to	-1.9	-0.7	to	-0.9	-1.6	to	-1.6
Fertilisation	-0.2	-0.1	0.0	to	0.0	0.1	to	0.1	-0.1	to	0.0	0.0	to	0.1
Traffic accidents (risk equiv.)	0.1	0.1	0.7	to	0.8	0.7	to	0.8	1.6	to	2.2	1.6	to	2.2
Traffic Congestion (car km equiv.)	0.1	0.1	7.2	to	8.4	7.2	to	8.4	3.0	to	4.2	3.0	to	4.2
Traffic Noise (car km equiv.)	0.4	0.4	2.0	to	2.2	2.0	to	2.2	0.6	to	0.7	0.6	to	0.7
Water Quality Eutrophication (P equiv.)	0.0	0.0	0.0	to	0.0	0.0	to	0.0	0.0	to	0.0	0.0	to	0.0
Disaminity (kg LF waste equiv.)	37.0	11.2	14.6	to	11.0	4.6	to	3.5	27.8	to	24.2	8.5	to	7.4
TOTAL EXTERNALITIES	**77.1**	**13.5**	**51.3**	**to**	**47.1**	**26.5**	**to**	**28.7**	**60.4**	**to**	**53.8**	**12.7**	**to**	**12.4**
INTERNAL COSTS	**131.1**	**184.1**	**102.8**	**to**	**98.1**	**123.4**	**to**	**113.5**	**118.8**	**to**	**113.9**	**158.6**	**to**	**148.3**
TOTAL SOCIAL COSTS	**208.2**	**197.6**	**154.1**	**to**	**145.2**	**150.0**	**to**	**142.2**	**179.2**	**to**	**167.7**	**171.3**	**to**	**160.7**

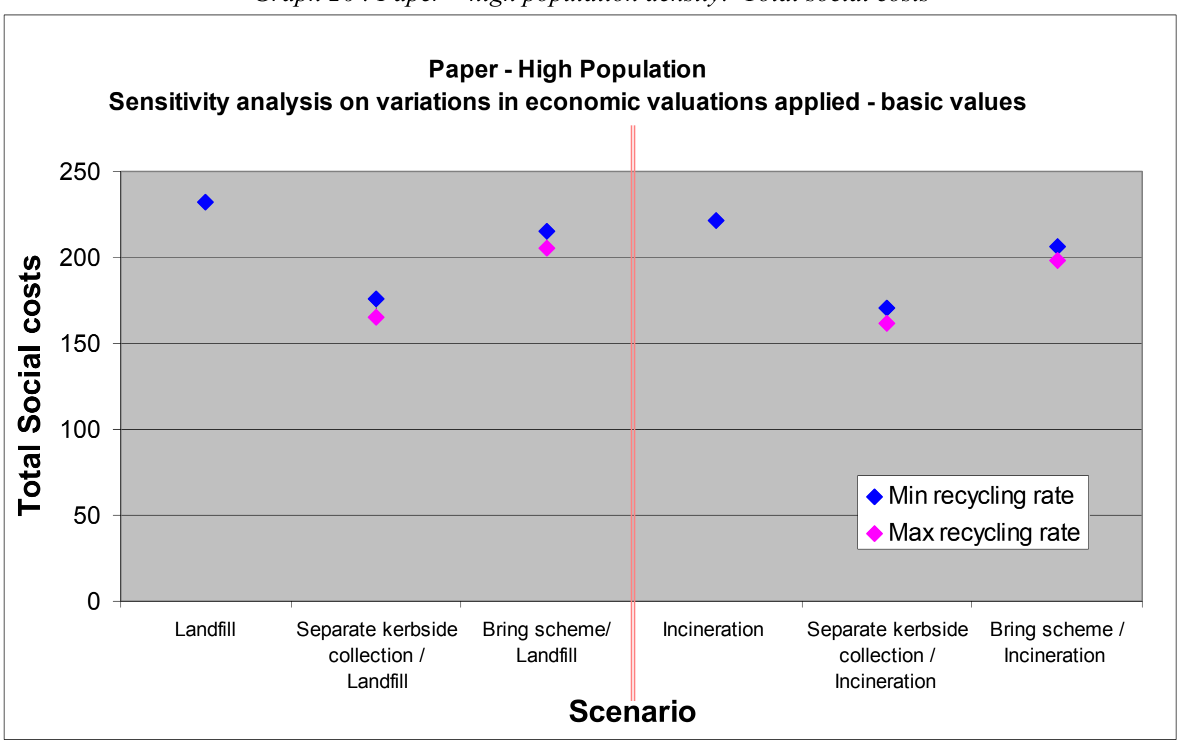
Table 18 : Paper – high population density: Internal costs, external costs and total social costs

Collection method	**N/A**	**N/A**	**Separate Kerbside collection**	**Separate kerbside collection**	**Bring scheme**	**Bring scheme**
Recycling rate	**0.0**	**0.0**	**55-65%**	**55-65%**	**19-29%**	**19-29%**
Residual waste management option	**Landfill**	**Incineration**	**Landfill**	**Incineration**	**Landfill**	**Incineration**
Exeternalities						
GWP (kg CO2 eq.)	32.4	16.9	26.4 to 25.3	19.4 to 19.9	30.8 to 30.0	18.3 to 19.0
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Acidification (Acid equiv.)	-0.1	-0.4	-0.4 to -0.4	-0.5 to -0.5	-0.2 to -0.3	-0.5 to -0.5
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Toxicity Gaseous (SO2 equiv.)	-0.6	-1.5	-1.1 to -1.1	-1.5 to -1.4	-0.7 to -0.7	-1.4 to -1.4
Toxicity Metals non carcinogens (Pb equiv.)	0.0	-0.2	-0.1 to -0.2	-0.2 to -0.2	-0.1 to -0.1	-0.2 to -0.2
Toxicity Particulates & aerosols (PM10 equiv)	5.0	-13.2	-7.8 to -10.2	-16.0 to -16.5	-2.7 to -6.8	-17.5 to -19.7
Toxicity Smog (ethylene equiv.)	1.8	0.0	0.4 to 0.1	-0.4 to -0.5	1.3 to 1.0	-0.2 to -0.3
Black smoke (kg dust eq.)	-0.3	-1.4	-1.4 to -1.6	-1.9 to -2.0	-0.7 to -1.0	-1.6 to -1.8
Fertilisation	-0.2	0.0	0.1 to 0.2	0.2 to 0.3	-0.1 to 0.0	0.1 to 0.1
Traffic accidents (risk equiv.)	0.2	0.2	0.6 to 0.7	0.6 to 0.7	0.7 to 0.9	0.7 to 0.9
Traffic Congestion (car km equiv.)	8.2	8.2	32.6 to 37.1	32.6 to 37.1	22.1 to 29.4	22.1 to 29.4
Traffic Noise (car km equiv.)	0.2	0.2	0.6 to 0.7	0.6 to 0.7	0.3 to 0.3	0.3 to 0.3
Water Quality Eutrophication (P equiv.)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Disaminity (kg LF waste equiv.)	37.0	11.2	16.8 to 13.2	5.2 to 4.1	30.0 to 26.4	9.2 to 8.1
TOTAL EXTERNALITIES	**83.5**	**19.8**	**66.8 to 63.7**	**38.1 to 41.5**	**80.7 to 79.3**	**29.2 to 34.1**
INTERNAL COSTS	**148.8**	**201.8**	**108.9 to 101.6**	**132.7 to 120.2**	**134.0 to 126.3**	**177.0 to 163.9**
TOTAL SOCIAL COSTS	**232.3**	**221.6**	**175.7 to 165.4**	**170.9 to 161.7**	**214.8 to 205.5**	**206.1 to 198.0**

Graph 25 : Paper – low population density: Total social cost



Graph 26 : Paper – high population density: Total social costs



5.3 Main findings:

For low population density, a kerbside collection scheme achieving a recycling rate of 61-71% is the optimum system for the scenarios considered. This is not dependent on the available alternative waste management option.

For high population density, a kerbside collection scheme achieving a recycling rate of 55-65% is the optimum system for the scenarios considered. This is not dependent on the available alternative waste management option.

5.4 Sensitivity analysis

5.4.1 Methodological choices

5.4.1.1 Choice of external valuations

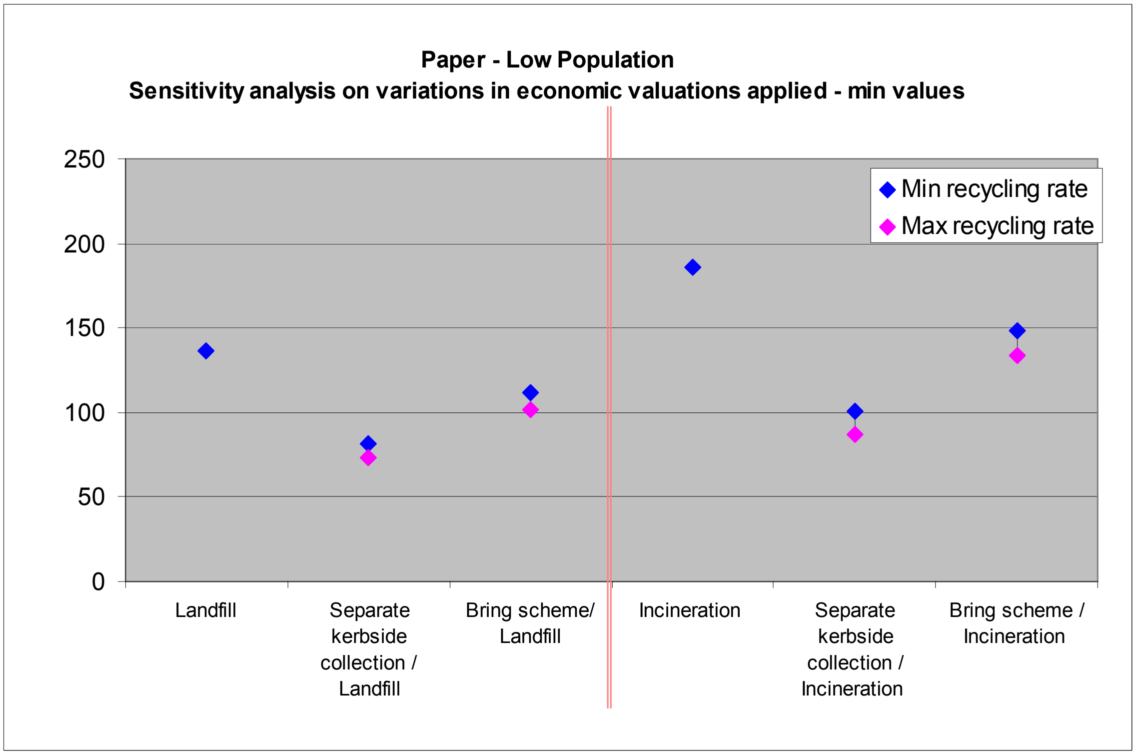
The graph below shows the sensitivity of the analysis to the economic valuations applied to the defined environmental impacts. The graph has been produced by considering the same environmental impact results, but applying different impact assessment valuations (see Annex 4 for a list of maximum and minimum valuations applied).

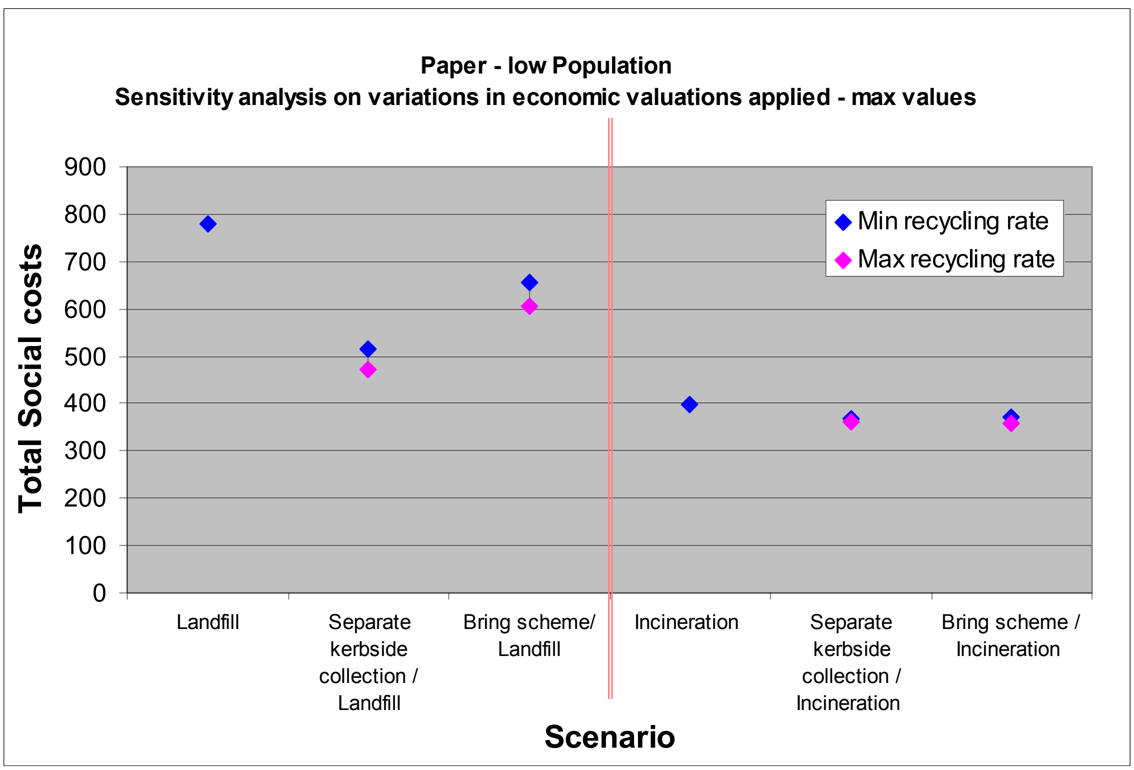
Table 19: Summary of the sensitivity analysis to economic valuations

Low population density			
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Kerbside	Kerbside	Kerbside
Incineration	Kerbside	Kerbside	Kerbside - Bring
High population density			
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Kerbside	Kerbside	Kerbside
Incineration	Kerbside	Kerbside	Kerbside

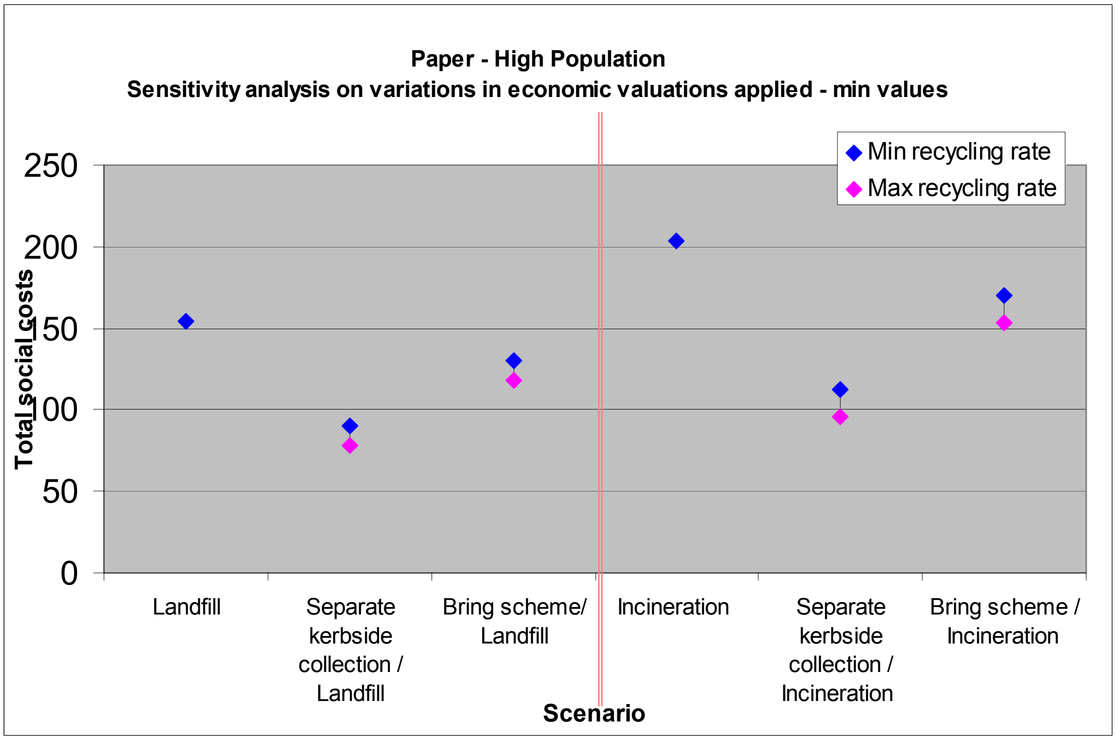
The graphs show that results (i.e. optimum systems) are very slightly sensitive to the external economic valuations applied.

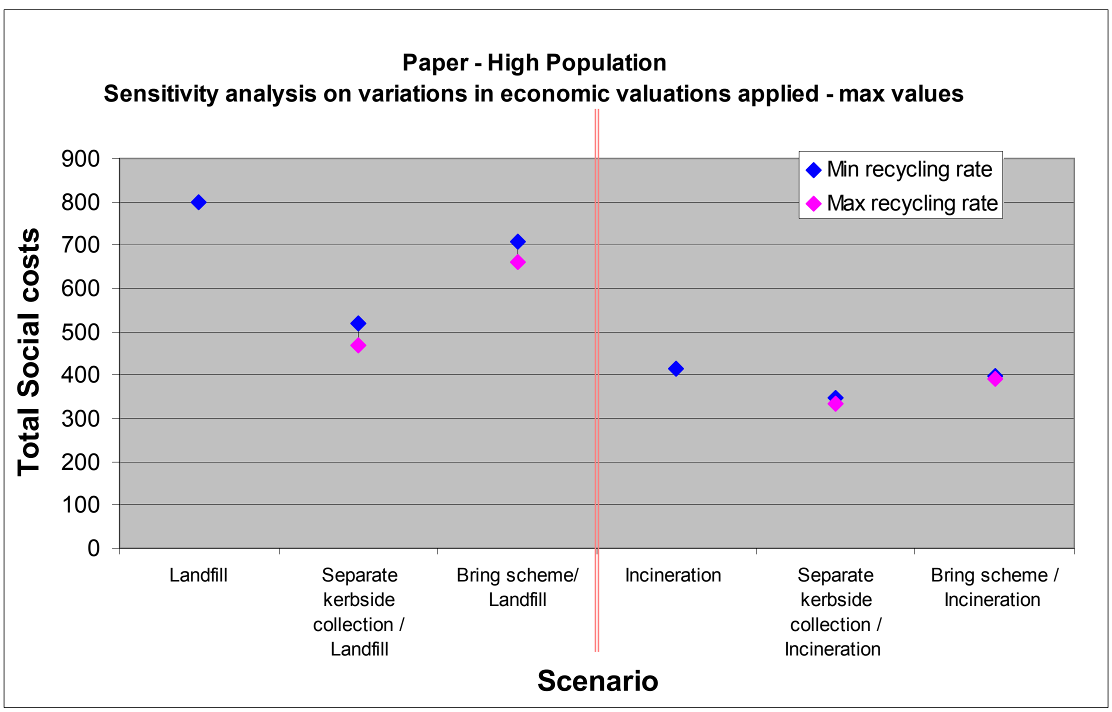
Graph 27 : Paper – low population density: Sensitivity of the results to the external economic valuations applied





Graph 28 : Paper – high population density: Sensitivity of the results to the external valuations applied





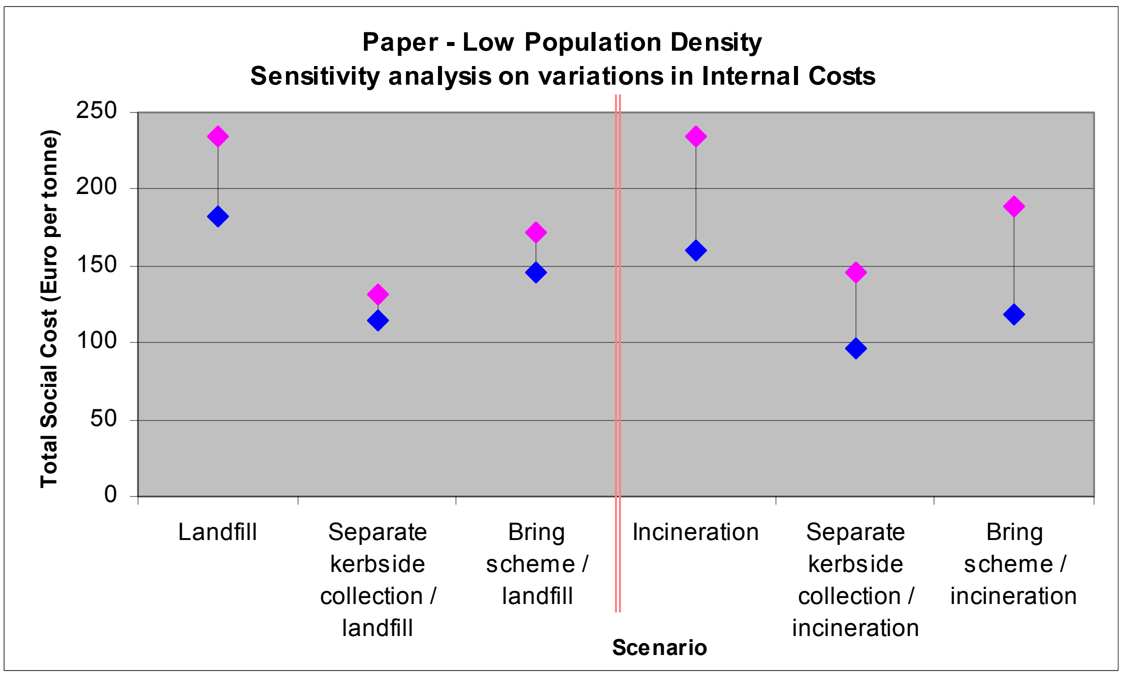
5.4.1.2 Internal costs

The internal costs applied in this study have been sourced mostly from the UK, France and Belgium. Even where equivalent waste management practices are compared internal costs can vary considerably between Member States, depending on a range of factors such as cost of living and geographical considerations (mountainous regions, island populations, etc.). In this part of the sensitivity analysis, the effect on the results of considering a +/-20% variation in internal costs is investigated. The results are presented in the graph below.

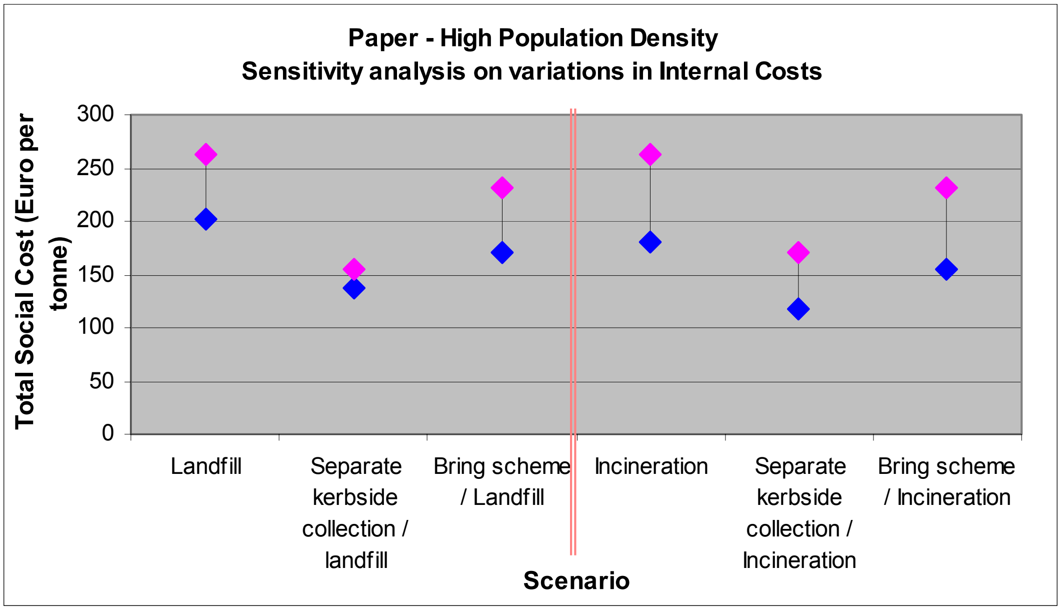
The following points should be noted:

- For low population density where landfill is the MSW option, a kerbside collection scheme achieving a recycling rate of 61-71% is the optimum system for the scenarios considered.
- For low population density where incineration is the MSW option it is no longer possible to distinguish between 100% incineration, separate kerbside collection achieving a recycling rate of 61-71% and a bring scheme achieving a recycling rate of 25-35%.
- For high population density where landfill is the MSW option a kerbside collection scheme achieving a recycling rate of 61-71% is the optimum system for the scenarios considered
- For high population density where incineration is the MSW option it is no longer possible to distinguish between 100% incineration, separate kerbside collection achieving a recycling rate of 61-71% and a bring scheme achieving a recycling rate of 25-35%.

Graph 29 : Paper – low population density: Sensitivity of the results to the internal economic costs considered



Graph 30 : Paper – high population density: Sensitivity of results to the internal economic costs considered

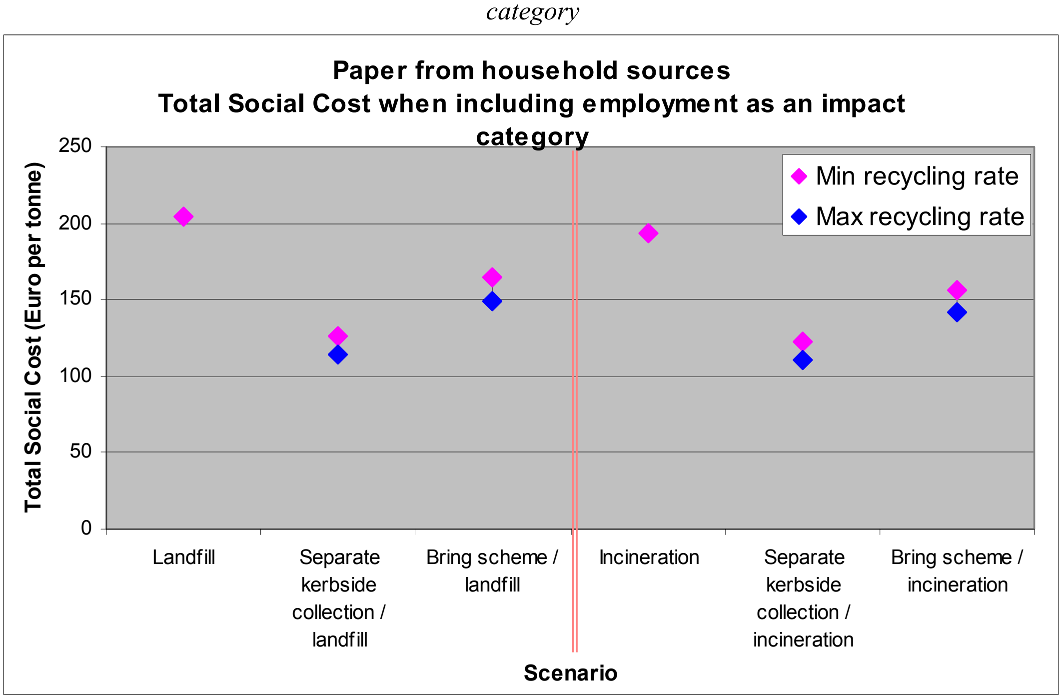


5.4.1.3 Inclusion of employment as an impact category

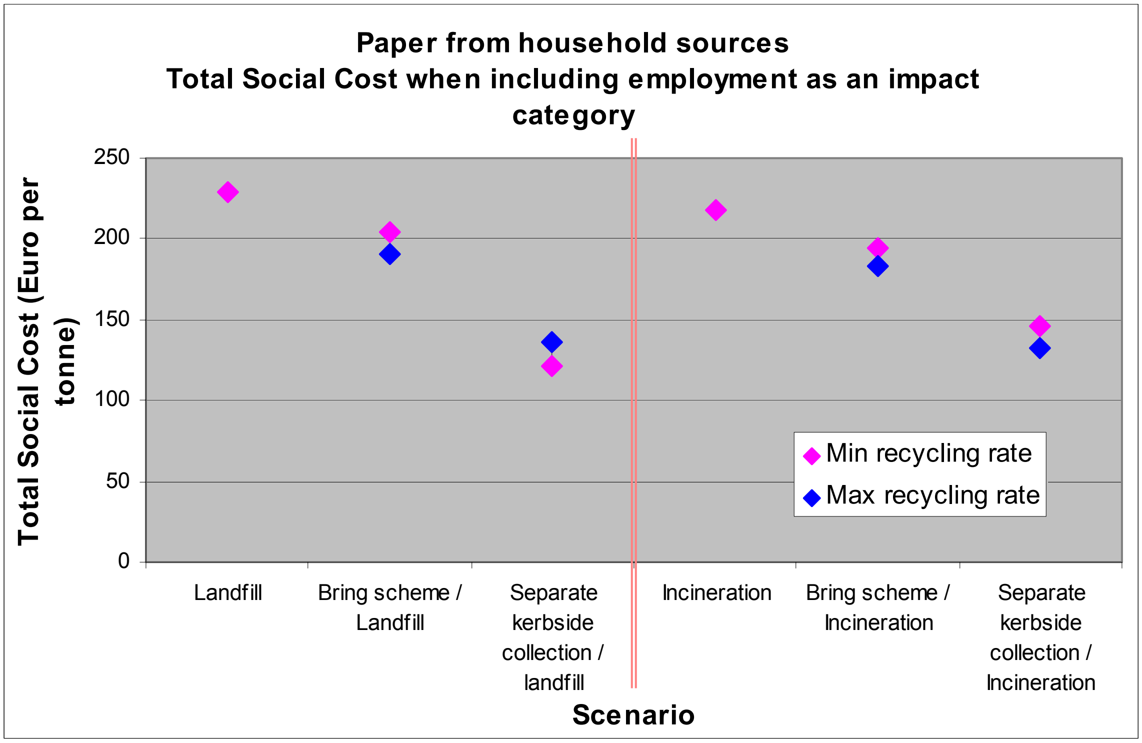
The graph below shows the sensitivity of the analysis to the inclusion of employment as an impact category. The graph has been produced by including employment along with the other environmental impacts used in the baseline analysis.

The main conclusions drawn are not sensitive to the inclusion of this additional parameter.

Graph 31 : Paper – low population density: Sensitivity of the results to the addition of employment as an impact category



Graph 32 : Paper – high population density: Sensitivity of the results to the addition of employment as an impact category



5.4.2 Scenario and modelling choices

Findings from the sensitivity analysis of scenario and modelling choices are summarised in the table below.

Table 20 : Summary of sensitivity analysis of scenario and modelling choices for paper

Parameter investigated	Influence on CBA results	Influence on conclusions drawn
Incineration model Combined heat and power	Total social cost of incineration options is reduced No influence on the relative standing of alternative systems	No influence on the choice of optimum system
Incineration model Offset electricity	Total social cost of incineration options is reduced No influence on the relative standing of alternative systems	No influence on the choice of optimum system
Transport distances MSW collection round Kerbside collection round Collection from bring bank Transport from sorting plant to reprocessor	Similar total social costs observed for separate kerbside collection and bring scheme scenarios. No distinction between kerbside collection and bring scheme scenarios is possible	Could influence choice of optimum scenario – broader optimum recycling range would be achieved
Transport distance Consumer transport to bring bank	Total social costs of recycling options increased, but no influence on the relative standing of alternative systems	No influence on the choice of optimum system

6 Liquid beverage cartons from household sources

6.1 Scenarios considered

The table below summarises the parameters considered for the baseline scenarios modelled.

Table 21 : Scenarios considered for aseptic composite beverage cartons

	Population density	Selective collection scheme	Recycling rate achieved	MSW waste management option
Scenario 1	Low	None	0%	Landfill
Scenario 2	Low	None	0%	Incineration
Scenario 3	Low	Separate kerbside collection (fibres recycled, foil/plastic residual to landfill)	55-65%	Landfill
Scenario 4	Low	Separate kerbside collection (fibres recycled, foil/plastic residual to incineration)	55-65%	Landfill
Scenario 5	Low	Separate kerbside collection (fibres recycled, foil/plastic residual to incineration)	55-65%	Incineration
Scenario 6	Low	Bring scheme (fibre recycled, foil/plastic residual to landfill)	24-34%	Landfill
Scenario 7	Low	Bring scheme (fibre recycled, foil/plastic residual to incineration)	24-34%	Landfill
Scenario 8	Low	Bring scheme (fibre recycled, foil/plastic residual to incineration)	24-34%	Incineration
Scenario 9	High	None	0%	Landfill
Scenario 10	High	None	0%	Incineration
Scenario 11	High	Separate kerbside collection (fibres recycled, foil/plastic residual to landfill)	55-65%	Landfill
Scenario 12	High	Separate kerbside collection (fibres recycled, foil/plastic residual to incineration)	55-65%	Landfill
Scenario 13	High	Separate kerbside collection (fibres recycled, foil/plastic residual to incineration)	55-65%	Incineration
Scenario 14	High	Bring scheme (fibre recycled, foil/plastic residual to landfill)	24-34%	Landfill
Scenario 15	High	Bring scheme (fibre recycled, foil/plastic residual to incineration)	24-34%	Landfill
Scenario 16	High	Bring scheme (fibre recycled, foil/plastic residual to incineration)	24-34%	Incineration

Other recycling routes such as valorisation in a cement kiln were not considered due to the necessary limitation of the number of scenarios and to a lack of readily available LCI data to support the analysis.

6.2 Results of the cost benefit analysis for liquid beverage cartons

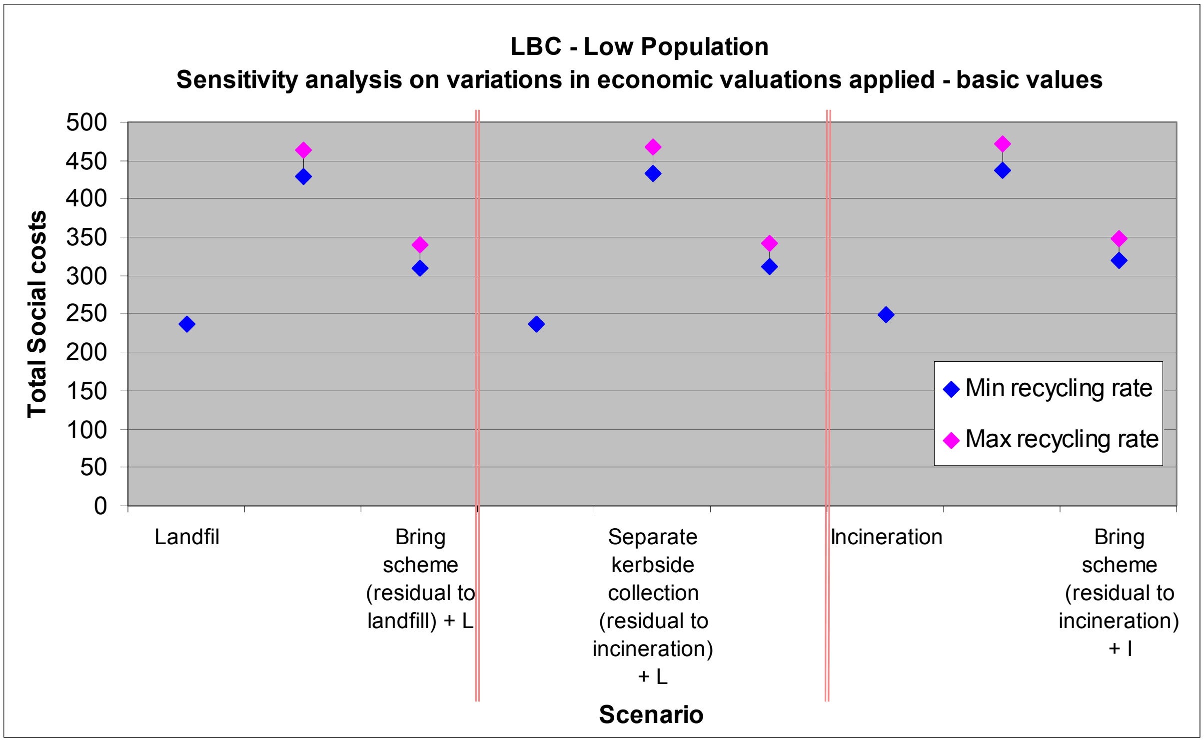
Table 22 : LBC – low population density: Internal costs, external costs and total social costs

Collection method	N/A	N/A	Kerbside collection (fibres recycled, foil/plastic residual to landfill)	Separate kerbside collection (fibres recycled, foil/plastic residual to incineration)	kerbside collection (fibres recycled, foil/plastic residual to incineration)	Bring scheme (fibre recycled, foil/plastic residual to landfill)	Bring scheme (fibre recycled, foil/plastic residual to incineration)	Bring scheme (fibre recycled, foil/plastic residual to incineration)
Recycling rate	**0.0**	**0.0**	**55-65%**	**55-65%**	**55-65%**	**24-34%**	**24-34%**	**24-34%**
Residual waste management option	**Landfill**	**Incineration**	**Landfill**	**Landfill**	**Incineration**	**Landfill**	**Landfill**	**Incineration**
Exeternalities								
GWP (kg CO2 eq.)	24.2	21.0	21.0 to 20.4	25.5 to 25.8	24.1 to 24.7	22.8 to 22.2	24.8 to 25.0	22.4 to 22.9
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Acidification (Acid equiv.)	-0.1	-0.6	-0.2 to -0.2	-0.3 to -0.3	-0.5 to -0.5	-0.1 to -0.1	-0.2 to -0.2	-0.5 to -0.5
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Toxicity Gaseous (SO2 equiv.)	-0.4	-2.0	-0.4 to -0.5	-0.9 to -1.0	-1.6 to -1.6	-0.2 to -0.1	-0.4 to -0.4	-1.6 to -1.4
Toxicity Metals non carcinogens (Pb equiv.)	0.0	-0.2	0.0 to -0.1	-0.1 to -0.1	-0.2 to -0.2	0.0 to 0.0	0.0 to 0.0	-0.2 to -0.2
Toxicity Particulates & aerosols (PM10 equiv)	7.1	-17.1	23.6 to 26.6	17.5 to 19.4	6.6 to 10.9	10.3 to 11.7	7.7 to 7.9	-10.7 to -8.0
Toxicity Smog (ethylene equiv.)	1.4	0.0	1.0 to 0.9	1.0 to 0.9	0.3 to 0.4	1.3 to 1.2	1.2 to 1.2	0.2 to 0.2
Black smoke (kg dust eq.)	-0.1	-1.8	-0.7 to -0.8	-1.2 to -1.4	-1.9 to -1.9	-0.4 to -0.4	-0.6 to -0.7	-1.8 to -1.8
Fertilisation	-0.2	-0.1	-0.2 to -0.2	-0.2 to -0.2	-0.2 to -0.2	-0.2 to -0.2	-0.2 to -0.2	-0.1 to -0.1
Traffic accidents (risk equiv.)	0.1	0.1	0.9 to 1.0	0.9 to 1.0	0.9 to 1.0	1.7 to 2.4	1.7 to 2.4	1.7 to 2.4
Traffic Congestion (car km equiv.)	0.1	0.1	10.0 to 11.8	10.0 to 11.8	10.0 to 11.8	4.5 to 6.3	4.5 to 6.3	4.5 to 6.3
Traffic Noise (car km equiv.)	0.4	0.4	2.4 to 2.8	2.4 to 2.8	2.4 to 2.8	1.0 to 1.3	1.0 to 1.3	1.0 to 1.3
Water Quality Eutrophication (P equiv.)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Disaminity (kg LF waste equiv.)	37.0	11.7	22.0 to 19.3	18.6 to 15.3	7.2 to 6.4	30.5 to 27.8	29.0 to 25.6	9.7 to 8.9
Employment	-3.7	-4.0	-19.4 -22.2	-19.4 -22.2	-19.5 -22.3	-4.9 -5.5	-4.9 -5.5	-5.2 -5.7
TOTAL	**69.6**	**11.6**	**79.3 to 81.1**	**73.2 to 73.8**	**47.1 to 53.5**	**71.3 to 72.0**	**68.6 to 68.2**	**24.6 to 30.0**
INTERNAL COSTS	**168.0**	**237.0**	**349.1 to 382.0**	**359.5 to 394.3**	**390.5 to 418.4**	**238.1 to 267.3**	**242.6 to 273.7**	**295.0 to 319.2**
TOTAL SOCIAL	**237.6**	**248.6**	**428.4 to 463.1**	**432.6 to 468.1**	**437.6 to 472.0**	**309.4 to 339.3**	**311.2 to 341.9**	**319.6 to 349.2**

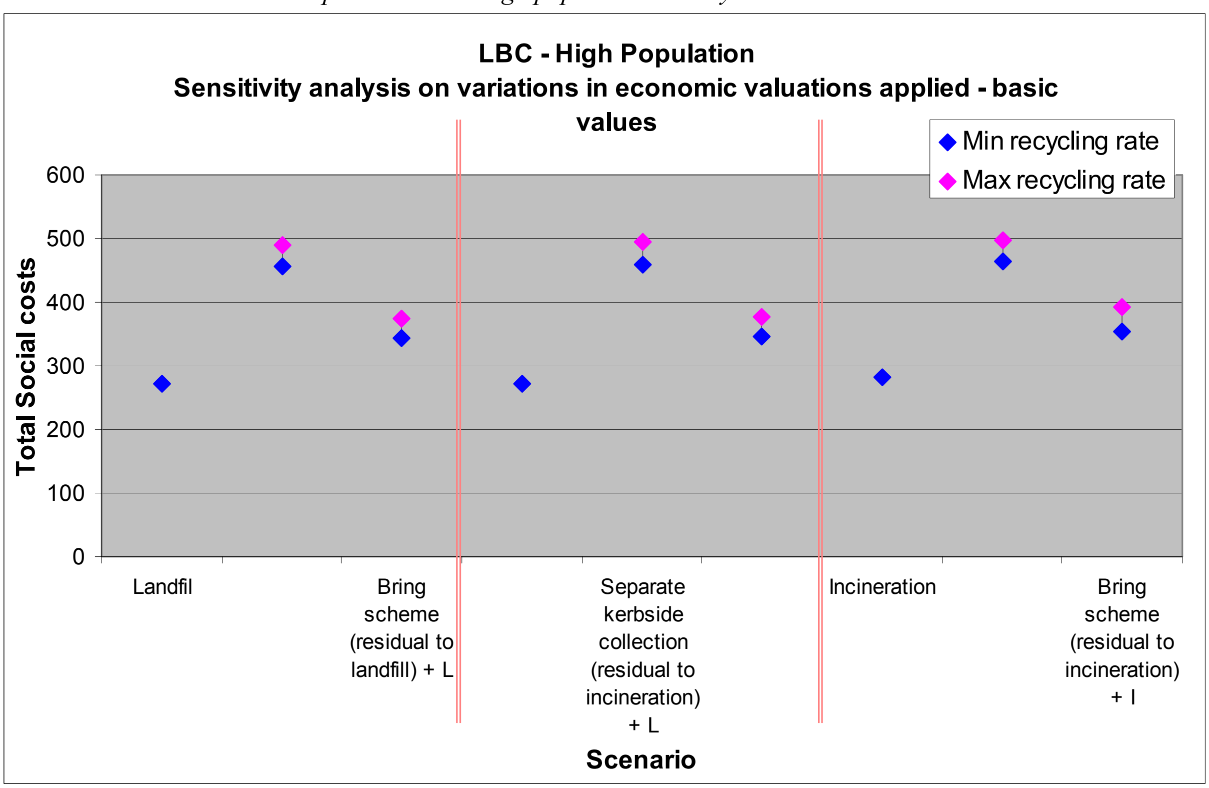
Table 23 : LBC – high population density: Internal costs, external costs and total social costs

Collection method	**N/A**	**N/A**	**Separate Kerbside collection (fibres recycled, foil/plastic residual to landfill)**	**Separate kerbside collection (fibres recycled, foil/plastic residual to incineration)**	**Separate kerbside collection (fibres recycled, foil/plastic residual to incineration)**	**Bring scheme (fibre recycled, foil/plastic residual to landfill)**	**Bring scheme (fibre recycled, foil/plastic residual to incineration)**	**Bring scheme (fibre recycled, foil/plastic residual to incineration)**
Recycling rate	**0.0**	**0.0**	**55-65%**	**55-65%**	**55-65%**	**24-34%**	**24-34%**	**24-34%**
Residual waste management option	**Landfill**	**Incineration**	**Landfill**	**Landfill**	**Incineration**	**Landfill**	**Landfill**	**Incineration**
Exeternalities								
GWP (kg CO2 eq.)	24.1	20.9	20.3 to 19.6	24.9 to 25.0	23.4 to 23.9	22.4 to 21.7	24.4 to 24.5	22.0 to 22.4
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Acidification (Acid equiv.)	-0.1	-0.6	-0.2 to -0.2	-0.3 to -0.4	-0.6 to -0.6	-0.1 to -0.2	-0.2 to -0.2	-0.6 to -0.5
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Toxicity Gaseous (SO2 equiv.)	-0.4	-2.0	-0.6 to -0.6	-1.1 to -1.2	-1.8 to -1.7	-0.4 to -0.3	-0.6 to -0.7	-1.8 to -1.7
Toxicity Metals non carcinogens (Pb equiv.)	0.0	-0.2	-0.1 to -0.1	-0.1 to -0.2	-0.2 to -0.2	0.0 to 0.0	0.0 to -0.1	-0.2 to -0.2
Toxicity Particulates & aerosols (PM10 equiv)	5.8	-18.7	16.4 to 18.4	10.4 to 11.2	-0.6 to 2.7	6.4 to 6.7	3.8 to 2.9	-14.8 to -13.2
Toxicity Smog (ethylene equiv.)	1.4	0.0	0.7 to 0.5	0.6 to 0.5	0.0 to 0.0	1.1 to 0.9	1.0 to 0.9	0.0 to 0.0
Black smoke (kg dust eq.)	-0.2	-1.8	-0.9 to -1.0	-1.3 to -1.5	-2.1 to -2.1	-0.5 to -0.6	-0.7 to -0.9	-1.9 to -2.0
Fertilisation	-0.2	-0.1	-0.1 to 0.0	-0.1 to 0.0	0.0 to 0.0	-0.1 to -0.1	-0.1 to -0.1	0.0 to 0.0
Traffic accidents (risk equiv.)	0.2	0.2	1.1 to 1.3	1.1 to 1.3	1.1 to 1.3	0.9 to 1.2	0.9 to 1.2	0.9 to 1.2
Traffic Congestion (car km equiv.)	8.2	7.6	50.4 to 58.1	50.4 to 58.1	50.1 to 57.9	29.7 to 38.6	29.7 to 38.6	29.2 to 38.2
Traffic Noise (car km equiv.)	0.2	0.2	1.2 to 1.4	1.2 to 1.4	1.2 to 1.4	0.5 to 0.7	0.5 to 0.7	0.5 to 0.6
Water Quality Eutrophication (P equiv.)	0.0	0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0	0.0 to 0.0
Disaminity (kg LF waste equiv.)	37.0	11.7	22.0 to 19.3	18.6 to 15.3	7.2 to 6.4	30.5 to 27.8	29.0 to 25.6	9.7 to 8.9
TOTAL EXTERNALITIES	**75.9**	**17.1**	**110.5 to 116.7**	**104.3 to 109.5**	**77.8 to 88.9**	**90.4 to 96.4**	**87.7 to 92.6**	**43.0 to 53.7**
INTERNAL COSTS	**196.0**	**265.0**	**345.4 to 372.5**	**355.7 to 384.8**	**386.8 to 408.9**	**253.1 to 276.9**	**257.6 to 283.3**	**310.1 to 337.9**
TOTAL SOCIAL COSTS	**271.9**	**282.1**	**455.8 to 489.3**	**460.0 to 494.2**	**464.6 to 497.8**	**343.5 to 373.3**	**345.3 to 375.9**	**353.0 to 391.6**

Graph 33 : LBC – low population density: Total social cost



Graph 34 : LBC – high population density: Total social cost



6.3 Main findings:

From an Total Social cost perspective, where landfill is the MSW option 100% landfilling is the preferred waste management system from the scenarios considered for both high and low population density and regardless of the final treatment of the rejects.
Where incineration is the MSW option, 100% incineration is the preferred waste management system from the scenarios considered for both high and low population density.

6.4 Sensitivity analysis

6.4.1 Methodological choices

6.4.1.1 Choice of external valuations

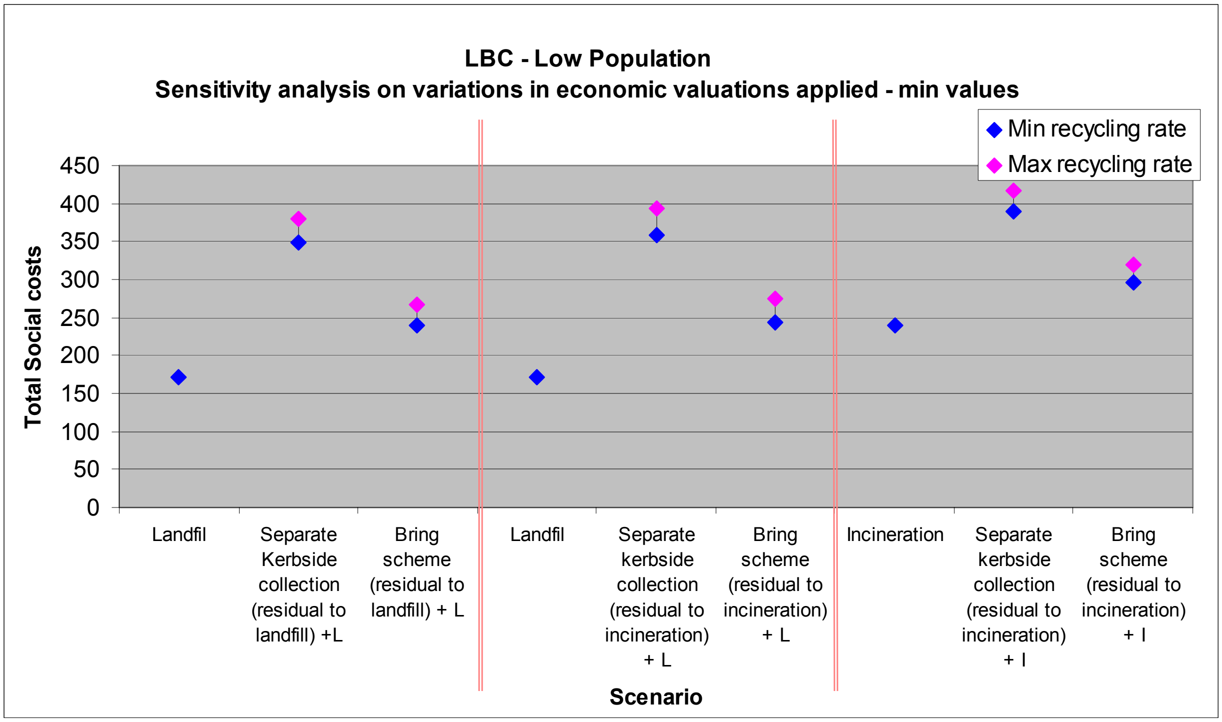
The graphs below shows the sensitivity of the analysis to the economic valuations applied to the defined environmental impacts. The graphs have been produced by considering the same environmental impact results, but applying different impact assessment valuations (see Annex 4 for a list of maximum and minimum valuations applied).

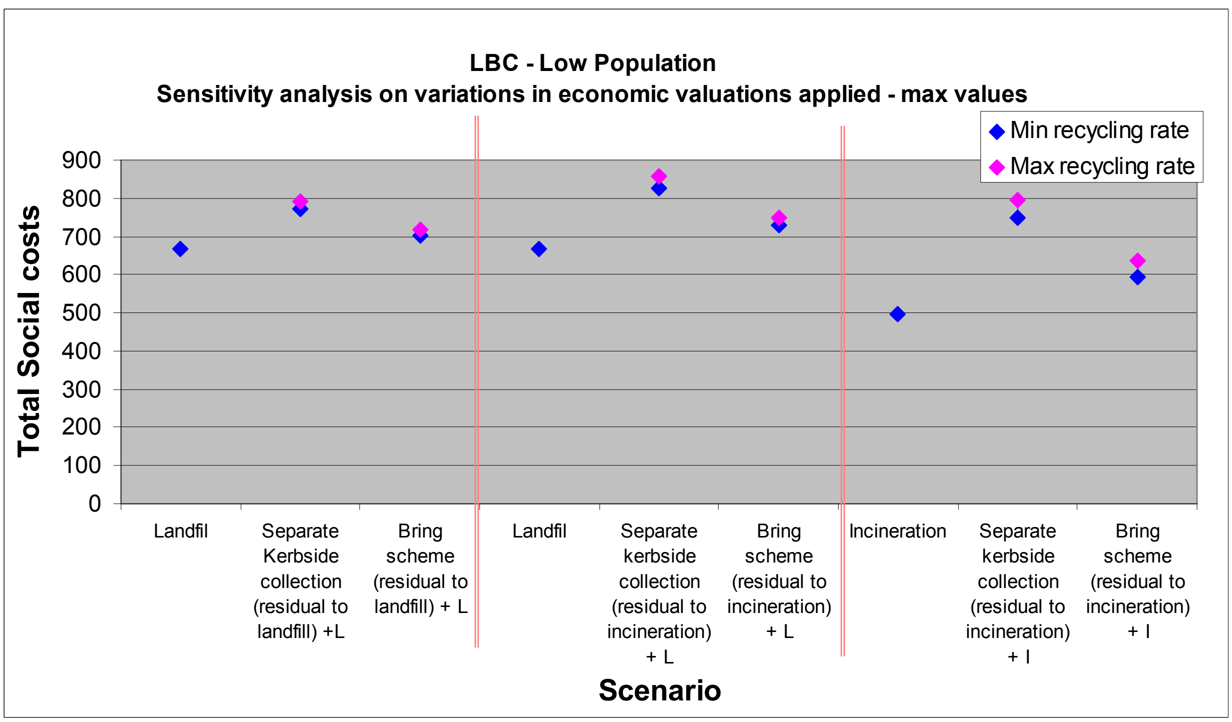
The graphs show that the results achieved and conclusions drawn are not sensitive to the economic values applied to environmental impact categories.

Table 24: summary of the sensitivity analysis to economic valuations

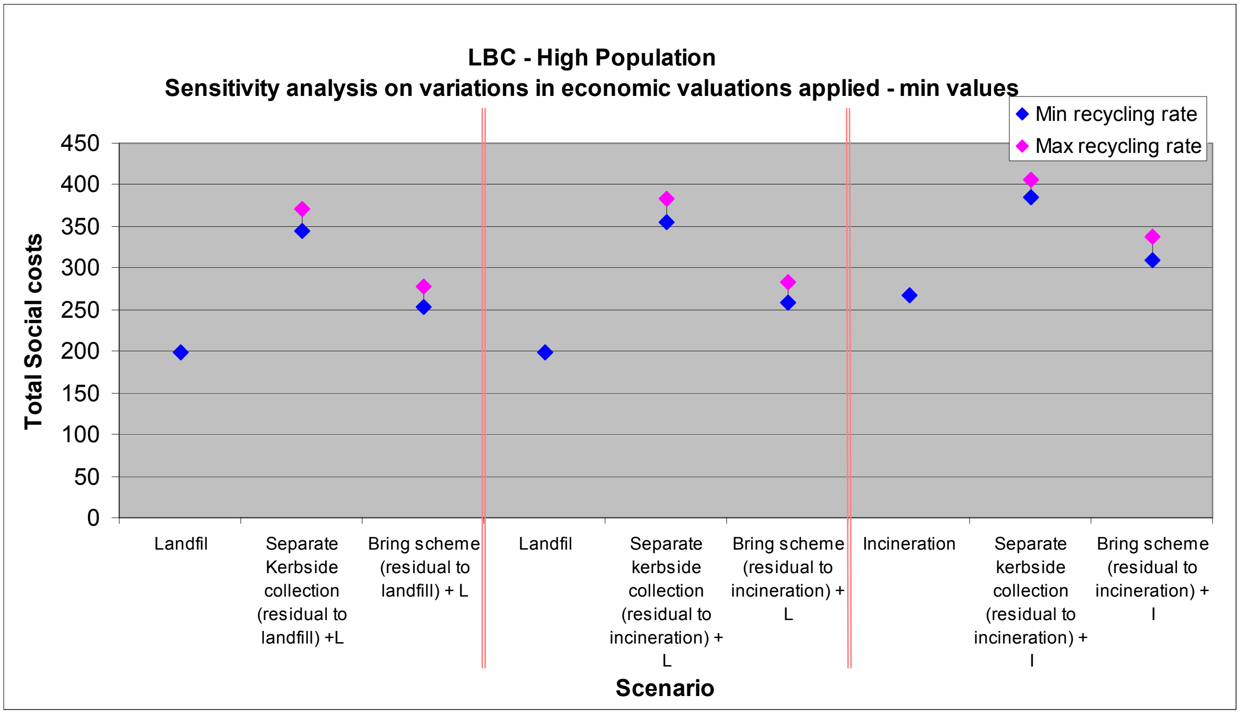
	Low population density		
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill (fibres recycled, foil/plastic residual to landfill)	No SC	No SC	No SC
Landfill (fibres recycled, foil/plastic residual to incineration)	No SC	No SC	No SC
Incineration	No SC	No SC	No SC
	High population density		
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill (fibres recycled, foil/plastic residual to landfill)	No SC	No SC	No SC
Landfill (fibres recycled, foil/plastic residual to incineration)	No SC	No SC	No SC
Incineration	No SC	No SC	No SC

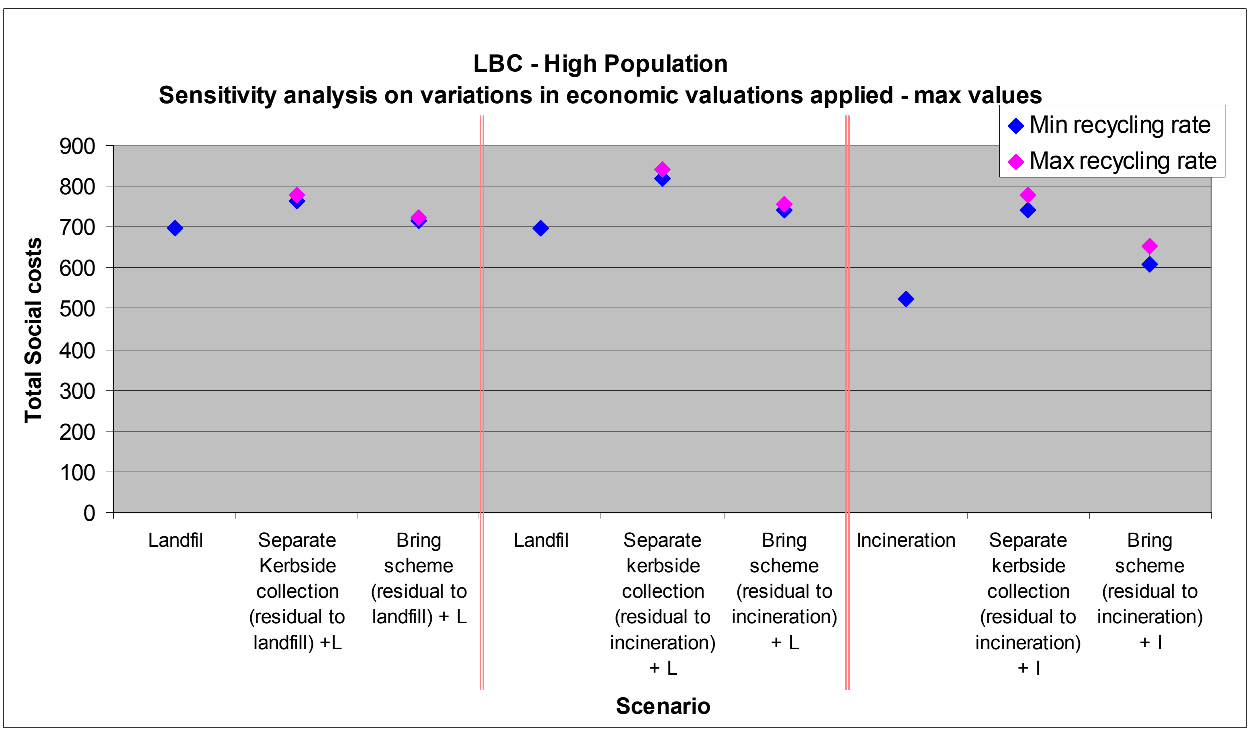
Graph 35 : LBC – low population density: Sensitivity of the results to the external economic valuations applied





Graph 36 : LBC – high population density: Sensitivity of the results to the external economic valuations applied



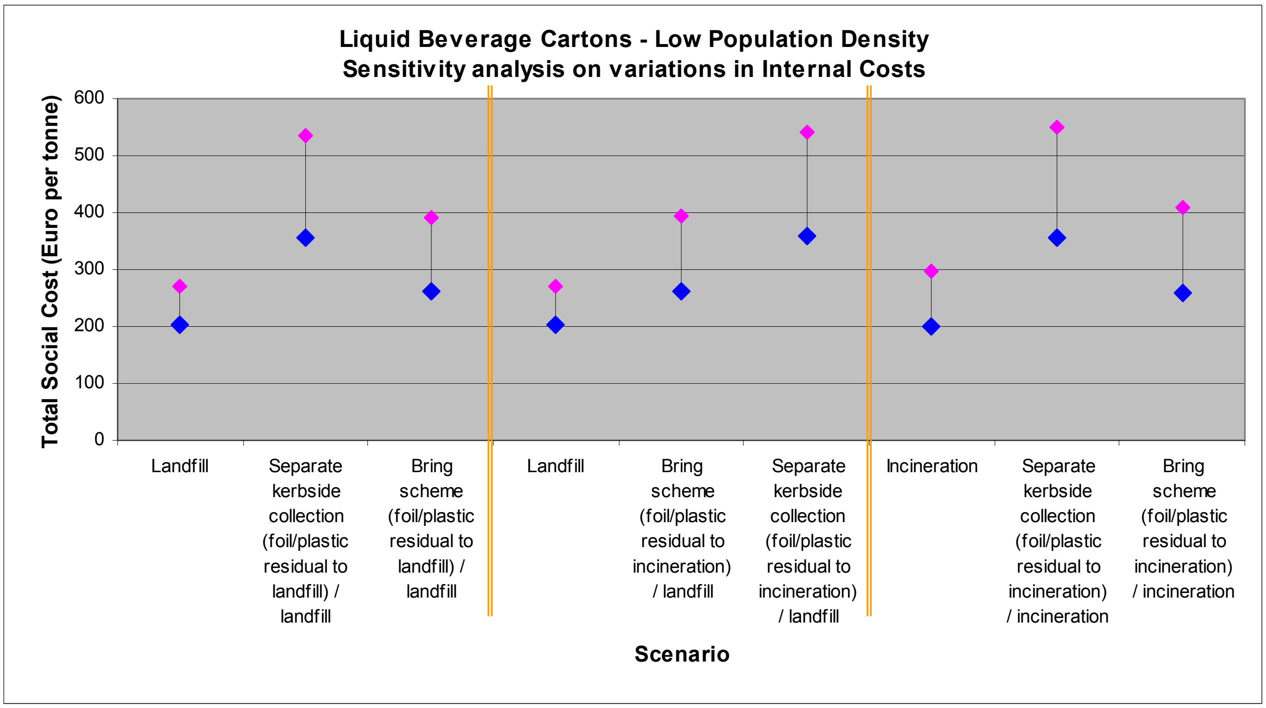


6.4.1.2 Internal costs

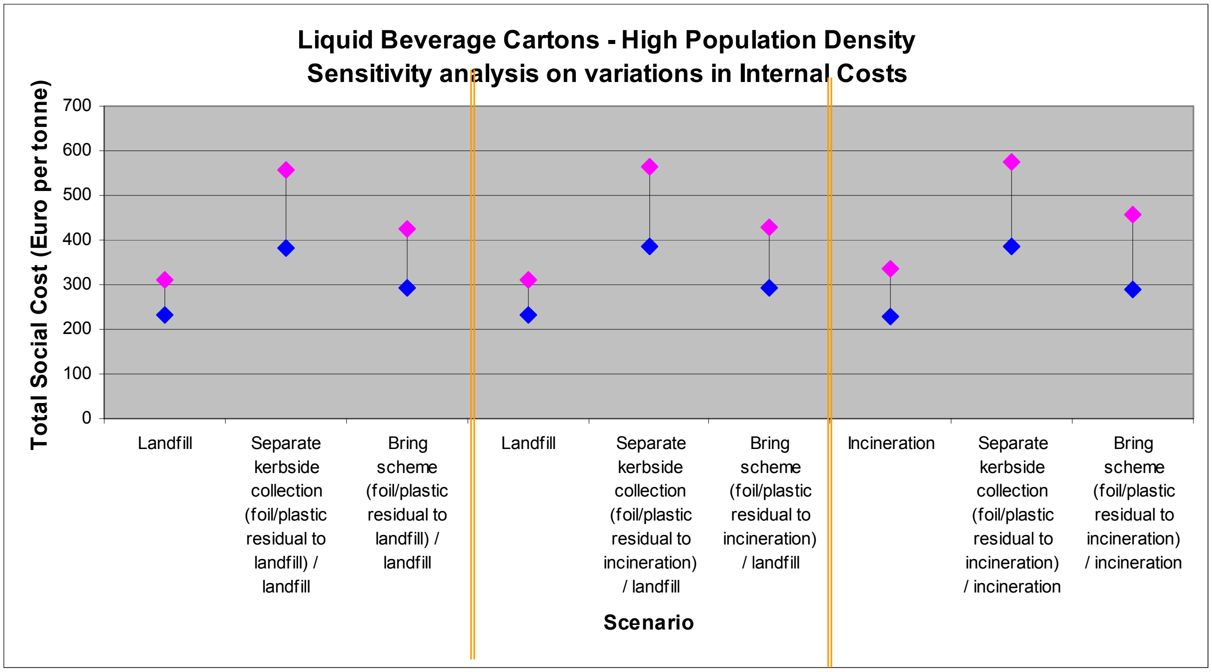
The internal costs applied in this study have been sourced mostly from the UK, France and Belgium. Even where equivalent waste management practices are compared internal costs can vary considerably between Member States, depending on a range of factors such as cost of living and geographical considerations (mountainous regions, island populations, etc.). In this part of the sensitivity analysis, the effect on the results of considering a +/-20% variation in internal costs is investigated. The results are presented in the graph below.

The graphs show that the results achieved and conclusions drawn are sensitive to potential variations in internal costs. If a +/-20% variation in internal costs is considered, where landfill is the MSW option it is no longer possible to distinguish between 100% landfill and a bring scheme achieving a recycling rate of 24-34% for either high or low population density.
Where incineration is the MSW option it is no longer possible to distinguish between 100% incineration and a bring scheme achieving a recycling rate of 24-34% for either high or low population density.

Graph 37 : LBC – low population density: Sensitivity of the results to the internal economic costs considered



Graph 38 : LBC – high population density: Sensitivity of the results to the internal economic costs considered

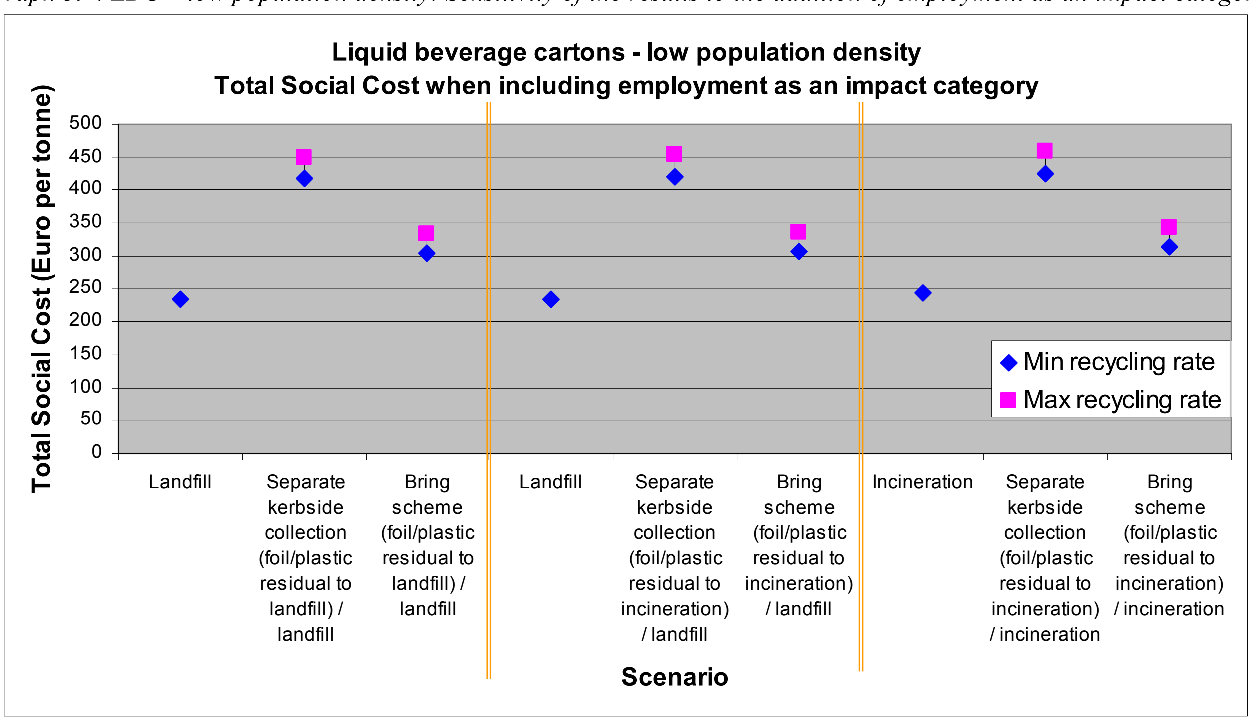


6.4.1.3 Inclusion of employment as an impact category

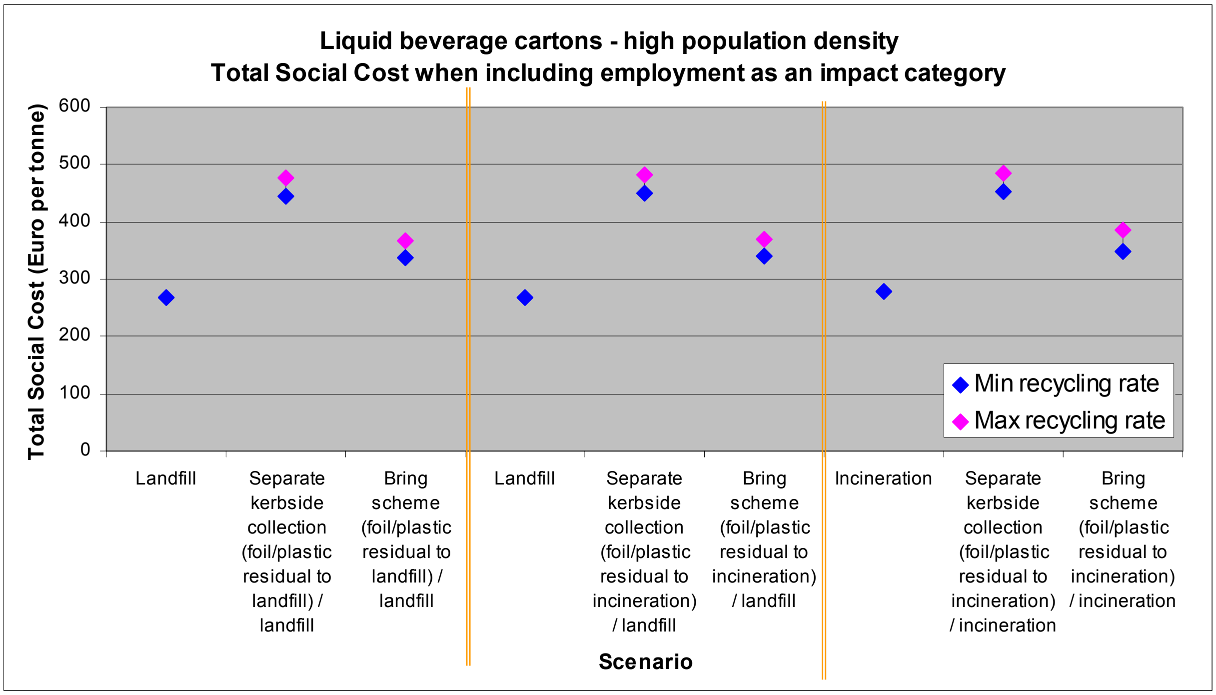
The graph below shows the sensitivity of the analysis to the inclusion of employment as an impact category. The graph has been produced by including employment along with the other environmental impacts used in the baseline analysis.

The graphs show that the results achieved and conclusions drawn are not sensitive to inclusion of this impact category.

Graph 39 : LBC – low population density: Sensitivity of the results to the addition of employment as an impact category



Graph 40 : LBC – low population density: Sensitivity of the results to the addition of employment as an impact category



6.4.2 Scenario and modelling choices

Findings from the sensitivity analysis of scenario and modelling choices are summarised in the table below.

Table 25 : Summary of sensitivity analysis of scenario and modelling choices for liquid beverage cartons

Parameter investigated	Influence on CBA results	Influence on conclusions drawn
Incineration model Combined heat and power	No influence on the relative standing of scenarios modelled	No influence on choice of optimum waste management system from the scenarios considered No influence on choice of optimum recycling rate
Incineration model Offset electricity	No influence on the relative standing of scenarios modelled	No influence on choice of optimum waste management system from the scenarios considered No influence on choice of optimum recycling rate
Transport distances MSW collection round Kerbside collection round Collection from bring bank Transport from sorting plant to reprocessor	No influence on the relative standing of scenarios modelled	No influence on choice of optimum waste management system from the scenarios considered No influence on choice of optimum recycling rate
Transport distance Consumer transport to bring bank	No influence on the relative standing of scenarios modelled	No influence on choice of optimum waste management system from the scenarios considered No influence on choice of optimum recycling rate

7 Glass from household sources

7.1 Scenarios considered

The table below summarises the parameters considered for the baseline scenarios modelled.

Table 26 : Scenarios considered for glass

	Population density	Selective collection scheme	Recycling rate achieved	MSW waste management option
Scenario 1	Low	None	0%	Landfill
Scenario 2	Low	None	0%	Incineration
Scenario 3	Low	Bring scheme	73-83%	Landfill
Scenario 4	Low	Bring scheme	73-83%	Incineration
Scenario 5	High	None	0%	Landfill
Scenario 6	High	None	0%	Incineration
Scenario 7	High	Bring scheme	42-91%	Landfill
Scenario 8	High	Bring scheme	42-91%	Incineration

7.2 Results of the cost benefit analysis for glass

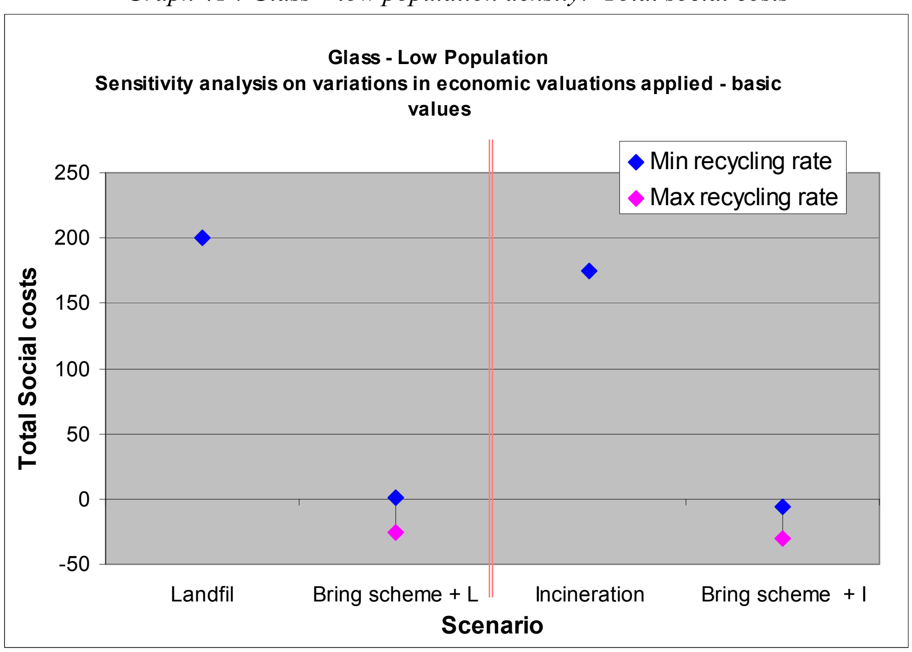
Table 27 : Glass – low population density: Internal costs, external costs and total social costs

Collection method	N/A	N/A	Bring			Bring		
Recycling rate	**0.0**	**0.0**	**73-83%**			**73-83%**		
Residual waste management option	**Landfill**	**Incineration**	**Landfill**			**Incineration**		
Exeternalities								
GWP (kg CO2 eq.)	0.4	0.9	-19.5	to	-22.2	-19.3	to	-22.1
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0	to	0.0	0.0	to	0.0
Acidification (Acid equiv.)	0.0	0.1	-2.9	to	-3.3	-2.9	to	-3.3
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0	to	0.0	0.0	to	0.0
Toxicity Gaseous (SO2 equiv.)	0.1	0.3	-16.3	to	-18.5	-16.2	to	-18.5
Toxicity Metals non carcinogens (Pb equiv.)	0.1	0.1	-0.3	to	-0.3	-0.3	to	-0.3
Toxicity Particulates & aerosols (PM10 equiv)	9.1	10.1	-60.5	to	-70.0	-60.2	to	-69.8
Toxicity Smog (ethylene equiv.)	0.3	0.3	-3.3	to	-3.8	-3.3	to	-3.8
Black smoke (kg dust eq.)	0.2	0.4	-7.5	to	-8.6	-7.5	to	-8.6
Fertilisation	-0.1	-0.1	2.3	to	2.6	2.3	to	2.6
Traffic accidents (risk equiv.)	0.1	0.1	4.6	to	5.2	4.6	to	5.2
Traffic Congestion (car km equiv.)	0.1	0.1	6.5	to	7.4	6.5	to	7.4
Traffic Noise (car km equiv.)	0.4	0.4	1.3	to	1.4	1.3	to	1.4
Water Quality Eutrophication (P equiv.)	0.0	0.0	-0.2	to	-0.2	-0.2	to	-0.2
Disaminity (kg LF waste equiv.)	37.0	10.1	10.0	to	6.3	2.7	to	1.7
TOTAL EXTERNALITIES	**47.7**	**22.8**	**-85.7**	**to**	**-104.0**	**-92.4**	**to**	**-108.2**
INTERNAL COSTS	**152.2**	**152.1**	**86.7**	**to**	**77.7**	**86.7**	**to**	**77.7**
TOTAL SOCIAL COSTS	**199.9**	**174.9**	**1.0**	**to**	**-26.2**	**-5.8**	**to**	**-30.5**

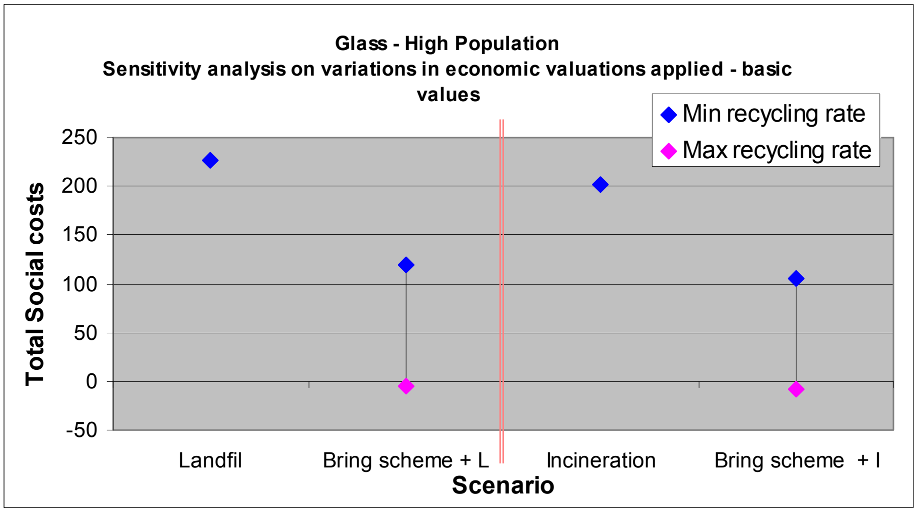
Table 28 : Glass – high population density: Internal costs, external costs and total social costs

Collection method	N/A	N/A	Bring			Bring		
Recycling rate	**0**	**0**	**42-91%**			**42-91%**		
Residual waste management option	**Landfill**	**Incineration**	**Landfill**			**Incineration**		
Externalities								
GWP (kg CO2 eq.)	0.3	0.8	-11.4	to	-25	-11.1	to	-24.9
Ozone depletion (kg CFC 11 eq.)	0	0	0	to	0	0	to	0
Acidification (Acid equiv.)	0	0.1	-1.7	to	-3.6	-1.6	to	-3.6
Toxicity Carcinogens (Cd equiv)	0	0	0	to	0	0	to	0
Toxicity Gaseous (SO2 equiv.)	0.1	0.3	-9.6	to	-20.9	-9.5	to	-20.9
Toxicity Metals non carcinogens (Pb equiv.)	0.1	0.1	-0.2	to	-0.4	-0.2	to	-0.4
Toxicity Particulates & aerosols (PM10 equiv)	7.9	8.8	-33.3	to	-81.4	-32.8	to	-81.3
Toxicity Smog (ethylene equiv.)	0.2	0.2	-2	to	-4.5	-2	to	-4.5
Black smoke (kg dust eq.)	0.2	0.3	-4.4	to	-9.6	-4.3	to	-9.6
Fertilisation	-0.1	-0.1	1.4	to	3	1.3	to	3
Traffic accidents (risk equiv.)	0.2	0.2	1.2	to	2.4	1.2	to	2.4
Traffic Congestion (car km equiv.)	8.2	8.2	33.6	to	63.4	33.7	to	63.4
Traffic Noise (car km equiv.)	0.2	0.2	0.6	to	1	0.6	to	1
Water Quality Eutrophication (P equiv.)	0	0	-0.1	to	-0.3	-0.1	to	-0.3
Disaminity (kg LF waste equiv.)	37	10.1	21.5	to	3.3	5.9	to	0.9
TOTAL EXTERNALITIES	**54.1**	**29.1**	**-4.4**	**to**	**-72.6**	**-18.9**	**to**	**-74.9**
INTERNAL COSTS	**172.5**	**173.3**	**123.8**	**to**	**66.9**	**124.2**	**to**	**67**
TOTAL SOCIAL COSTS	**226.6**	**202.4**	**119.4**	**to**	**-5.7**	**105.4**	**to**	**-7.9**

Graph 41 : Glass – low population density: Total social costs



Graph 42 : Glass – high population density: Total social costs



7.3 Main findings:

For low population density, a bring scheme achieving a recycling rate of 73-83% is the optimum system for the scenarios modelled.
For high population density, a bring scheme achieving a recycling rate of 42-91% is the optimum system for the scenarios modelled.

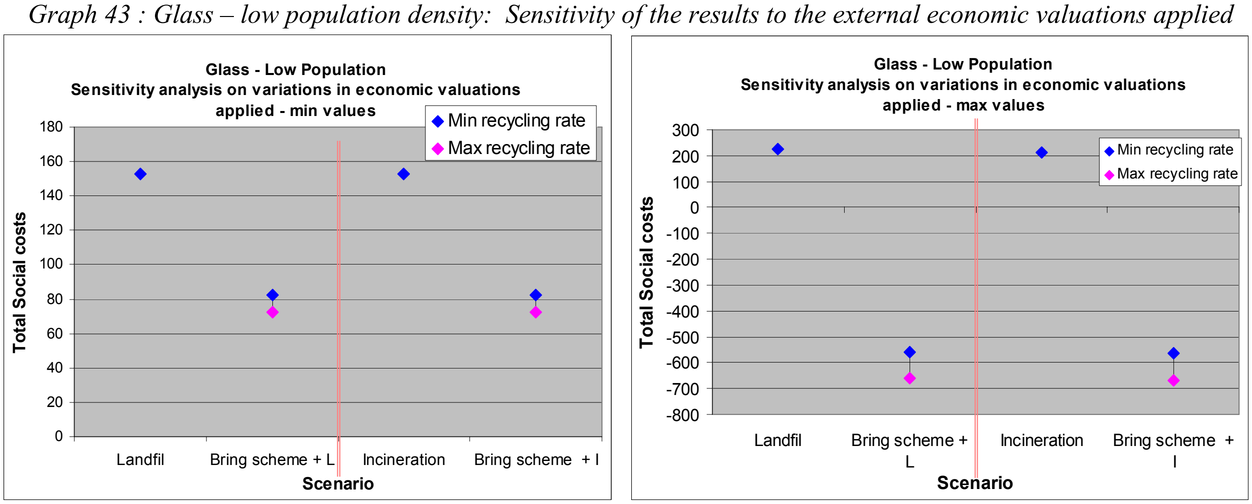
7.4 Sensitivity analysis

7.4.1 Methodological choices

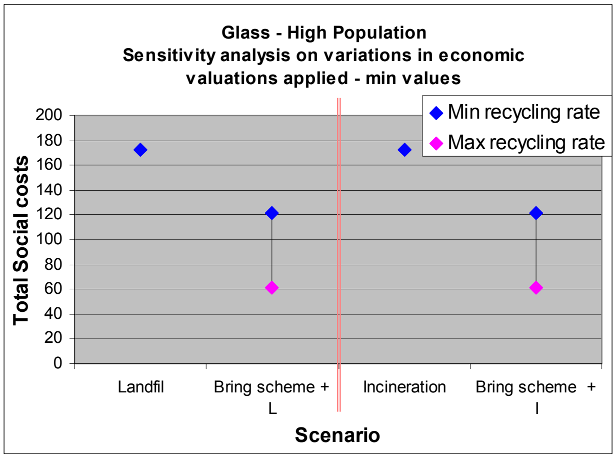
7.4.1.1 Choice of external valuations

The graph below shows the sensitivity of the analysis to the economic valuations applied to the defined environmental impacts. The graph has been produced by considering the same environmental impact results, but applying different impact assessment valuations (see Annex 4 for a list of maximum and minimum valuations applied).
The graphs below show that the general conclusions are not changed by applying different economic valuations.

Graph 43 : Glass – low population density: Sensitivity of the results to the external economic valuations applied



Graph 44 : Glass – high population density: Sensitivity of the results to the external economic valuations applied



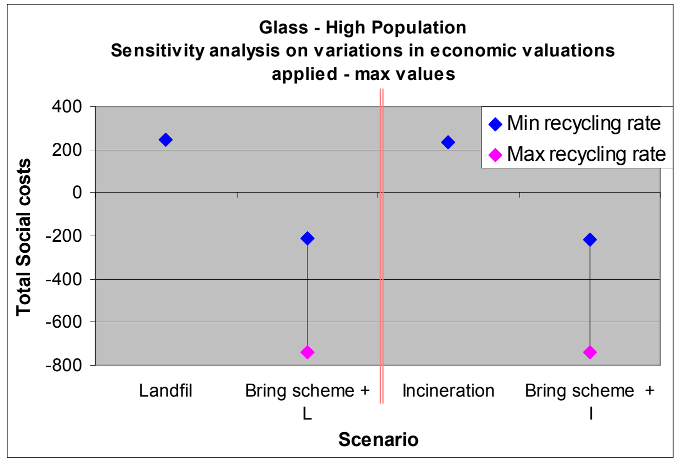


Table 29: Summary of the sensitivity analysis to the economic valuations

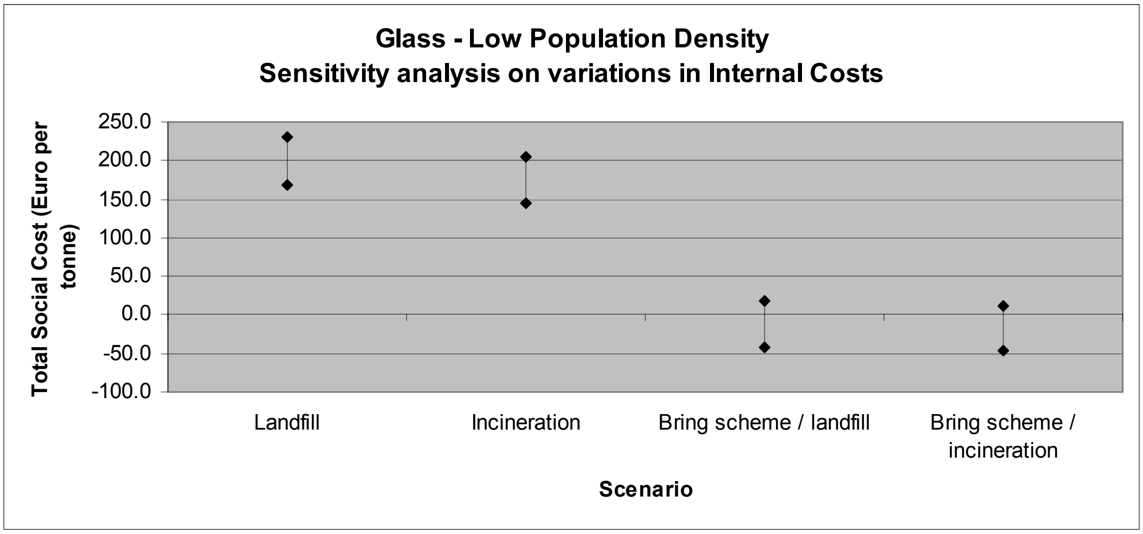
	Low population density		
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Bring	Bring	Bring
Incineration	Bring	Bring	Bring
	High population density		
Residual waste management option	Basic economic values	Min Economic values	Max economic values
Landfill	Bring	Bring	Bring
Incineration	Bring	Bring	Bring

7.4.1.2 Internal costs

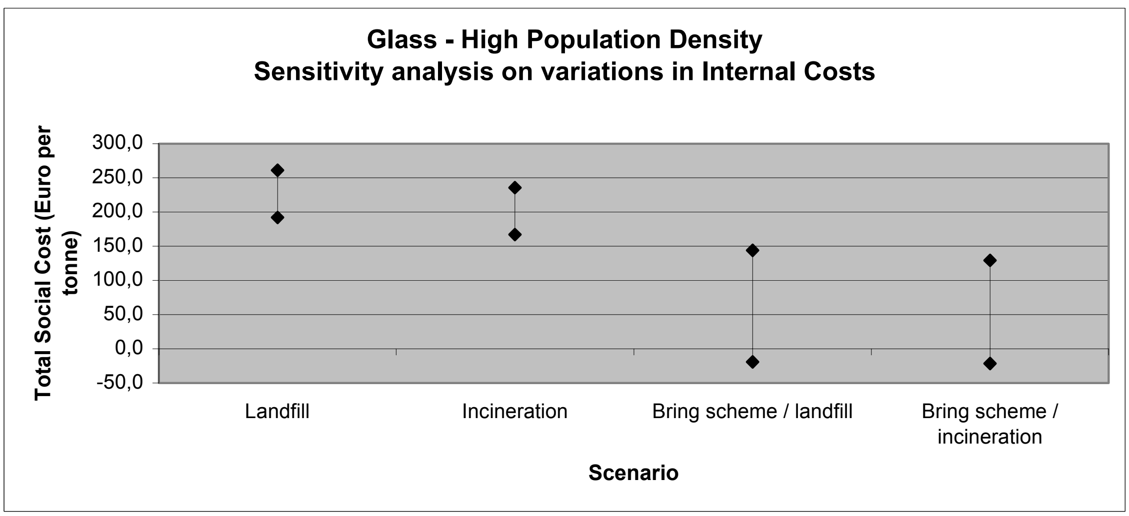
The internal costs applied in this study have been sourced mostly from the UK, France and Belgium. Even where equivalent waste management practices are compared internal costs can vary considerably between Member States, depending on a range of factors such as cost of living and geographical considerations (mountainous regions, island populations, etc.). In this part of the sensitivity analysis, the effect on the results of considering a +/-20% variation in internal costs is investigated.

The results are presented in the graph below, which shows that the general conclusions drawn are not sensitive to this parameter.

Graph 45 : Glass – low population density: Sensitivity of the results to the internal economic costs considered



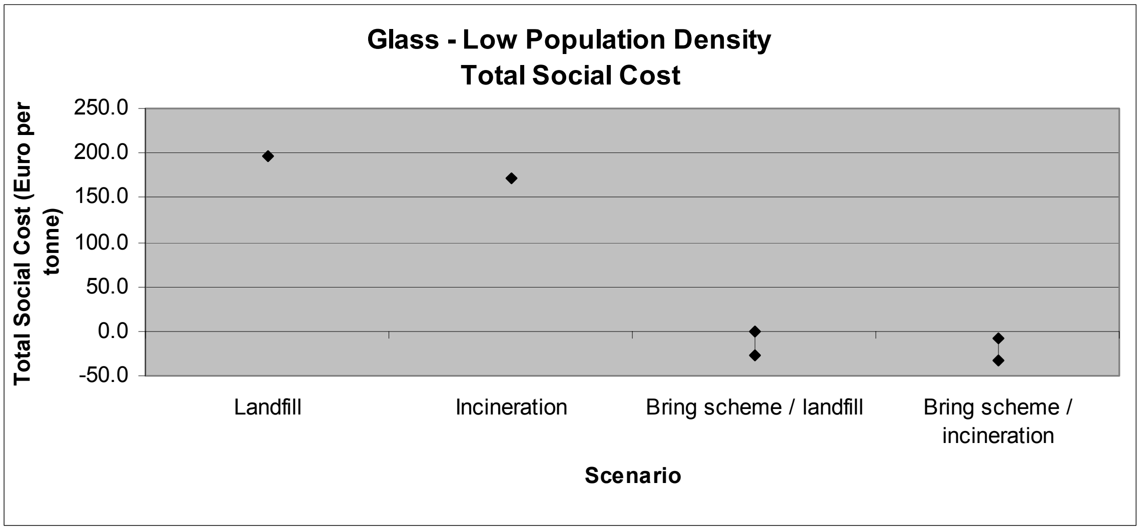
Graph 46 : Glass – high population density: Sensitivity of the results to the internal economic costs considered



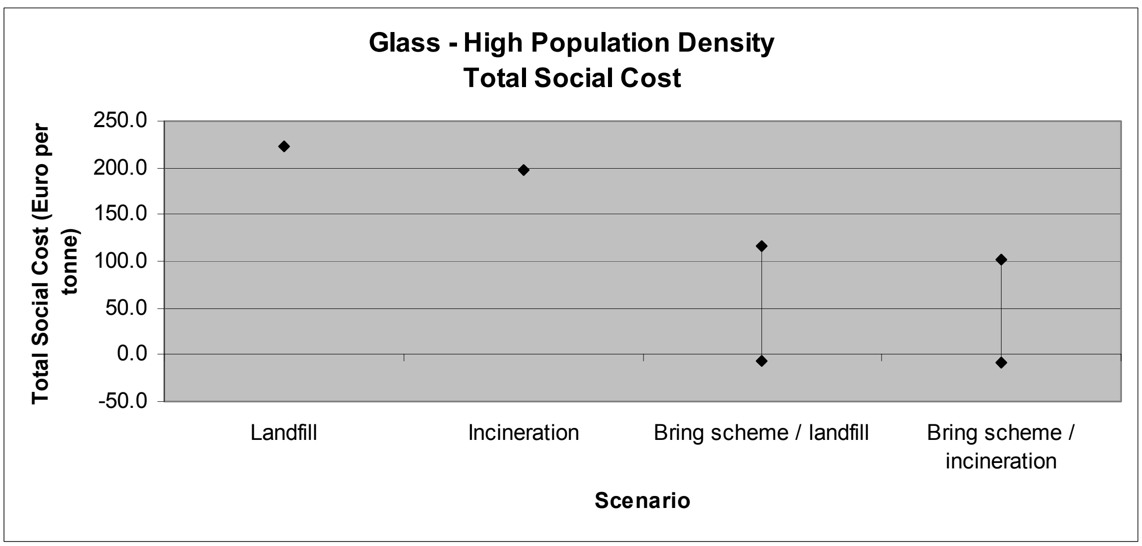
7.4.1.3 Inclusion of employment as an impact category

The graph below shows the sensitivity of the analysis to the inclusion of employment as an impact category. The graph has been produced by including employment along with the other environmental impacts used in the baseline analysis. The general conclusions drawn are not affected by the inclusion of this impact category.

Graph 47 : Glass – low population density: Sensitivity of the results to the addition of employment as an impact category



Graph 48 : Glass – high population density: Sensitivity of the results to the addition of employment as an impact category



7.4.2 Scenario and modelling choices

Findings from the sensitivity analysis of scenario and modelling choices are summarised in the table below.

Table 30 : Summary of sensitivity analysis of scenario and modelling choices for glass

Parameter investigated	Influence on CBA results	Influence on conclusions drawn
Incineration model Combined heat and power	No influence	No influence
Incineration model Offset electricity	No influence	No influence
Transport distances MSW collection round Kerbside collection round Collection from bring bank Transport from sorting plant to reprocessor	No influence	No influence
Transport distance Consumer transport to bring bank	No influence	No influence
Alternative LCI data	Not considered	Not considered
Alternative reprocessing options	Not considered	Not considered

The results are generally robust to the parameters investigated in the sensitivity analysis. However, it should be noted that alternative LCI data has not been investigated. Also, no consideration of alternative reprocessing options has been made. Alternative reprocessing options may be crucial for countries to achieve higher recycling rates where an imbalance in supply and demand exists.

8 PE Film from commercial and industrial sources

8.1 Scenarios considered

The table below summarises the parameters considered for the baseline scenarios modelled.

Table 31 : Scenarios considered for PE film

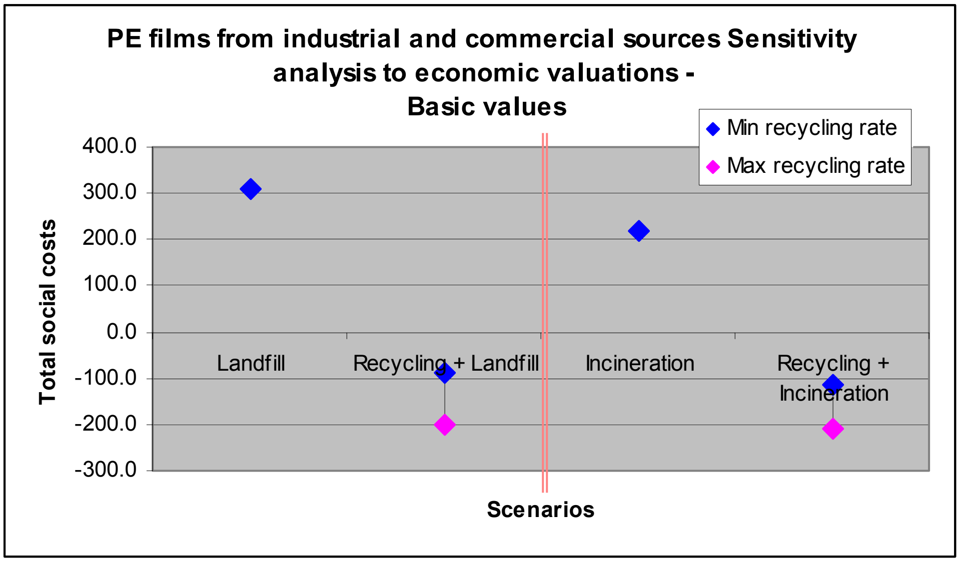
	Selective collection scheme	Recycling rate achieved	MSW waste management option
Scenario 1	None	0%	Landfill
Scenario 2	None	0%	Incineration
Scenario 3	Separate collection	70-90%	Landfill
Scenario 4	Separate collection	70-90%	Incineration

8.2 Results of the cost benefit analysis for PE film

Table 32 : PE film: Internal costs, external costs and total social costs

Collection method	**N/A**	**N/A**	**Recycling**			**Recycling**		
Recycling rate	**0.0**	**0.0**	**70-90%**			**70-90%**		
Residual waste management option	**Landfill**	**Incineration**	**Landfill**			**Incineration**		
Exeternalities								
GWP (kg CO2 eq.)	0.4	39.8	-15.6	to	-20.2	-3.8	to	-16.2
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0	to	0.0	0.0	to	0.0
Acidification (Acid equiv.)	0.1	-1.3	-3.0	to	-3.8	-3.4	to	-4.0
Toxicity Carcinogens (Cd equiv)	0.0	-0.1	0.0	to	0.0	0.0	to	0.0
Toxicity Gaseous (SO2 equiv.)	0.2	-4.6	-7.8	to	-10.0	-9.2	to	-10.5
Toxicity Metals non carcinogens (Pb equiv.)	0.1	-0.5	4.8	to	6.1	4.6	to	6.1
Toxicity Particulates & aerosols (PM10 equiv)	9.6	-50.0	-111.5	to	-146.1	-129.4	to	-152.0
Toxicity Smog (ethylene equiv.)	0.2	-0.4	-15.3	to	-19.8	-15.5	to	-19.9
Black smoke (kg dust eq.)	0.2	-4.3	-8.5	to	-11.0	-9.9	to	-11.4
Fertilisation	-0.1	0.0	5.0	to	6.5	5.1	to	6.5
Traffic accidents (risk equiv.)	0.2	0.2	0.2	to	0.3	0.2	to	0.3
Traffic Congestion (car km equiv.)	8.2	8.2	12.0	to	13.0	12.0	to	13.0
Traffic Noise (car km equiv.)	0.2	0.2	0.3	to	0.3	0.3	to	0.3
Water Quality Eutrophication (P equiv.)	0.0	-0.1	-0.4	to	-0.5	-0.4	to	-0.5
Disaminity (kg LF waste equiv.)	37.0	13.3	11.1	to	3.7	4.0	to	1.3
TOTAL EXTERNALITIES	**56.1**	**0.4**	**-128.7**	**to**	**-181.5**	**-145.4**	**to**	**-187.1**
INTERNAL COSTS	**255.2**	**217.2**	**42.0**	**to**	**-18.9**	**30.6**	**to**	**-22.7**
TOTAL SOCIAL COSTS	**311.3**	**217.6**	**-86.7**	**to**	**-200.4**	**-114.8**	**to**	**-209.8**

Graph 49 : PE film: Total social costs



8.3 Main findings:

Where landfill is the MSW option, recycling of source separated material (achieving a recycling rate of 70-90%) is the optimum waste management system for the scenarios considered.
Where incineration is the MSW option, recycling of source separated material (achieving a recycling rate of 70-90%) is the optimum waste management system for the scenarios considered.

8.4 Sensitivity analysis

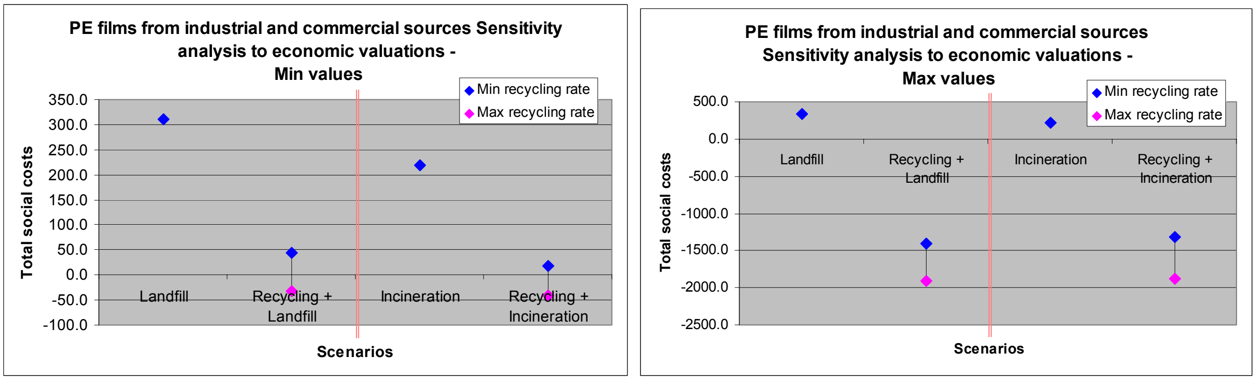
8.4.1 Methodological choices

8.4.1.1 Choice of external valuations

The graph below shows the sensitivity of the analysis to the economic valuations applied to the defined environmental impacts. The graph has been produced by considering the same impact results, but applying different impact assessment valuations (see Annex 4 for a list of maximum and minimum valuations applied).

The graphs show that the results achieved and conclusions drawn are not sensitive to the economic valuations applied to environmental impacts.

Graph 50 : PE film: Sensitivity of the results to the external economic valuations applied

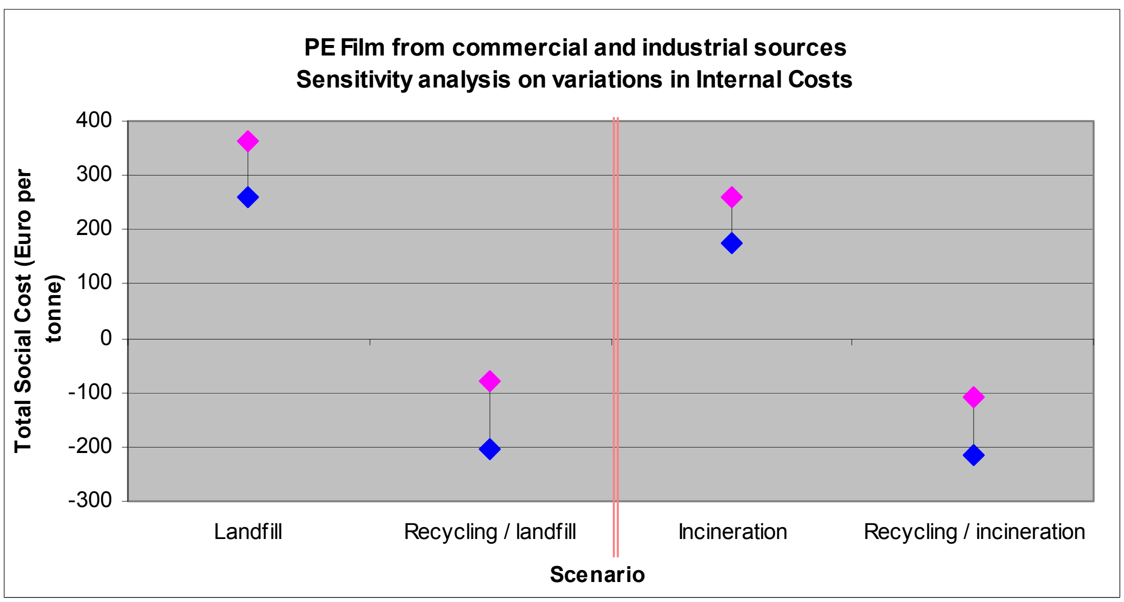


8.4.1.2 Internal costs

Internal costs can vary considerably between Member States, depending on a range of factors such as cost of living and geographical considerations (mountainous regions, island populations, etc.). To account for this variation, the dependency of the internal costs on the results have been investigated. The effect on the results of considering a +/-20% variation in internal costs is presented in the graph below.

The graph shows that the results are not sensitive to this parameter.

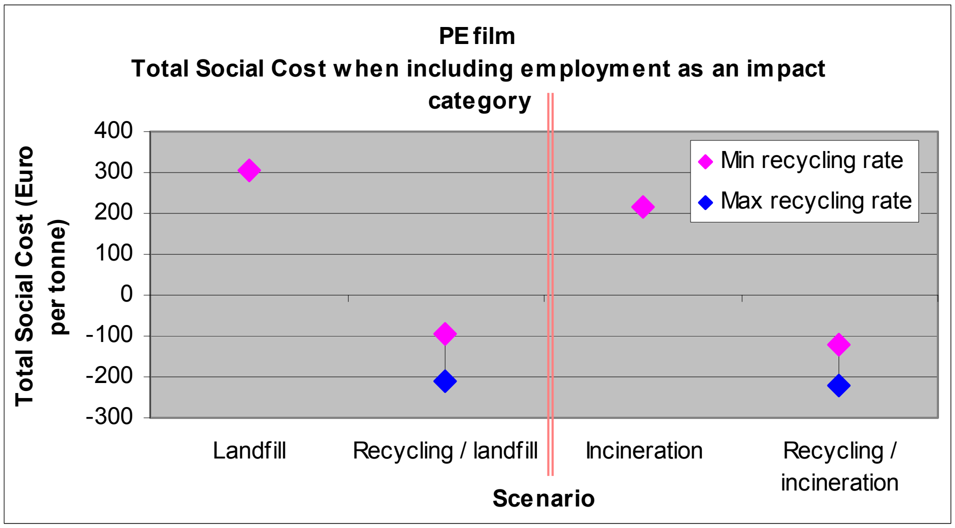
Graph 51 : PE film: Sensitivity of the results to the internal economic costs considered



8.4.1.3 Inclusion of employment as an impact category

The graph below shows the sensitivity of the analysis to the inclusion of employment as an impact category. The graph has been produced by including employment along with the other environmental impacts used in the baseline analysis. The graph shows that the results achieved and conclusions drawn are not sensitive to inclusion of this external impact category.

Graph 52 : PE film: Sensitivity of the results to the inclusion of employment as an impact category



8.4.2 Sensitivity analysis: Scenario and modelling choices

Findings from the sensitivity analysis of scenario and modelling choices are summarised in the table below.

Table 33 : Summary of sensitivity analysis of scenario and modelling choices for PE film

Parameter investigated	Influence on CBA results	Influence on conclusions drawn
Incineration model Combined heat and power	Incineration costs reduced No effect on the relative standing of scenarios	No effect on the choice of optimal scenario
Incineration model Offset electricity	Incineration costs reduced No effect on the relative standing of scenarios	No effect on the choice of optimal scenario
Transport distances Collection for landfill and incineration Collection for recycling	No effect on the relative standing of scenarios	No effect on the choice of optimal scenario
Offset virgin production – save ratio considered	No effect on the relative standing of scenarios	No effect on the choice of optimal scenario

9 Corrugated board from industrial sources

9.1 Scenarios considered

The table below summarises the parameters considered for the baseline scenarios modelled.

Table 34 : Scenarios considered for corrugated board

	Selective collection scheme	Recycling rate achieved	MSW waste management option
Scenario 1	None	0%	Landfill
Scenario 2	None	0%	Incineration
Scenario 3	Separate collection	70-90%	Landfill
Scenario 4	Separate collection	70-90%	Incineration

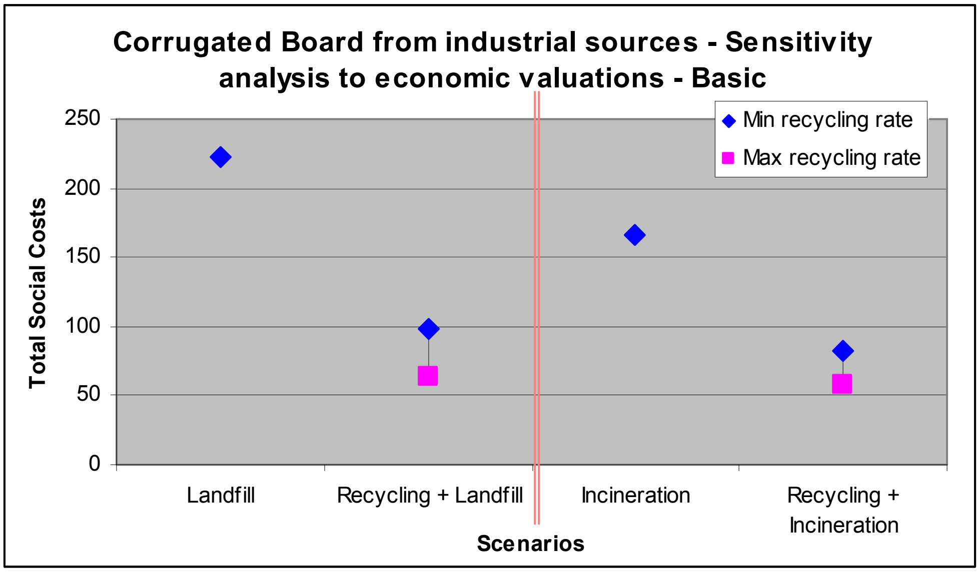
9.2 Results of the cost benefit analysis for corrugated board

This section presents and discusses the results of the cost benefit analysis for corrugated board.

Table 35 : Corrugated board: Internal costs, external costs and total social costs

Collection method	**N/A**	**N/A**	**Recycling**			**Recycling**		
Recycling rate	**0.0**	**0.0**	**70-90%**			**70-90%**		
Residual waste management option	**Landfill**	**Incineration**	**Landfill**			**Incineration**		
Exeternalities								
GWP (kg CO2 eq.)	32.3	16.9	24.1	to	21.8	19.5	to	20.2
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0	to	0.0	0.0	to	0.0
Acidification (Acid equiv.)	-0.2	-0.4	-0.4	to	-0.5	-0.5	to	-0.6
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0	to	0.0	0.0	to	0.0
Toxicity Gaseous (SO2 equiv.)	-0.7	-1.6	-1.3	to	-1.5	-1.6	to	-1.6
Toxicity Metals non carcinogens (Pb equiv.)	0.0	-0.2	-0.2	to	-0.2	-0.2	to	-0.2
Toxicity Particulates & aerosols (PM10 equiv)	2.6	-14.1	-26.1	to	-34.3	-31.1	to	-36.0
Toxicity Smog (ethylene equiv.)	1.8	-0.1	-0.2	to	-0.8	-0.8	to	-1.0
Black smoke (kg dust eq.)	-0.3	-1.4	-1.9	to	-2.4	-2.2	to	-2.5
Fertilisation	-0.2	0.0	0.4	to	0.5	0.4	to	0.5
Traffic accidents (risk equiv.)	0.1	0.1	0.1	to	0.2	0.1	to	0.2
Traffic Congestion (car km equiv.)	1.3	1.3	8.2	to	10.2	8.2	to	10.2
Traffic Noise (car km equiv.)	0.1	0.1	0.1	to	0.0	0.1	to	0.1
Water Quality Eutrophication (P equiv.)	0.0	0.0	0.0	to	0.0	0.0	to	0.0
Disaminity (kg LF waste equiv.)	37.0	11.2	11.3	to	4.0	3.6	to	1.4
TOTAL EXTERNALITIES	**73.9**	**11.8**	**14.0**	**to**	**-3.1**	**-4.7**	**to**	**-9.4**
INTERNAL COSTS	**148.8**	**154.8**	**84.5**	**to**	**66.2**	**86.3**	**to**	**66.8**
TOTAL SOCIAL COSTS	**222.7**	**166.6**	**98.5**	**to**	**63.0**	**81.7**	**to**	**57.4**

Graph 53 : Corrugated board: Total social costs



9.3 Main findings:

Where landfill is the MSW option, recycling of source separated material (achieving a recycling rate of 70-90%) is the optimum waste management system for the scenarios considered.
Where incineration is the MSW option, recycling of source separated material (achieving a recycling rate of 70-90%) is the optimum waste management system for the scenarios considered.

9.4 Sensitivity analysis

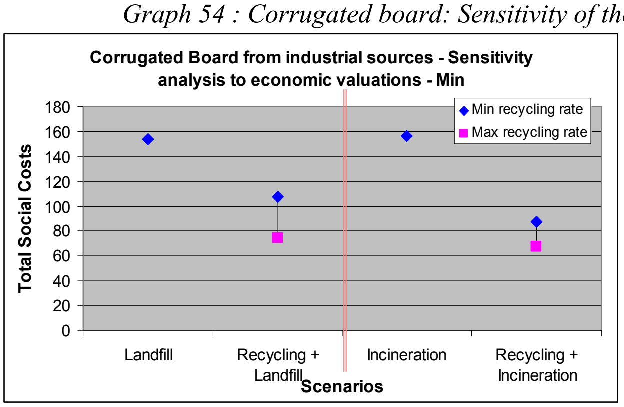
9.4.1 Methodological choices

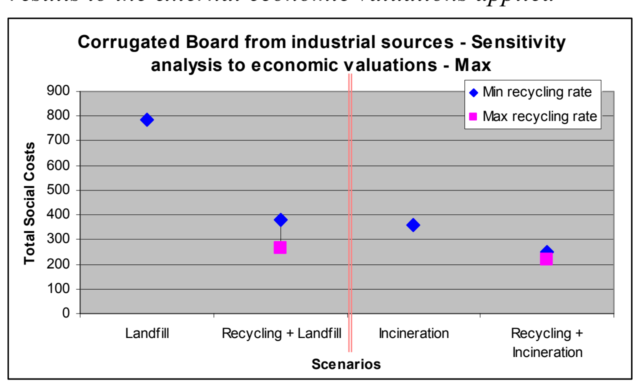
9.4.1.1 Choice of external valuations

The graph below shows the sensitivity of the analysis to the economic valuations applied to the defined environmental impacts. The graph has been produced by considering the same environmental impact results, but applying different impact assessment valuations (see Annex 4 for a list of maximum and minimum valuations applied).

The graph shows that the results achieved and conclusions that can be drawn are not sensitive to the economic valuations applied.

Graph 54 : Corrugated board: Sensitivity of the results to the external economic valuations applied



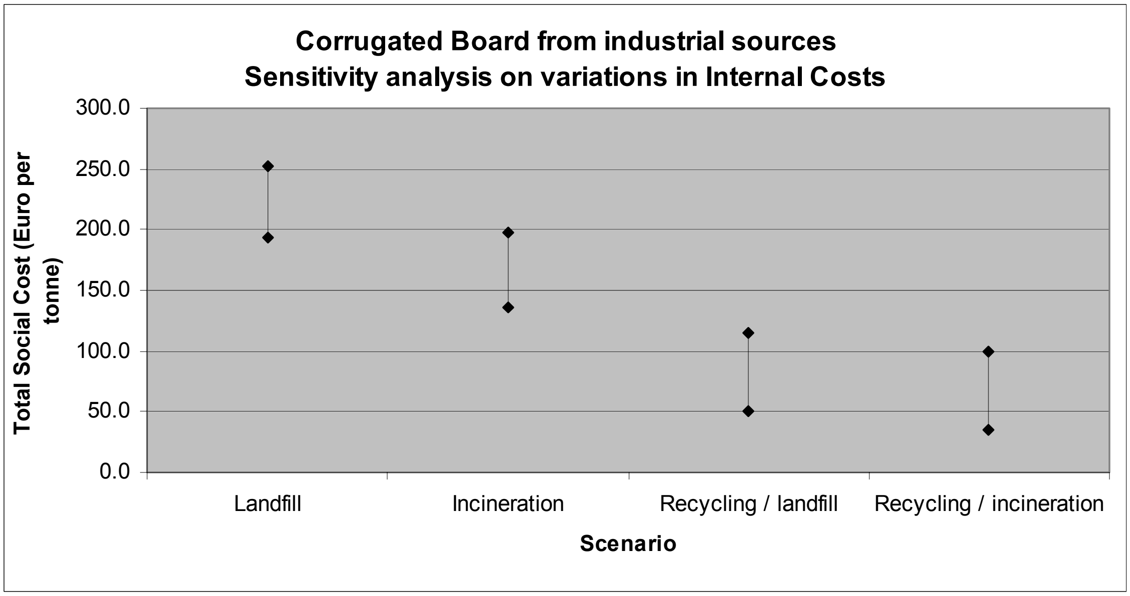


9.4.1.2 Internal costs

The internal costs applied in this study have been sourced mostly from the UK, France and Belgium. Even where equivalent waste management practices are compared internal costs can vary considerably between Member States, depending on a range of factors such as cost of living and geographical considerations (mountainous regions, island populations, etc.). In this part of the sensitivity analysis, the effect on the results of considering a +/-20% variation in internal costs is investigated. The results are presented in the graph below.

The graph shows that the results achieved and conclusions that can be drawn are not sensitive to this parameter.

Graph 55 : Corrugated board: Sensitivity of the results to the internal economic costs considered.

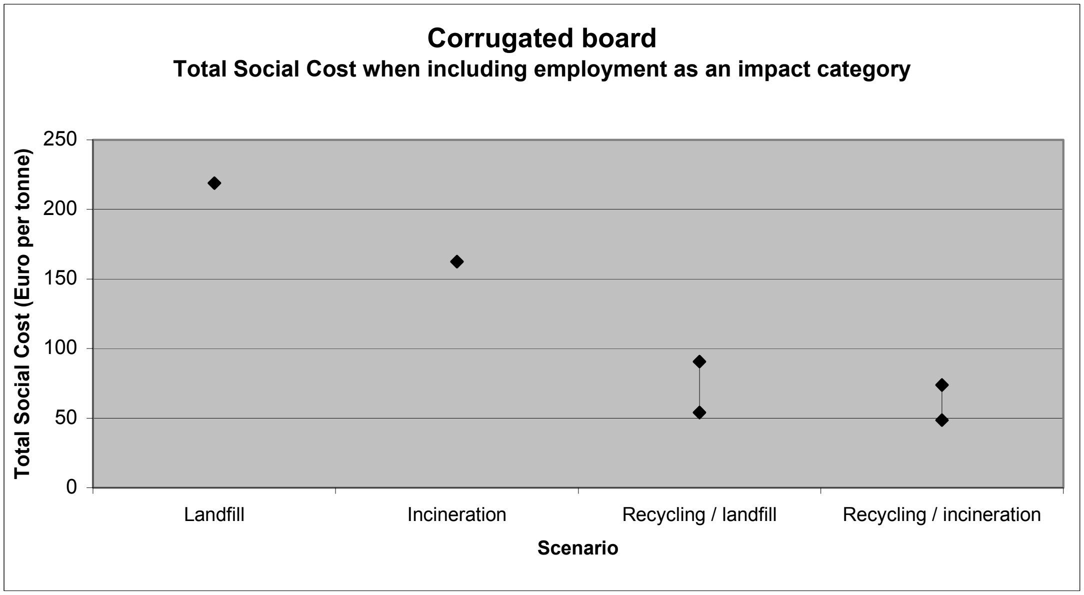


9.4.1.3 Inclusion of employment as an impact category

The graph below shows the sensitivity of the analysis to the inclusion of employment as an impact category. The graph has been produced by including employment along with the other environmental impacts used in the baseline analysis.

The graph shows that the results achieved and conclusions that can be drawn are not sensitive to this parameter.

Graph 56 : Corrugated board: Sensitivity of the results to the addition of employment as an impact category



9.4.2 Scenario and modelling choices

Findings from the sensitivity analysis of scenario and modelling choices are summarised in the table below.

Table 36 : Summary of sensitivity analysis of scenario and modelling choices for corrugated board

Parameter investigated	Influence on CBA results	Influence on conclusions drawn
Incineration model Combined heat and power	Total social cost of incineration reduced No effect on the relative standing of scenarios	No effect on choice of optimum system
Incineration model Offset electricity	Total social cost of incineration reduced No effect on the relative standing of scenarios	No effect on choice of optimum system
Transport distances Collection for landfill or incineration Collection for recycling	No effect on the relative standing of scenarios	No effect on choice of optimum system
Reprocessing overseas Addition of a distance of 1000 km by ocean ship	No effect on the relative standing of scenarios	No effect on choice of optimum system

Annex 11: Presentation of the Global recycling targets per Member State

This section presents the results of the targets calculation per Member State.

The 16 first pages concern the calculation of the minimum recycling targets, i.e. applying the lowest recycling rate of the ranges to the packaging mix described in annex 6. The 16 last pages concern the calculation of the maximum recycling targets per Member State, i.e. applying the highest recycling rate of the ranges to the packaging mix described in annex 6.

The calculation methodology is described in the main report in chapter 3.4.

Minimum recycling rates

AUSTRIA	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	75			33
		LDPE films	55	0%	55%	29
		Other	20	0%	21%	4
	Wood		60	0%	50%	29
	Steel		4	0%	80%	3
	Cardboard		384	0%	64%	233
	glass		47	0%	50%	22
	Other		0	0%	0%	0
Total			570			320
		Global Target Industrial waste				56%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				47%	0%	37%	16%	
	Plastics		112					25
		PET bottles	20	70%	35%	59%	59%	13
		LPDE films	24	0%	0%	0%	0%	0
		HDPE bottles	24	57%	28%	48%	48%	13
		other	44	0%	0%	0%	0%	0
	Steel		69	15%	80%	40%	80%	24
	aluminium	total	9					2
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	98	61%	61%	55%	55%	57
	composites	liquid beverage cartons	23	0%	0%	0%	0%	0
		mainly based on plastic	4	0%	0%	0%	0%	0
		mainly based on cardboard	5	0%	0%	0%	0%	0
		mainly based on Aluminium	3	0%	0%	0%	0%	0
	Glass		183	73%	73%	42%	42%	104
	Other		0	0%	0%	0%	0%	0
Total			506					211
	Global Target Household waste							42%

Total			1,076					532
				Global target (Industrial + Household waste)				49%

data in blue are input data specific to each MS
data in red are the results of this study
data in green is calculated based on blue and red data

Minimum recycling rates

Belgium	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	91			32
		LDPE films	42	0%	55%	22
		Other	49	0%	21%	10
	Wood		168	0%	50%	80
	Steel		56	0%	80%	43
	Cardboard		371	0%	64%	226
	glass		4	0%	50%	2
	Other		14	0%	0%	0
Total			704			382
		Global Target Industrial waste				54%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				7%	7%	43%	43%	
	Plastics		162					34
		PET bottles	44	70%	35%	59%	59%	26
		LPDE films	43	0%	0%	0%	0%	0
		HDPE bottles	18	57%	28%	48%	48%	8
		other	57	0%	0%	0%	0%	0
	Steel		80	15%	80%	40%	80%	47
	aluminium	total	14					3
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	153	61%	61%	55%	55%	85
	composites	liquid beverage cartons	20	0%	0%	0%	0%	0
		mainly based on plastic	3	0%	0%	0%	0%	0
		mainly based on cardboard	5	0%	0%	0%	0%	0
		mainly based on Aluminium	2	0%	0%	0%	0%	0
	Glass		330	73%	73%	42%	42%	153
	Other		0	0%	0%	0%	0%	0
Total			768					322
	Global Target Household waste							42%

Total			1,472					704
				Global target (Industrial + Household waste)				48%

data in blue are input data specific to each MS
data in red are the results of this study
data in green is calculated based on blue and red data

Minimum recycling rates

DENMARK	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	109			38
		LDPE films	51	0%	55%	27
		Other	58	0%	21%	12
	Wood		84	0%	50%	40
	Steel		11	0%	80%	8
	Cardboard		314	0%	64%	191
	glass		0	0%	50%	0
	Other		0	0%	0%	0
Total			518			278
				Global Target Industrial waste		54%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		**High**		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				0%	66%	0%	34%	
	Plastics		63					38
		PET bottles	5	70%	35%	59%	59%	2
		LPDE films	20	0%	0%	0%	0%	0
		HDPE food bottles	17	57%	28%	48%	48%	6
		other	21	0%	0%	0%	0%	0
	Steel		37	15%	80%	40%	80%	30
	aluminium	total	7					2
	Wood		9	0%	0%	0%	0%	0
	Cardboard	total	121	61%	61%	55%	55%	71
	composites	liquid beverage cartons	0	0%	0%	0%	0%	0
		mainly based on plastic	1	0%	0%	0%	0%	0
		mainly based on cardboard	1	0%	0%	0%	0%	0
		mainly based on Aluminium	1	0%	0%	0%	0%	0
	Glass		176	73%	73%	42%	42%	110
	Other		0	0%	0%	0%	0%	0
Total			416					221
	Global Target Household waste							53%

Total			934					499
				Global target (Industrial + Household waste)				53%

data in blue are input data specific to each MS
data in red are the results of this study
data in green is calculated based on blue and red data

Minimum recycling rates

FINLAND	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	48			17
		LDPE films	22	0%	55%	12
		other	26	0%	21%	5
	Wood		0	0%	50%	0
	Steel		18	0%	80%	13
	Cardboard		192	0%	64%	117
	glass		6	0%	50%	3
	Other		0	0%	0%	0
Total			264			150
		Global Target Industrial waste				57%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				58%	0%	40%	2%	
	Plastics		37					11
		PET bottles	6	70%	35%	59%	59%	4
		LPDE films	17	0%	0%	0%	0%	0
		HDPE bottles	15	57%	28%	48%	48%	8
		other	0	0%	0%	0%	0%	0
	Steel		14	15%	80%	40%	80%	4
	aluminium	total	2					0
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	18	61%	61%	55%	55%	10
	composites	liquid beverage cartons	29	0%	0%	0%	0%	0
		mainly based on plastic	4	0%	0%	0%	0%	0
		mainly based on cardboard	7	0%	0%	0%	0%	0
		mainly based on Aluminium	0	0%	0%	0%	0%	0
	Glass		50	73%	73%	42%	42%	30
	Other		0	0%	0%	0%	0%	0
Total			162					56
	Global Target Household waste							35%

Total			425					206
				Global target (Industrial + Household waste)				48%

data in blue are input data specific to each MS
data in red are the results of this study
data in green is calculated based on blue and red data

Minimum recycling rates

FRANCE	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	730			232
		LDPE films	260	0%	55%	137
		Other	470	0%	21%	95
	Wood		1,690	0%	50%	803
	Steel		280	0%	80%	213
	Cardboard		3,100	0%	64%	1,885
	glass		960	0%	50%	456
	Other		0	0%	0%	0
Total			6,760			3,588
		Global Target Industrial waste				53%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				22%	8%	32%	39%	
	Plastics		902					197
		PET bottles	250	70%	35%	59%	59%	148
		LPDE films	140	0%	0%	0%	0%	0
		HDPE bottles	100	57%	28%	48%	48%	48
		other	412	0%	0%	0%	0%	0
	Steel		350	15%	80%	40%	80%	187
	aluminium	total	36					8
	Wood		10	0%	0%	0%	0%	0
	Cardboard	total	872	61%	61%	55%	55%	495
	composites	liquid beverage cartons	120	0%	0%	0%	0%	0
		mainly based on plastic	18	0%	0%	0%	0%	0
		mainly based on cardboard	28	0%	0%	0%	0%	0
		mainly based on Aluminium	15	0%	0%	0%	0%	0
	Glass		2,550	73%	73%	42%	42%	1,308
	Other		0	0%	0%	0%	0%	0
Total			4,901					2,195
	Global Target Household waste							45%

Total			11,661					5,783
				Global target (Industrial + Household waste)				50%

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Minimum recycling rates

GERMANY	2000		Amount of waste	Optimised recycling/reuse target		Amount of waste to be recycled
	Material	**Application**		Low packaging amount	High packaging amount	
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	870			301
		LDPE films	384	0%	55%	202
		Other	486	0%	21%	98
	Wood		1,969	0%	50%	935
	Steel		654	0%	80%	497
	Cardboard		4,350	0%	64%	2,645
	glass		88	0%	50%	42
	Other		0	0%	0%	0
Total			7,930			4,419
		Global Target Industrial waste				56%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				16%	10%	44%	30%	
	Plastics		628					130
		PET bottles	100	70%	35%	59%	59%	58
		LPDE films	175	0%	0%	0%	0%	0
		HDPE bottles	152	57%	28%	48%	48%	72
		other	201	0%	0%	0%	0%	0
	Steel		358	15%	80%	40%	80%	187
	aluminium	total	62					11
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	978	61%	61%	55%	55%	553
	composites	liquid beverage cartons	209	0%	0%	0%	0%	0
		mainly based on plastic	32	0%	0%	0%	0%	0
		mainly based on cardboard	48	0%	0%	0%	0%	0
		mainly based on Aluminium	26	0%	0%	0%	0%	0
	Glass		3,512	73%	73%	42%	42%	1,758
	Other		14	0%	0%	0%	0%	0
Total			5,867					2,638
	Global Target Household waste							45%

Total			13,798					7,058
				Global target (Industrial + Household waste)				51%

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Minimum recycling rates

GREECE	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	Application	waste	Low packaging amount	High packaging amount	to be recycled
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	129.4			35
		LDPE films	27.8	0%	55%	15
		Other	101.6	0%	21%	21
	Wood		38.3	0%	50%	18
	Steel		107.8	0%	80%	82
	Cardboard		402.7	0%	64%	245
	glass		118.1	0%	50%	56
	Other		21.6	0%	0%	0
Total			818			436
		Global Target Industrial waste				53%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				41%	0%	59%	0%	
	Plastics		232					33
		PET bottles	35	70%	35%	59%	59%	22
		LPDE films	25	0%	0%	0%	0%	0
		HDPE bottles	21	57%	28%	48%	48%	11
		other	152	0%	0%	0%	0%	0
	Steel		87	15%	80%	40%	80%	26
	aluminium	total	14					4
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	302	61%	61%	55%	55%	174
	composites	liquid beverage cartons	25	0%	0%	0%	0%	0
		mainly based on plastic	4	0%	0%	0%	0%	0
		mainly based on cardboard	6	0%	0%	0%	0%	0
		mainly based on Aluminium	3	0%	0%	0%	0%	0
	Glass		145	73%	73%	42%	42%	79
	Other		0	0%	0%	0%	0%	0
Total			818					316
	Global Target Household waste							39%

Total			1,635					752
				Global target (Industrial + Household waste)				46%

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Minimum recycling rates

IRELAND	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	52			15
		LDPE films	13	0%	55%	7
		Other	39	0%	21%	8
	Wood		0	0%	50%	0
	Steel		10	0%	80%	8
	Cardboard		242	0%	64%	147
	glass		52	0%	50%	25
	Other		31	0%	0%	0
Total			387			194
		Global Target Industrial waste				50%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		**High**		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				49%	2%	48%	1%	
	Plastics		117					12
		PET bottles	11	70%	35%	59%	59%	7
		LPDE films	11	0%	0%	0%	0%	0
		HDPE bottles	9	57%	28%	48%	48%	5
		other	86	0%	0%	0%	0%	0
	Steel		21	15%	80%	40%	80%	6
	aluminium	total	8					1
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	50	61%	61%	55%	55%	29
	composites	liquid beverage cartons	8	0%	0%	0%	0%	0
		mainly based on plastic	1	0%	0%	0%	0%	0
		mainly based on cardboard	2	0%	0%	0%	0%	0
		mainly based on Aluminium	1	0%	0%	0%	0%	0
	Glass		59	73%	73%	42%	42%	34
	Other		32	0%	0%	0%	0%	0
Total			300					82
	Global Target Household waste							27%

Total			687					276
				Global target (Industrial + Household waste)				40%

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Minimum recycling rates

ITALY	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	Application	waste	Low packaging amount	High packaging amount	to be recycled
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	591			204
		LDPE films	261	0%	55%	137
		Other	330	0%	21%	67
	Wood		2,295	0%	50%	1,090
	Steel		223	0%	80%	170
	Cardboard		2,875	0%	64%	1,748
	glass		60	0%	50%	28
	Other		0	0%	0%	0
Total			6,043			3,240
		Global Target Industrial waste				54%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				26%	2%	66%	6%	
	Plastics		1,309					368
		PET bottles	426	70%	35%	59%	59%	261
		LPDE films	248	0%	0%	0%	0%	0
		HDPE bottles	215	57%	28%	48%	48%	107
		other	420	0%	0%	0%	0%	0
	Steel		247	15%	80%	40%	80%	91
	aluminium	total	57					10
	Wood		109	0%	0%	0%	0%	0
	Cardboard	total	1,300	61%	61%	55%	55%	737
	composites	liquid beverage cartons	10	0%	0%	0%	0%	0
		mainly based on plastic	2	0%	0%	0%	0%	0
		mainly based on cardboard	2	0%	0%	0%	0%	0
		mainly based on Aluminium	1	0%	0%	0%	0%	0
	Glass		2,189	73%	73%	42%	42%	1,110
	Other		0	0%	0%	0%	0%	0
Total			5,227					2,316
	Global Target Household waste							44%

Total			11,270					5,556
				Global target (Industrial + Household waste)				49%

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max

Minimum recycling rates

LUXEMBOURG	2000		Amount of waste	Optimised recycling/reuse target		Amount of waste to be recycled
	Material	Application		Low packaging amount	High packaging amount	
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	5			2
		LDPE films	2	0%	55%	1
		Other	3	0%	21%	1
	Wood		9	0%	50%	4
	Steel		3	0%	80%	2
	Cardboard		19	0%	64%	12
	glass		0	0%	50%	0
	Other		1	0%	0%	0
Total			36			20
		Global Target Industrial waste				54%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				10%	24%	20%	46%	
	Plastics		7					1
		PET bottles	2	70%	35%	59%	59%	1
		LPDE films	2	0%	0%	0%	0%	0
		HDPE bottles	1	57%	28%	48%	48%	0
		other	2	0%	0%	0%	0%	0
	Steel		2	15%	80%	40%	80%	1
	aluminium	total	0.5					0
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	11	61%	61%	55%	55%	7
	composites	liquid beverage cartons	1	0%	0%	0%	0%	0
		mainly based on plastic	0	0%	0%	0%	0%	0
		mainly based on cardboard	0	0%	0%	0%	0%	0
		mainly based on Aluminium	1	0%	0%	0%	0%	0
	Glass		17	73%	73%	42%	42%	9
	Other		0	0%	0%	0%	0%	0
Total			40					19
							Global Target Household waste	46%

Total			77					38
							Global target (Industrial + Household waste)	50%

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Minimum recycling rates

NL	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	256			82
		LDPE films	92	0%	55%	49
		Other	164	0%	21%	33
	Wood		379	0%	50%	180
	Steel		118	0%	80%	90
	Cardboard		1,128	0%	64%	686
	glass		23	0%	50%	11
	Other		0	0%	0%	0
Total			1,905			1,049
		Global Target Industrial waste				55%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		**High**		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				6%	6%	44%	44%	
	Plastics		235					63
		PET bottles	67	70%	35%	59%	59%	39
		LPDE films	59	0%	0%	0%	0%	0
		HDPE bottles	51	57%	28%	48%	48%	24
		other	58	0%	0%	0%	0%	0
	Steel		92	15%	80%	40%	80%	54
	aluminium	total	10.4					3
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	447	61%	61%	55%	55%	249
	composites	liquid beverage cartons	47	0%	0%	0%	0%	0
		mainly based on plastic	7	0%	0%	0%	0%	0
		mainly based on cardboard	11	0%	0%	0%	0%	0
		mainly based on Aluminium	6	0%	0%	0%	0%	0
	Glass		436	73%	73%	42%	42%	200
	Other		0	0%	0%	0%	0%	0
Total			1,291					569
	Global Target Household waste							44%

Total			3,196					1,618
				Global target (Industrial + Household waste)				51%

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Minimum recycling rates

PORTUGAL	2000		Amount of waste	Optimised recycling/reuse target		Amount of waste to be recycled
	Material	Application		Low packaging amount	High packaging amount	
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	24			13
		LDPE films	24	0%	55%	13
		Other	0	0%	21%	0
	Wood		7	0%	50%	3
	Steel		20	0%	80%	15
	Cardboard		75	0%	64%	45
	glass		22	0%	50%	10
	Other		4	0%	0%	0
Total			152			87
				Global Target Industrial waste		57%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				36%	4%	55%	5%	
	Plastics		289					104
		PET bottles	106	70%	35%	59%	59%	66
		LPDE films	98	0%	0%	0%	0%	0
		HDPE bottles	75	57%	28%	48%	48%	38
		other	10	0%	0%	0%	0%	0
	Steel		81	15%	80%	40%	80%	28
	aluminium	total	14.6					2
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	198	61%	61%	55%	55%	114
	composites	liquid beverage cartons	12	0%	0%	0%	0%	0
		mainly based on plastic	2	0%	0%	0%	0%	0
		mainly based on cardboard	3	0%	0%	0%	0%	0
		mainly based on Aluminium	2	0%	0%	0%	0%	0
	Glass		314	73%	73%	42%	42%	171
	Other		0	0%	0%	0%	0%	0
Total			915					418
	Global Target Household waste							46%

Total			1,067					505
				Global target (Industrial + Household waste)				47%

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Minimum recycling rates

SPAIN	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	411			123
		LDPE films	125	0%	55%	66
		Other	286	0%	21%	58
	Wood		443	0%	50%	211
	Steel		43	0%	80%	33
	Cardboard		1,627	0%	64%	989
	glass		0	0%	50%	0
	Other		177	0%	0%	0
Total			2,702			1,356
		Global Target Industrial waste				50%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				51%	4%	42%	3%	
	Plastics		601					160
		PET bottles	159	70%	35%	59%	59%	101
		LPDE films	130	0%	0%	0%	0%	0
		HDPE bottles	112	57%	28%	48%	48%	58
		other	200	0%	0%	0%	0%	0
	Steel		235	15%	80%	40%	80%	71
	aluminium	total	41.5					9
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	828	61%	61%	55%	55%	483
	composites	liquid beverage cartons	117	0%	0%	0%	0%	0
		mainly based on plastic	18	0%	0%	0%	0%	0
		mainly based on cardboard	27	0%	0%	0%	0%	0
		mainly based on Aluminium	15	0%	0%	0%	0%	0
	Glass		1,523	73%	73%	42%	42%	899
	Other		19	0%	0%	0%	0%	0
Total			3,423					1,621
	Global Target Household waste							47%

Total			6,125					2,977
				Global target (Industrial + Household waste)				49%

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Minimum recycling rates

SWEDEN	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	40			14
		LDPE films	19	0%	55%	10
		Other	21	0%	21%	4
	Wood		0	0%	50%	0
	Steel		53	0%	80%	40
	Cardboard		370	0%	64%	225
	glass		60	0%	50%	28
	Other		0	0%	0%	0
Total			523			308
		Global Target Industrial waste				59%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				26%	47%	9%	18%	
	Plastics		94					19
		PET bottles	19	70%	35%	59%	59%	10
		LPDE films	25	0%	0%	0%	0%	0
		HDPE bottles	22	57%	28%	48%	48%	9
		other	27	0%	0%	0%	0%	0
	Steel		9	15%	80%	40%	80%	6
	aluminium	total	7.5					5
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	150	61%	61%	55%	55%	89
	composites	liquid beverage cartons	40	0%	0%	0%	0%	0
		mainly based on plastic	6	0%	0%	0%	0%	0
		mainly based on cardboard	9	0%	0%	0%	0%	0
		mainly based on Aluminium	5	0%	0%	0%	0%	0
	Glass		111	73%	73%	42%	42%	72
	Other		0	0%	0%	0%	0%	0
Total			433					190
						Global Target Household waste		44%

Total			956					498
				Global target (Industrial + Household waste)				52%

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Minimum recycling rates

UK	2000		Amount of waste	Optimised recycling/reuse target		Amount of waste to be recycled
	Material	**Application**		Low packaging amount	High packaging amount	
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	587			207
		LDPE films	273	0%	55%	144
		Other	314	0%	21%	64
	Wood		670	0%	50%	318
	Steel		217	0%	80%	165
	Cardboard		3,373	0%	64%	2,051
	glass		350	0%	50%	166
	Other		40	0%	0%	0
Total			5,237			2,907
		Global Target Industrial waste				56%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		**High**		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				13%	3%	69%	15%	
	Plastics		1,084					240
		PET bottles	252	70%	35%	59%	59%	151
		LPDE films	190	0%	0%	0%	0%	0
		HDPE bottles	183	57%	28%	48%	48%	89
		other	459	0%	0%	0%	0%	0
	Steel		533	15%	80%	40%	80%	234
	aluminium	total	108.0					30
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	420	61%	61%	55%	55%	235
	composites	liquid beverage cartons	51	0%	0%	0%	0%	0
		mainly based on plastic	7	0%	0%	0%	0%	0
		mainly based on cardboard	11	0%	0%	0%	0%	0
		mainly based on Aluminium	6	0%	0%	0%	0%	0
	Glass		1,848	73%	73%	42%	42%	868
	Other		0	0%	0%	0%	0%	0
Total			4,068					1,606
	Global Target Household waste							39%

Total			9,305					4,513
				Global target (Industrial + Household waste)				49%

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Minimum recycling rates

EU	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	4,018			1,348
		LDPE films	1,651	0%	55%	869
		Other	2,367	0%	21%	479
	Wood		7,812	0%	50%	3,711
	Steel		1,818	0%	80%	1,382
	Cardboard		18,823	0%	64%	11,444
	glass		1,789	0%	50%	850
	Other		289	0%	0%	0
Total			34,549			18,735
		Global Target Industrial waste				54%

				Percentage of population living in				
				areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				27%	12%	41%	20%	
	Plastics		5,871					1,374
		PET bottles	1,502	70%	35%	59%	59%	887
		LPDE films	1,205	0%	0%	0%	0%	0
		HDPE bottles	1,015	57%	28%	48%	48%	487
		other	2,150	0%	0%	0%	0%	0
	Steel		2,214	15%	80%	40%	80%	1,022
	aluminium	total	391.6					96
		cans	140	31%	76%	45%	76%	72
		other rigid and semi-rigid	131	0%	50%	6%	50%	24
		flexible	121	0%	0%	0%	0%	0
	Wood		128	0%	0%	0%	0%	0
	Cardboard	total	5,947	61%	61%	55%	55%	3,411
	composites	liquid beverage cartons	710	0%	0%	0%	0%	0
		mainly based on plastic	109	0%	0%	0%	0%	0
		mainly based on cardboard	165	0%	0%	0%	0%	0
		mainly based on Aluminium	86	0%	0%	0%	0%	0
	Glass		13,445	73%	73%	42%	42%	7,288
	Other		65	0%	0%	0%	0%	0
Total			29,132					13,191
	Global Target Household waste							45%

Total			63,681					31,926
				Global target (Industrial + Household waste)				50%

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Maximum recycling rates

AUSTRIA	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	75			47
		LDPE films	55	0%	75%	39
		Other	20	0%	41%	8
	Wood		60	0%	70%	40
	Steel		4	0%	90%	3
	Cardboard		384	0%	80%	292
	glass		47	0%	83%	37
	Other		0	0%	0%	0
Total			570			420
		Global Target Industrial waste				74%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				47%	0%	37%	16%	
	Plastics		112					30
		PET bottles	20	80%	45%	69%	69%	15
		LPDE films	24	0%	0%	0%	0%	0
		HDPE bottles	24	67%	38%	58%	58%	15
		other	44	0%	0%	0%	0%	0
	Steel		69	60%	80%	60%	80%	43
	aluminium	total	9					3
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	98	71%	71%	65%	65%	66
	composites	liquid beverage cartons	23	0%	0%	0%	0%	0
		mainly based on plastic	4	0%	0%	0%	0%	0
		mainly based on cardboard	5	0%	0%	0%	0%	0
		mainly based on Aluminium	3	0%	0%	0%	0%	0
	Glass		183	83%	83%	91%	91%	160
	Other		0	0%	0%	0%	0%	0
Total			506					302
	Global Target Household waste							60%

Total			1,076					722
				Global target (Industrial + Household waste)				67%

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Maximum recycling rates

Belgium	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	Application	waste	Low packaging amount	High packaging amount	to be recycled
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	91			49
		LDPE films	42	0%	75%	30
		Other	49	0%	41%	19
	Wood		168	0%	70%	112
	Steel		56	0%	90%	48
	Cardboard		371	0%	80%	282
	glass		4	0%	83%	3
	Other		14	0%	0%	0
Total			704			494
		Global Target Industrial waste				70%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				7%	7%	43%	43%	
	Plastics		162					40
		PET bottles	44	80%	45%	69%	69%	30
		LPDE films	43	0%	0%	0%	0%	0
		HDPE bottles	18	67%	38%	58%	58%	10
		other	57	0%	0%	0%	0%	0
	Steel		80	60%	80%	60%	80%	56
	aluminium	total	14					3
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	153	71%	71%	65%	65%	101
	composites	liquid beverage cartons	20	0%	0%	0%	0%	0
		mainly based on plastic	3	0%	0%	0%	0%	0
		mainly based on cardboard	5	0%	0%	0%	0%	0
		mainly based on Aluminium	2	0%	0%	0%	0%	0
	Glass		330	83%	83%	91%	91%	297
	Other		0	0%	0%	0%	0%	0
Total			768					497
	Global Target Household waste							65%

Total			1,472					991
				Global target (Industrial + Household waste)				67%

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Maximum recycling rates

DENMARK	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	109			59
		LDPE films	51	0%	75%	36
		Other	58	0%	41%	23
	Wood		84	0%	70%	56
	Steel		11	0%	90%	9
	Cardboard		314	0%	80%	239
	glass		0	0%	83%	0
	Other		0	0%	0%	0
Total			518			363
				Global Target Industrial waste		70%

				Percentage of population living in				
				areas where population density is L/H and waste are I/L				
				Low		**High**		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				0%	66%	0%	34%	
	Plastics		63					40
		PET bottles	5	80%	45%	69%	69%	3
		LPDE films	20	0%	0%	0%	0%	0
		HDPE food bottles	17	67%	38%	58%	58%	8
		other	21	0%	0%	0%	0%	0
	Steel		37	60%	80%	60%	80%	30
	aluminium	total	7					2
	Wood		9	0%	0%	0%	0%	0
	Cardboard	total	121	71%	71%	65%	65%	83
	composites	liquid beverage cartons	0	0%	0%	0%	0%	0
		mainly based on plastic	1	0%	0%	0%	0%	0
		mainly based on cardboard	1	0%	0%	0%	0%	0
		mainly based on Aluminium	1	0%	0%	0%	0%	0
	Glass		176	83%	83%	91%	91%	151
	Other		0	0%	0%	0%	0%	0
Total			416					276
	Global Target Household waste							66%

Total			934					639
				Global target (Industrial + Household waste)				68%

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Maximum recycling rates

FINLAND	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	Application	waste	Low packaging amount	High packaging amount	to be recycled
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	48			26
		LDPE films	22	0%	75%	16
		other	26	0%	41%	10
	Wood		0	0%	70%	0
	Steel		18	0%	90%	15
	Cardboard		192	0%	80%	146
	glass		6	0%	83%	4
	Other		0	0%	0%	0
Total			264			192
		Global Target Industrial waste				73%

				Percentage of population living in areas where population density is L/H and waste are l/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				58%	0%	40%	2%	
	Plastics		37					13
		PET bottles	6	80%	45%	69%	69%	4
		LPDE films	17	0%	0%	0%	0%	0
		HDPE bottles	15	67%	38%	58%	58%	9
		other	0	0%	0%	0%	0%	0
	Steel		14	60%	80%	60%	80%	9
	aluminium	total	2					1
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	18	71%	71%	65%	65%	12
	composites	liquid beverage cartons	29	0%	0%	0%	0%	0
		mainly based on plastic	4	0%	0%	0%	0%	0
		mainly based on cardboard	7	0%	0%	0%	0%	0
		mainly based on Aluminium	0	0%	0%	0%	0%	0
	Glass		50	83%	83%	91%	91%	43
	Other		0	0%	0%	0%	0%	0
Total			162					78
	Global Target Household waste							48%

Total			425					270
				Global target (Industrial + Household waste)				63%

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Maximum recycling rates

FRANCE	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	730			371
		LDPE films	260	0%	75%	186
		Other	470	0%	41%	184
	Wood		1,690	0%	70%	1,124
	Steel		280	0%	90%	239
	Cardboard		3,100	0%	80%	2,356
	glass		960	0%	83%	757
	Other		0	0%	0%	0
Total			6,760			4,847
		Global Target Industrial waste				72%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				22%	8%	32%	39%	
	Plastics		902					232
		PET bottles	250	80%	45%	69%	69%	173
		LPDE films	140	0%	0%	0%	0%	0
		HDPE bottles	100	67%	38%	58%	58%	58
		other	412	0%	0%	0%	0%	0
	Steel		350	60%	80%	60%	80%	243
	aluminium	total	36					10
	Wood		10	0%	0%	0%	0%	0
	Cardboard	total	872	71%	71%	65%	65%	583
	composites	liquid beverage cartons	120	0%	0%	0%	0%	0
		mainly based on plastic	18	0%	0%	0%	0%	0
		mainly based on cardboard	28	0%	0%	0%	0%	0
		mainly based on Aluminium	15	0%	0%	0%	0%	0
	Glass		2,550	83%	83%	91%	91%	2,259
	Other		0	0%	0%	0%	0%	0
Total			4,901					3,326
	Global Target Household waste							68%

Total			11,661					8,173
				Global target (Industrial + Household waste)				70%

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Maximum recycling rates

GERMANY	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	870			466
		LDPE films	384	0%	75%	275
		Other	486	0%	41%	191
	Wood		1,969	0%	70%	1,309
	Steel		654	0%	90%	559
	Cardboard		4,350	0%	80%	3,306
	glass		88	0%	83%	69
	Other		0	0%	0%	0
Total			7,930			5,709
		Global Target Industrial waste				72%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		**High**		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				16%	10%	44%	30%	
	Plastics		628					155
		PET bottles	100	80%	45%	69%	69%	68
		LPDE films	175	0%	0%	0%	0%	0
		HDPE bottles	152	67%	38%	58%	58%	87
		other	201	0%	0%	0%	0%	0
	Steel		358	60%	80%	60%	80%	244
	aluminium	total	62					13
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	978	71%	71%	65%	65%	651
	composites	liquid beverage cartons	209	0%	0%	0%	0%	0
		mainly based on plastic	32	0%	0%	0%	0%	0
		mainly based on cardboard	48	0%	0%	0%	0%	0
		mainly based on Aluminium	26	0%	0%	0%	0%	0
	Glass		3,512	83%	83%	91%	91%	3,123
	Other		14	0%	0%	0%	0%	0
Total			5,867					4,186
	Global Target Household waste							71%

Total			13,798					9,895
				Global target (Industrial + Household waste)				72%

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Maximum recycling rates

GREECE	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	Application	waste	Low packaging amount	High packaging amount	to be recycled
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	129.4			60
		LDPE films	27.8	0%	75%	20
		Other	101.6	0%	41%	40
	Wood		38.3	0%	70%	25
	Steel		107.8	0%	90%	92
	Cardboard		402.7	0%	80%	306
	glass		118.1	0%	83%	93
	Other		21.6	0%	0%	0
Total			818			576
		Global Target Industrial waste				70%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				41%	0%	59%	0%	
	Plastics		232					39
		PET bottles	35	80%	45%	69%	69%	25
		LPDE films	25	0%	0%	0%	0%	0
		HDPE bottles	21	67%	38%	58%	58%	13
		other	152	0%	0%	0%	0%	0
	Steel		87	60%	80%	60%	80%	52
	aluminium	total	14					6
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	302	71%	71%	65%	65%	204
	composites	liquid beverage cartons	25	0%	0%	0%	0%	0
		mainly based on plastic	4	0%	0%	0%	0%	0
		mainly based on cardboard	6	0%	0%	0%	0%	0
		mainly based on Aluminium	3	0%	0%	0%	0%	0
	Glass		145	83%	83%	91%	91%	127
	Other		0	0%	0%	0%	0%	0
Total			818					428
	Global Target Household waste							52%

Total			1,635					1,004
				Global target (Industrial + Household waste)				61%

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Maximum recycling rates

IRELAND	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	52			25
		LDPE films	13	0%	75%	9
		Other	39	0%	41%	15
	Wood		0	0%	70%	0
	Steel		10	0%	90%	8
	Cardboard		242	0%	80%	184
	glass		52	0%	83%	41
	Other		31	0%	0%	0
Total			387			258
		Global Target Industrial waste				67%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				49%	2%	48%	1%	
	Plastics		117					14
		PET bottles	11	80%	45%	69%	69%	8
		LPDE films	11	0%	0%	0%	0%	0
		HDPE bottles	9	67%	38%	58%	58%	6
		other	86	0%	0%	0%	0%	0
	Steel		21	60%	80%	60%	80%	13
	aluminium	total	8					2
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	50	71%	71%	65%	65%	34
	composites	liquid beverage cartons	8	0%	0%	0%	0%	0
		mainly based on plastic	1	0%	0%	0%	0%	0
		mainly based on cardboard	2	0%	0%	0%	0%	0
		mainly based on Aluminium	1	0%	0%	0%	0%	0
	Glass		59	83%	83%	91%	91%	51
	Other		32	0%	0%	0%	0%	0
Total			300					114
	Global Target Household waste							38%

Total			687					372
				Global target (Industrial + Household waste)				54%

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Maximum recycling rates

ITALY	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	591			316
		LDPE films	261	0%	75%	187
		Other	330	0%	41%	130
	Wood		2,295	0%	70%	1,526
	Steel		223	0%	90%	191
	Cardboard		2,875	0%	80%	2,185
	glass		60	0%	83%	47
	Other		0	0%	0%	0
Total			6,043			4,265
		Global Target Industrial waste				71%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				26%	2%	66%	6%	
	Plastics		1,309					432
		PET bottles	426	80%	45%	69%	69%	304
		LPDE films	248	0%	0%	0%	0%	0
		HDPE bottles	215	67%	38%	58%	58%	129
		other	420	0%	0%	0%	0%	0
	Steel		247	60%	80%	60%	80%	152
	aluminium	total	57					15
	Wood		109	0%	0%	0%	0%	0
	Cardboard	total	1,300	71%	71%	65%	65%	867
	composites	liquid beverage cartons	10	0%	0%	0%	0%	0
		mainly based on plastic	2	0%	0%	0%	0%	0
		mainly based on cardboard	2	0%	0%	0%	0%	0
		mainly based on Aluminium	1	0%	0%	0%	0%	0
	Glass		2,189	83%	83%	91%	91%	1,943
	Other		0	0%	0%	0%	0%	0
Total			5,227					3,409
	Global Target Household waste							65%

Total			11,270					7,674
				Global target (Industrial + Household waste)				68%

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Maximum recycling rates

LUXEMBOURG	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	waste	Low packaging amount	High packaging amount	to be recycled
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	5			3
		LDPE films	2	0%	75%	2
		Other	3	0%	41%	1
	Wood		9	0%	70%	6
	Steel		3	0%	90%	2
	Cardboard		19	0%	80%	15
	glass		0	0%	83%	0
	Other		1	0%	0%	0
Total			36			26
				Global Target Industrial waste		70%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				10%	24%	20%	46%	
	Plastics		7					2
		PET bottles	2	80%	45%	69%	69%	1
		LPDE films	2	0%	0%	0%	0%	0
		HDPE bottles	1	67%	38%	58%	58%	0
		other	2	0%	0%	0%	0%	0
	Steel		2	60%	80%	60%	80%	2
	aluminium	total	0.5					0
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	11	71%	71%	65%	65%	8
	composites	liquid beverage cartons	1	0%	0%	0%	0%	0
		mainly based on plastic	0	0%	0%	0%	0%	0
		mainly based on cardboard	0	0%	0%	0%	0%	0
		mainly based on Aluminium	1	0%	0%	0%	0%	0
	Glass		17	83%	83%	91%	91%	15
	Other		0	0%	0%	0%	0%	0
Total			40					26
							Global Target Household waste	66%

Total			77					52
				Global target (Industrial + Household waste)				68%

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Maximum recycling rates

NL	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	256			130
		LDPE films	92	0%	75%	66
		Other	164	0%	41%	64
	Wood		379	0%	70%	252
	Steel		118	0%	90%	101
	Cardboard		1,128	0%	80%	858
	glass		23	0%	83%	18
	Other		0	0%	0%	0
Total			1,905			1,360
		Global Target Industrial waste				71%

				Percentage of population living in areas where population density is L/H and waste are l/L				
				Low		**High**		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				6%	6%	44%	44%	
	Plastics		235					75
		PET bottles	67	80%	45%	69%	69%	46
		LPDE films	59	0%	0%	0%	0%	0
		HDPE bottles	51	67%	38%	58%	58%	29
		other	58	0%	0%	0%	0%	0
	Steel		92	60%	80%	60%	80%	65
	aluminium	total	10.4					3
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	447	71%	71%	65%	65%	294
	composites	liquid beverage cartons	47	0%	0%	0%	0%	0
		mainly based on plastic	7	0%	0%	0%	0%	0
		mainly based on cardboard	11	0%	0%	0%	0%	0
		mainly based on Aluminium	6	0%	0%	0%	0%	0
	Glass		436	83%	83%	91%	91%	392
	Other		0	0%	0%	0%	0%	0
Total			1,291					829
	Global Target Household waste							64%

Total			3,196					2,188
				Global target (Industrial + Household waste)				68%

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data in red are the results of this study
data in green is calculated based on blue and red data

Maximum recycling rates

PORTUGAL	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	Application	waste	Low packaging amount	High packaging amount	to be recycled
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	24			17
		LDPE films	24	0%	75%	17
		Other	0	0%	41%	0
	Wood		7	0%	70%	5
	Steel		20	0%	90%	17
	Cardboard		75	0%	80%	57
	glass		22	0%	83%	17
	Other		4	0%	0%	0
Total			152			113
		Global Target Industrial waste				75%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				36%	4%	55%	5%	
	Plastics		289					122
		PET bottles	106	80%	45%	69%	69%	76
		LPDE films	98	0%	0%	0%	0%	0
		HDPE bottles	75	67%	38%	58%	58%	45
		other	10	0%	0%	0%	0%	0
	Steel		81	60%	80%	60%	80%	50
	aluminium	total	14.6					3
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	198	71%	71%	65%	65%	133
	composites	liquid beverage cartons	12	0%	0%	0%	0%	0
		mainly based on plastic	2	0%	0%	0%	0%	0
		mainly based on cardboard	3	0%	0%	0%	0%	0
		mainly based on Aluminium	2	0%	0%	0%	0%	0
	Glass		314	83%	83%	91%	91%	276
	Other		0	0%	0%	0%	0%	0
Total			915					584
						Global Target Household waste		64%

Total			1,067					697
						Global target (Industrial + Household waste)		65%

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Maximum recycling rates

SPAIN	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	411			201
		LDPE films	125	0%	75%	89
		Other	286	0%	41%	112
	Wood		443	0%	70%	295
	Steel		43	0%	90%	37
	Cardboard		1,627	0%	80%	1,236
	glass		0	0%	83%	0
	Other		177	0%	0%	0
Total			2,702			1,770
		Global Target Industrial waste				66%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		**High**		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				51%	4%	42%	3%	
	Plastics		601					187
		PET bottles	159	80%	45%	69%	69%	117
		LPDE films	130	0%	0%	0%	0%	0
		HDPE bottles	112	67%	38%	58%	58%	70
		other	200	0%	0%	0%	0%	0
	Steel		235	60%	80%	60%	80%	144
	aluminium	total	41.5					14
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	828	71%	71%	65%	65%	565
	composites	liquid beverage cartons	117	0%	0%	0%	0%	0
		mainly based on plastic	18	0%	0%	0%	0%	0
		mainly based on cardboard	27	0%	0%	0%	0%	0
		mainly based on Aluminium	15	0%	0%	0%	0%	0
	Glass		1,523	83%	83%	91%	91%	1,319
	Other		19	0%	0%	0%	0%	0
Total			3,423					2,229
	Global Target Household waste							65%

Total			6,125					3,999
				Global target (Industrial + Household waste)				65%

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Maximum recycling rates

SWEDEN	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	40			22
		LDPE films	19	0%	75%	13
		Other	21	0%	41%	8
	Wood		0	0%	70%	0
	Steel		53	0%	90%	45
	Cardboard		370	0%	80%	281
	glass		60	0%	83%	47
	Other		0	0%	0%	0
Total			523			395
		Global Target Industrial waste				76%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				26%	47%	9%	18%	
	Plastics		94					23
		PET bottles	19	80%	45%	69%	69%	12
		LPDE films	25	0%	0%	0%	0%	0
		HDPE bottles	22	67%	38%	58%	58%	11
		other	27	0%	0%	0%	0%	0
	Steel		9	60%	80%	60%	80%	7
	aluminium	total	7.5					5
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	150	71%	71%	65%	65%	104
	composites	liquid beverage cartons	40	0%	0%	0%	0%	0
		mainly based on plastic	6	0%	0%	0%	0%	0
		mainly based on cardboard	9	0%	0%	0%	0%	0
		mainly based on Aluminium	5	0%	0%	0%	0%	0
	Glass		111	83%	83%	91%	91%	95
	Other		0	0%	0%	0%	0%	0
Total			433					234
	Global Target Household waste							54%

Total			956					629
				Global target (Industrial + Household waste)				66%

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data in green is calculated based on blue and red data

Maximum recycling rates

UK	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	**Application**	**waste**	Low packaging amount	High packaging amount	**to be recycled**
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	587			319
		LDPE films	273	0%	75%	196
		Other	314	0%	41%	123
	Wood		670	0%	70%	446
	Steel		217	0%	90%	186
	Cardboard		3,373	0%	80%	2,563
	glass		350	0%	83%	276
	Other		40	0%	0%	0
Total			5,237			3,789
		Global Target Industrial waste				72%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	**Inc.**	**landfill**	**Inc.**	
Household waste				13%	3%	69%	15%	
	Plastics		1,084					283
		PET bottles	252	80%	45%	69%	69%	176
		LPDE films	190	0%	0%	0%	0%	0
		HDPE bottles	183	67%	38%	58%	58%	107
		other	459	0%	0%	0%	0%	0
	Steel		533	60%	80%	60%	80%	339
	aluminium	total	108.0					37
	Wood		0	0%	0%	0%	0%	0
	Cardboard	total	420	71%	71%	65%	65%	277
	composites	liquid beverage cartons	51	0%	0%	0%	0%	0
		mainly based on plastic	7	0%	0%	0%	0%	0
		mainly based on cardboard	11	0%	0%	0%	0%	0
		mainly based on Aluminium	6	0%	0%	0%	0%	0
	Glass		1,848	83%	83%	91%	91%	1,658
	Other		0	0%	0%	0%	0%	0
Total			4,068					2,594
	Global Target Household waste							64%

Total			9,305					6,384
				Global target (Industrial + Household waste)				69%

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data in red are the results of this study
data in green is calculated based on blue and red data

Maximum recycling rates

EU	2000		Amount of	Optimised recycling/reuse target		Amount of waste
	Material	Application	waste	Low packaging amount	High packaging amount	to be recycled
Industrial waste			1000 t/year	5%	95%	1000 t/year
	Plastics	Total	4,018			2,111
		LDPE films	1,651	0%	75%	1,182
		Other	2,367	0%	41%	929
	Wood		7,812	0%	70%	5,195
	Steel		1,818	0%	90%	1,555
	Cardboard		18,823	0%	80%	14,306
	glass		1,789	0%	83%	1,411
	Other		289	0%	0%	0
Total			34,549			24,577
		Global Target Industrial waste				71%

				Percentage of population living in areas where population density is L/H and waste are I/L				
				Low		High		
				landfill	Inc.	landfill	Inc.	
Household waste				27%	12%	41%	20%	
	Plastics		5,871					1,626
		PET bottles	1,502	80%	45%	69%	69%	1,037
		LPDE films	1,205	0%	0%	0%	0%	0
		HDPE bottles	1,015	67%	38%	58%	58%	589
		other	2,150	0%	0%	0%	0%	0
	Steel		2,214	60%	80%	60%	80%	1,472
	aluminium	total	391.6					122
	Wood		128	0%	0%	0%	0%	0
	Cardboard	total	5,947	71%	71%	65%	65%	4,006
	composites	liquid beverage cartons	710	0%	0%	0%	0%	0
		mainly based on plastic	109	0%	0%	0%	0%	0
		mainly based on cardboard	165	0%	0%	0%	0%	0
		mainly based on Aluminium	86	0%	0%	0%	0%	0
	Glass		13,445	83%	83%	91%	91%	11,811
	Other		65	0%	0%	0%	0%	0
Total			29,132					19,036
	Global Target Household waste							65%

Total			63,681					43,613
				Global target (Industrial + Household waste)				68%

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data in red are the results of this study
data in green is calculated based on blue and red data

Annex 12: Presentation of the CBA results (reuse)

Refillable and single trip PET beverage bottles from household sources

Scenarios considered

In order to investigate the costs and benefits of different types of PET beverage bottles, the delivery of 1000 litres of product to the consumer is compared for non-refillable (or "single trip") and refillable bottles. The analysis relates to 1.5 litre bottles. The weight of a refillable bottle is assumed to be 0.084 kg[1]. The weight of a single trip bottle is assumed to be 0.039 kg[2].

It is assumed that costs and burdens of transport will increase linearly as distance between filler and end market increases (i.e. same transport system whatever the distance). In order to compare the costs and benefits of single trip and refillables over a range of distances, eight wide-ranging scenarios have been modelled. These are listed in Table 1:

Table 1: Scenarios considered for single trip and refillable PET beverage bottles

Scenario	Distance to market*	Number of uses	Recycling rate
Reuse Scenario 1	0km	5 (i.e. every 6th bottle is new)	
Reuse Scenario 2	1800km	5 (i.e. every 6th bottle is new)	
Reuse Scenario 3	0km	20 (i.e. every 21st bottle is new)	
Reuse Scenario 4	1800km	20 (i.e. every 21st bottle is new)	
Single trip scenario 1	0km		20%
Single trip scenario 2	1800km		20%
Single trip scenario 3	0 km		80%
Single trip scenario 4	1800km		80%

*Distance to market = distance from filler to distribution centre

*Transport from distribution centre to supermarket / retail outlet is assumed to be a 100 km round trip for all scenarios

[1] *"Life Cycle Assessment of Packaging Systems for Beer and Soft Drinks, Disposable PET Bottles",* Danish Environmental Protection Agency, 1998

The following assumptions have been made in order to simplify the analysis:

- The common elements between the reusable and single trip bottles have been ignored. These include caps, labels,…
- The tertiary packaging (pallet, wrap film) has been neglected.
- Returnable bottles are assumed to be packed in reusable crates (99,4% reuse)
- Single trip bottles are packed in cartonboard trays with plastic film overwrap (100% to recycling)
- For single trip PET bottles, the portion that is not recycled is split evenly between landfill and incineration

Internal costs PET

The internal costs used for the analysis are listed in the table below.

Table 2 : Internal costs - PET bottles (refillable and single trip)

Costs (euro/1000l)								
Packaging material	PET	PET	PET	PET	PET	PET	PET	PET
Distance (filling to distribution)	0	1800	0	1800	0	1800	0	1800
Recycling rate	20%	20%	80%	80%	33%	33%	33%	33%
# uses	1	1	1	1	5	5	20	20
Production and filling	68.1	68.1	68.1	68.1	74.7	74.7	42.0	42.0
Transport Filling - Distribution	0.0	120.5	0.0	120.5	0.0	185.5	0.0	185.5
Transport Distribution - Supermarket	15.7	15.7	15.7	15.7	17.3	17.3	17.3	17.3
Deposit system	-	-	-	-	27.9	27.9	27.9	27.9
Transport Deposit (shops) - filling	-	-	-	-	8.2	156.6	8.2	156.6
Washing					75.9	75.9	75.9	75.9
Selective collection and recycling	2.9	2.9	11.8	11.8	2.1	2.1	0.5	0.5
Non selective collection and landfill	4.5	4.5	1.1	1.1	1.6	1.6	0.4	0.4
Non selective collection and incineration	4.1	4.1	1.0	1.0	1.5	1.5	0.4	0.4
Total internal costs	95.3	215.8	97.7	218.2	209.2	543.1	172.6	506.5

Transport cost is the principal cost for long distances. It is higher for refillable PET because there is a lower number of bottles in the truck and there is a return journey.

[2] *"Life Cycle Assessment of Packaging Systems for Beer and Soft Drinks, Disposable PET Bottles",* Danish Environmental Protection Agency, 1998

Also some other costs only exist for refillable PET: deposit system, washing. At the opposite, some costs (almost) only exist for single trip PET: recycling, incineration, landfilling.

The total internal costs are lower for single trip PET, whatever the transport distance.

Externalities PET

The external costs of each scenario are presented in the table below.

Table 3 : External costs - PET bottles (refillable and single trip)

PET bottles, 1.5l	PET	PET	PET	PET	PET	PET	PET	PET
Distance filling - distribution (km)	0	1800	0	1800	0	1800	0	1800
Recycling rate	20%	20%	80%	80%	33%	33%	33%	33%
# uses	1	1	1	1	5	5	20	20
Impacts categories								
GWP (kg CO2 eq.)	1.35	2.67	0.82	2.15	0.54	3.64	0.23	3.33
Ozone depletion (kg CFC 11 eq.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acidification (Acid equiv.)	0.27	0.35	0.15	0.23	0.10	0.29	0.03	0.22
Toxicity Carcinogens (Cd equiv)	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Toxicity Gaseous (SO2 equiv.)	0.94	1.18	0.52	0.76	0.35	0.93	0.11	0.69
Toxicity Metals non carcinogens (Pb equiv.)	0.26	0.30	0.17	0.20	0.14	0.23	0.09	0.18
Toxicity Particulates & aerosols (PM10 equiv)	48.80	68.33	31.06	50.60	18.10	64.73	7.09	53.72
Toxicity Smog (ethylene equiv.)	1.24	1.96	0.71	1.43	0.49	2.17	0.18	1.86
Black smoke (kg dust eq.)	0.67	0.97	0.39	0.69	0.25	0.95	0.09	0.79
Fertilisation	-0.40	-0.76	-0.24	-0.60	-0.16	-0.99	-0.06	-0.89
Traffic accidents (risk equiv.)	0.08	0.91	0.08	0.91	0.09	2.07	0.09	2.06
Traffic Congestion (car km equiv.)	1.93	21.53	1.91	21.51	2.12	48.79	2.08	48.75
Traffic Noise (car km equiv.)	0.13	1.47	0.13	1.47	0.15	3.34	0.14	3.34
Water Quality Eutrophication (P equiv.)	0.04	0.07	0.02	0.05	0.01	0.08	0.01	0.07
Disaminity (kg LF waste equiv.)	0.65	0.65	0.16	0.17	0.23	0.25	0.06	0.07
Total external cost	**55.97**	**99.65**	**35.89**	**79.58**	**22.42**	**126.48**	**10.13**	**114.20**

Observations

Again the external costs are very dependent on the transport distance, to a lesser extend on the recycling rate (for single trip) and only little on the number of trips (for refillables).

The sensitivity to the different factors is :

- recycling rate (delta = -20,08 € from 20% to 80%),
- number of trips (delta = -12,28 € from 5 to 20),
- transport distance (delta = +43,69 € or 104,06 € from 0 to 1800 km).

The principal environmental impacts are the emission of particulates (PM10) and, for long distances, traffic congestion.

From a purely environmental viewpoint, refillable PET is better as long as the transport distance between filler and distribution centre is lower than :

Refillable # uses	Single trip recycling%	Break even distance (km)
20	80%	770
20	20%	1370
5	80%	400
5	20%	1000

Total cost PET

The results of analysis are presented in the three graphs below. The graphs present the internal, external and total social costs (i.e. the sum of the internal and external costs) for each scenario as a function of the distance to market.

Table 4 shows the external, internal and Total Social costs (i.e. the sum of the internal and external costs) for each scenario as a function of distance to market.

Table 4 : External, Internal and Total Social costs for PET

	External	Internal	Total Social	Externa	Internal	Total Social	% internal	% internal
Distance (filling – distribution)	0	0	0	1800	1800	1800	0	1800
PET ST 1.5 20%	56	95	151	100	216	316	63%	68%
PET ST 1.5 80%	36	98	134	80	218	298	73%	73%
PET RE 1.5 33% 5U	22	209	232	127	543	670	90%	81%
PET RE 1.5 33% 20U	10	173	183	114	507	621	94%	82%

Figure 1: Internal costs – PET refills and single trip

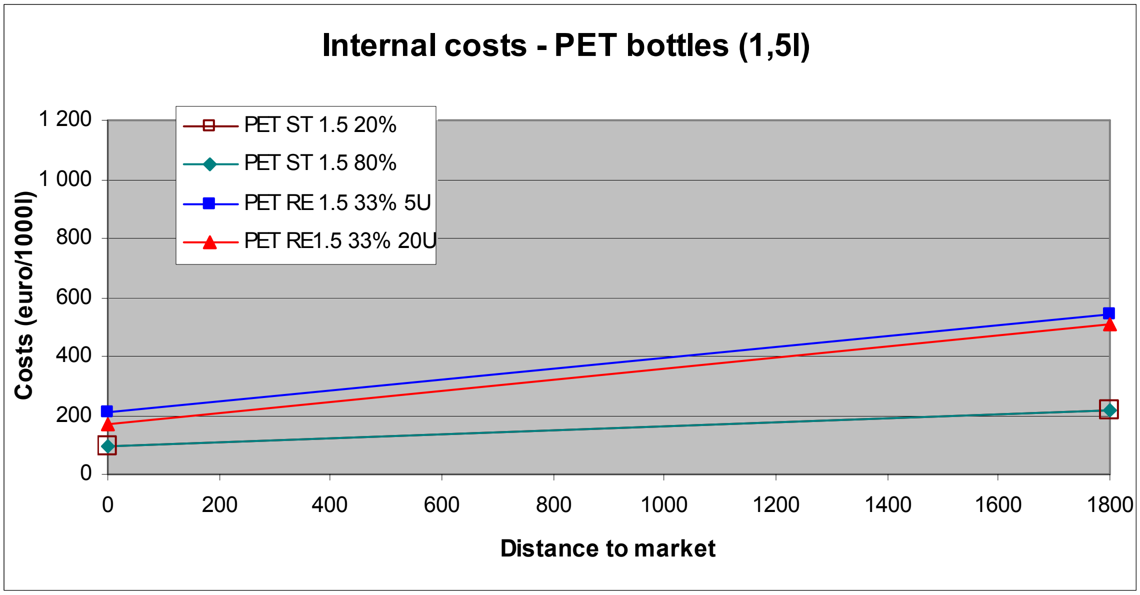


Figure 2 : External costs –PET refills and single trip

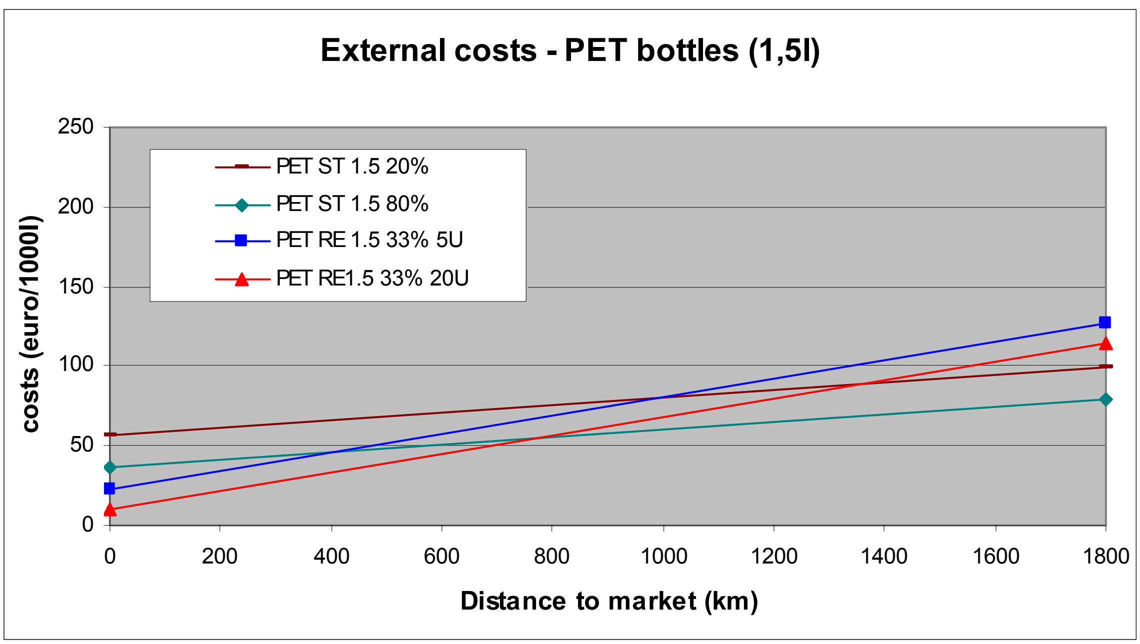
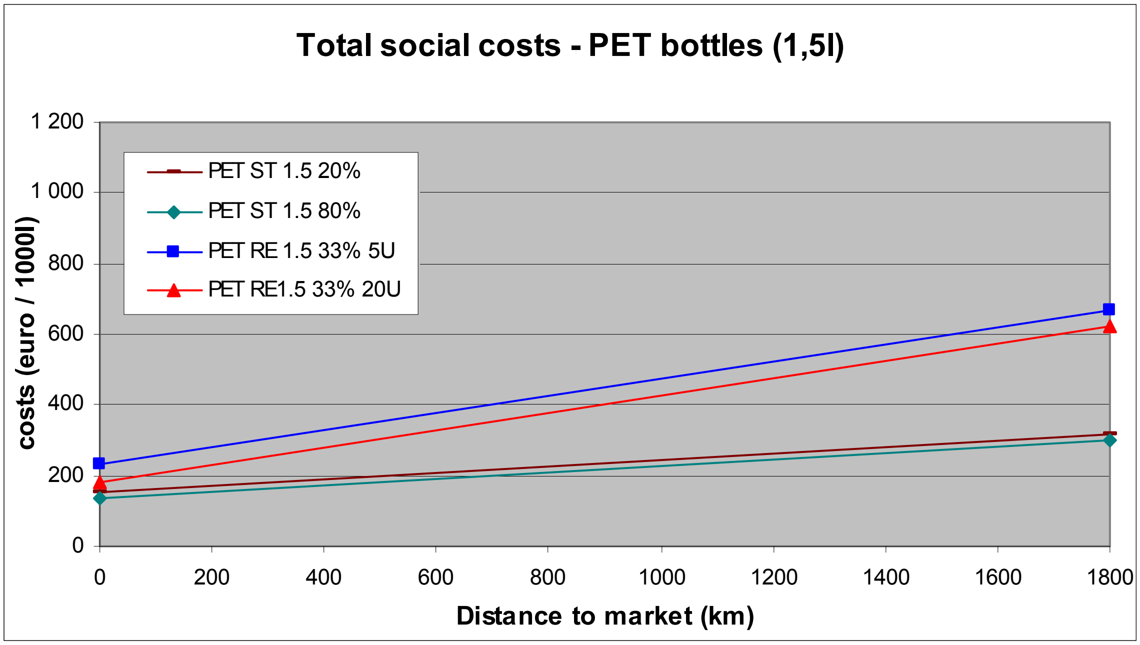


Figure 3 : Total social costs – PET refills and single trip



Conclusions PET

- Internal costs dominate the total social cost (between 63 and 94%). Single trip bottles are always cheaper
- External costs of Single trip bottles are higher for short distances and lower for long distances
- Total costs of Single trip bottles are always lower, whatever the distance and the recycling rate.

Summary of sensitivity analysis PET

The results achieved and conclusions drawn are sensitive to the economic valuations applied and the internal costs applied.

Refillable and single trip Glass beverage bottles from household source

Scenarios considered

In order to investigate the costs and benefits of different types of glass beverage bottles, the delivery of 1000 l of product to the consumer is compared for non-refillable (or "single trip") and refillable bottles. The analysis relates to 1 l bottles. The weight of a refillable bottle is assumed to be 0.50 kg, while the weight of a single trip bottle is assumed to be 0.28 kg.

It is assumed that costs and burdens of transport will increase in a linear manor as distance between filler and end market increases (i.e. same transport system whatever the distance). In order to compare the costs and benefits of single trip and refillables over a range of distances, eight wide-ranging scenarios have been modelled. These are listed in the table below:

Scenarios considered for single trip and refillable glass beverage bottles

Scenario	Distance to market*	Number of reuses	Recycling rate
Reuse Scenario 1	0km	5 (i.e. every 6th bottle is new)	
Reuse Scenario 2	1800km	5 (i.e. every 6th bottle is new)	
Reuse Scenario 3	0km	20 (i.e. every 21st bottle is new)	
Reuse Scenario 4	1800km	20 (i.e. every 21st bottle is new)	
Recycling scenario 1	0km		42%
Recycling scenario 2	1800km		42%
Recycling scenario 3	0km		91%
Recycling scenario 4	1800km		91%

*Distance to market = distance from filler to distribution centre

*Transport from distribution centre to supermarket/retail outlet is assumed to be a 100 km round trip for all scenarios

The following assumptions have been made in order to simplify the analysis:

- Common elements between the reusable and single trip bottles have been ignored. These include – the caps, labels.

- The transport packaging (pallet, wrap film) has been neglected.
- The Returnable bottles are assumed to be packed in reusable plastic crates (99.4% reuse)
- The single trip bottles are packed in Carton board trays with plastic film over wrap 100% of which goes to material recycling
- For single trip glass bottles, the portion that is not recycled is split evenly between landfill and incineration

Internal costs glass

The internal costs used for the analysis are listed in the table below.

Table 5: Internal costs - Glass bottles (refillable and single trip)

Costs (euro/1000l)								
Packaging material	Glass	Glass	Glass	Glass	Glass	Glass	Glass	Glass
Distance (filling to distribution)	0	1800	0	1800	0	1800	0	1800
Recycling rate	42%	42%	91%	91%	33%	33%	33%	33%
# uses	1	1	1	1	5	5	20	20
Production and filling	165	165	165	165	128	128	113	113
Transport Filling - Distribution	0	253	0	253	0	278	0	278
Transport Distribution - Supermarket	24	24	24	24	26	26	26	26
Deposit system	-	-	-	-	42	42	42	42
Transport Deposit (shops) - filling	-	-	-	-	12	235	12	235
Washing					114	114	114	114
Selective collection and recycling	7	7	15	15	1,9	1,9	0,5	0,5
Non selective collection and landfill	14	14	2,2	2,2	6	6	1,4	1,4
Non selective collection and incineration	14	14	2,2	2,2	6	6	1,5	1,5
Total internal costs	**224**	**477**	**208**	**461**	**336**	**837**	**311**	**812**

- Transport cost (in green) is an important cost for long distances. It is higher for refillable glass because there is a lower number of bottles in the truck and there is a return journey.
- The production & filling and the washing are also important.
- The waste management cost (collection, recycling, incineration and landfilling) is very low.
- Also some other costs only exist for refillable glass: management of the deposit system, washing. At the opposite, some costs (almost) only exist for single trip glass: recycling, incineration, landfilling.
- The total internal costs are lower for single trip Glass, whatever the transport distance.

Externalities glass

The environmental models for each option were constructed using Pira International's LCI/LCIA software PEMS. The life cycle inventory is then compiled. The environmental impacts associated with the inventory data set are then calculated. To achieve this, the inventory data are characterised according to the potential impact categories they contribute to, and then multiplied by classification values. Finally, the impact assessment data are multiplied by the economic valuation values (as listed in annex 4) to determine the external cost of each impact category.

The external costs of each scenario are presented in the table below:

Table 6: External costs

Glass bottles	Glass	Glass	Glass	Glass	Glass	Glass	Glass	Glass
Distance filling - distribution (km)	0	1800	0	1800	0	1800	0	1800
Recycling rate	42%	42%	91%	91%	33%	33%	33%	33%
# uses	1	1	1	1	5	5	20	20
Impact categories								
GWP (kg CO2 eq.)	3	5	3	4	1	6	0	5
Ozone depletion (kg CFC 11 eq.)	0	0	0	0	0	0	0	0
Acidification (Acid equiv.)	0	0	0	0	0	0	0	0
Toxicity Carcinogens (Cd equiv)	0	0	0	0	0	0	0	0
Toxicity Gaseous (SO2 equiv.)	1	1	1	1	0	1	0	1
Toxicity Metals non carcinogens (Pb equiv.)	1	2	1	1	1	1	0	0
Toxicity Particulates & aerosols (PM10 equiv)	148	173	130	155	56	125	19	89
Toxicity Smog (ethylene equiv.)	1	2	1	2	0	3	0	3
Black smoke (kg dust eq.)	1	1	1	1	0	1	0	1
Fertilisation	-1	-1	0	-1	0	-1	0	-1
Traffic accidents (risk equiv.)	0	1	0	1	0	3	0	3
Traffic Congestion (car km equiv.)	4	28	4	28	4	74	3	73
Traffic Noise (car km equiv.)	0	2	0	2	0	5	0	5
Water Quality Eutrophication (P equiv.)	0	0	0	0	0	0	0	0
Disaminity (kg LF waste equiv.)	5	5	1	1	2	2	0	1
Total external cost	**165**	**220**	**142**	**196**	**65**	**221**	**24**	**180**

Again the external costs are very dependent on the transport distance, to a lesser extend on the recycling rate (for single trip) and only little on the number of trips (for refillables).

The sensitivity to the different factors is :

- recycling rate (delta = -23,08 € from 20% to 80%),
- number of trips (delta = -40.3 € from 5 to 20),
- transport distance (delta = +54.24 € or 156,07 € from 0 to 1800 km).

From a purely environmental viewpoint, refillable glass is better as long as the transport distance between filler and distribution centre is lower than very long distances :

Refillable	Single trip	Break even distance (km)
# uses	recycling%	
20	91%	2080
20	42%	2490
5	91%	1370
5	42%	1780

Total cost glass

The results are presented in the three graphs below. The graphs present the internal, external and total social costs (i.e. the sum of the internal and external costs) for each scenario as a function of the distance to market.

Table 7 shows the external costs, the internal costs and the Total Social costs (i.e. the sum of the internal and external costs) for each scenario as a function of distance to market.

Table 7 : Costs of glass bottles (refillable and single trip)

	External		Internal		Total Social		% internal	% internal
Distance (filling – distribution)	0	1800	0	1800	0	1800	0	1800
Glass ST 1l 42%	165	220	224	477	389	696	58%	68%
Glass ST 1l 91%	142	196	208	461	350	657	59%	70%
Glass RE 1l 33% 5U	65	221	336	837	400	1057	84%	79%
Glass RE 1l 33% 20U	24	180	311	812	335	992	93%	82%

Figure 4: Internal costs – glass refills and single trip

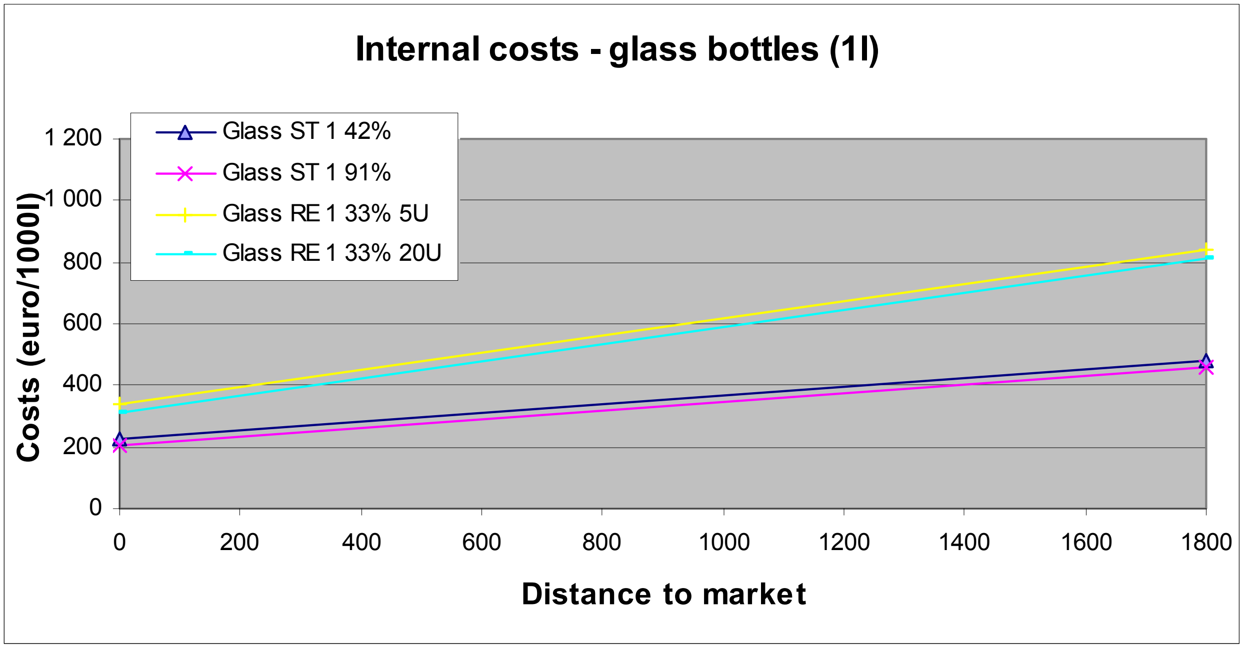


Figure 5 : External costs – glass refills and single trip

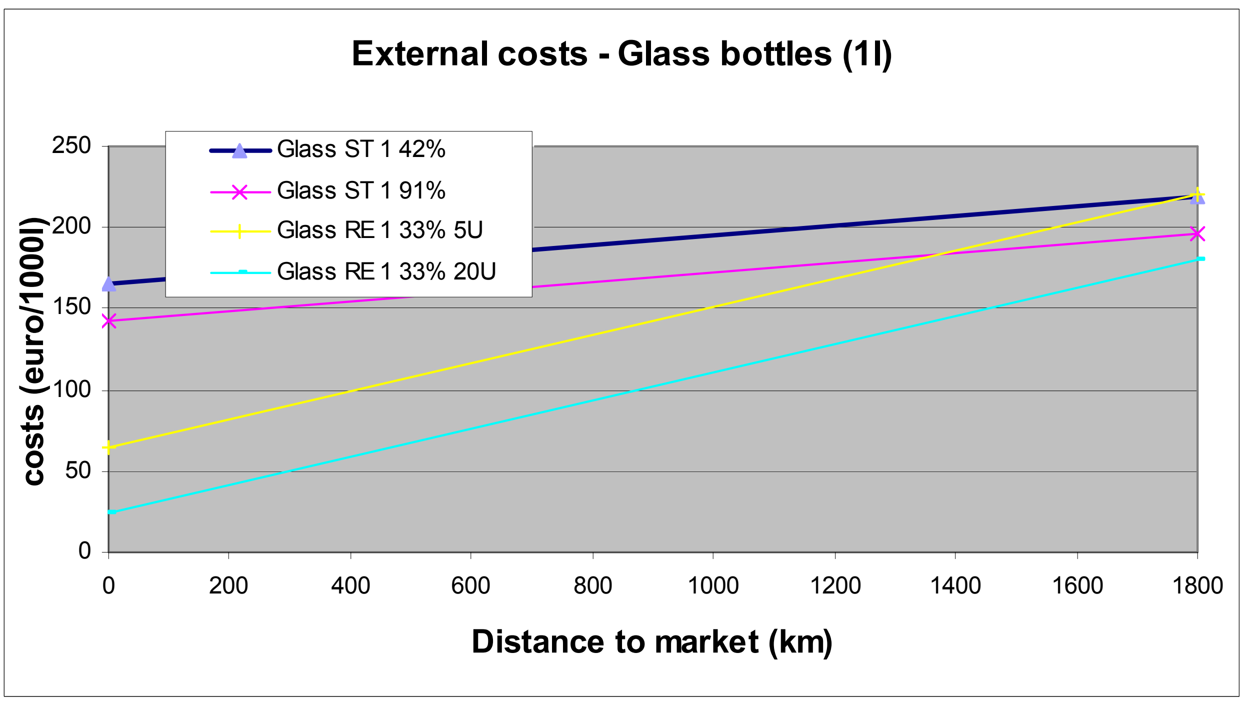
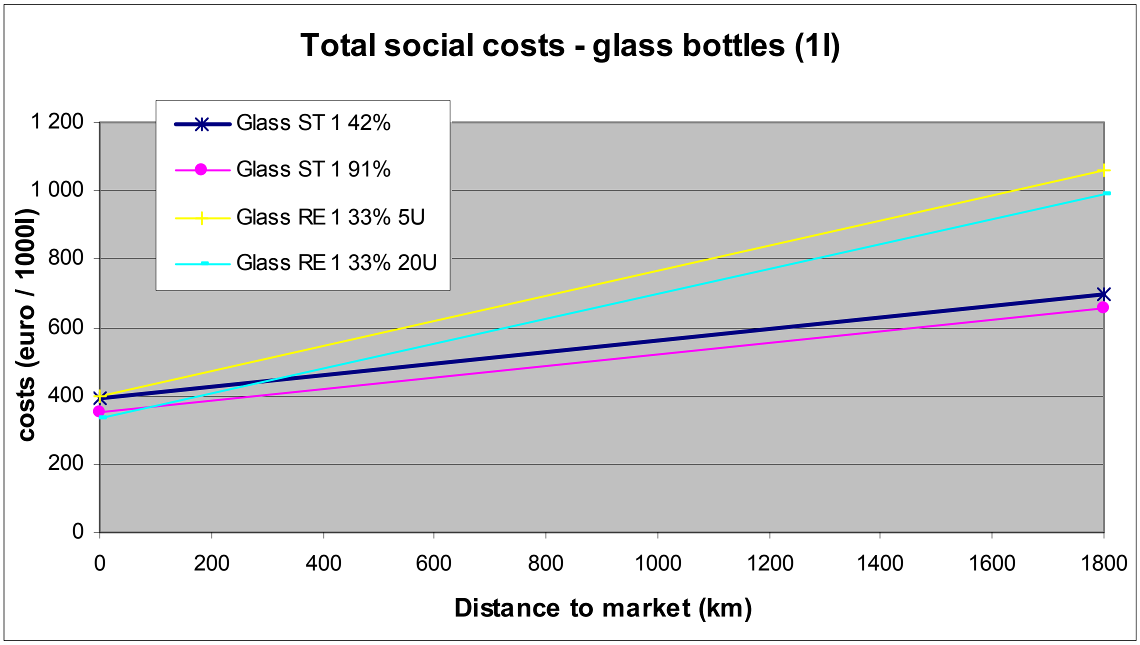


Figure 6 : Total social costs – glass refills and single trip



Conclusions glass

- Internal costs dominate the total social cost (between 59 and 93%).
- Single trip bottles are always cheaper (From an internal cost perspective).
- External costs of Single trip bottles are higher except for very long distances (>1380-2490 km)
- Total social costs of Single trip bottles are :
  - about the same as refillables up to 300 km and
  - lower for distances > 300 km.
- The single trip bottles with a high recycling rate (91%) are slightly better than the others (except refillable 20U for very short distances, i.e. < 100 km). The refillable system (5 uses) has the highest impact.

Summary of sensitivity analysis glass

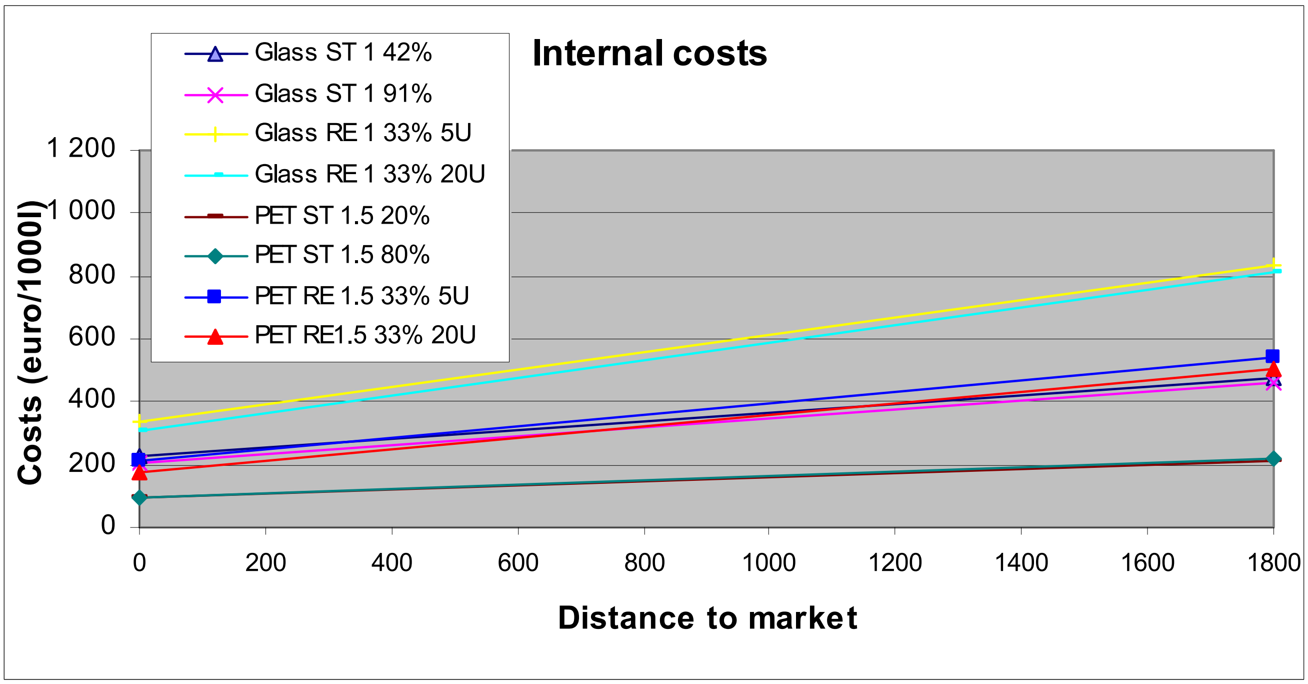
The results achieved and conclusions drawn are sensitive to the economic valuations applied and to the internal costs applied.

The distances over which the refillable bottles are a preferred option are sensitive to the return rate assumed. At a return rate of less than 50% the refillables are no longer preferable from a total social cost perspective for any distance.

Comparison of refillable and single trip PET and glass

Following figures show on common graphs the results presented separately above. The comparison is fair as the same volumes have been used for both packaging materials and the modelled systems are representative of the market (Remark : 1l PET bottles recently appeared on the market but there are still no 1.5 litre glass bottles).

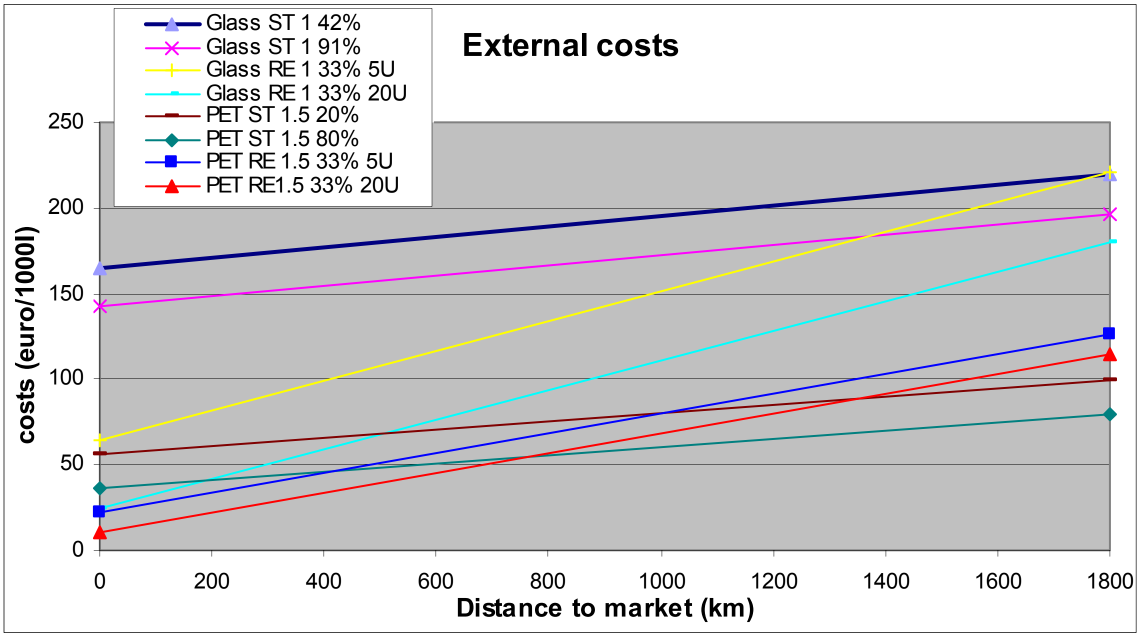
Figure 7 : Internal costs



From an internal cost perspective,

- PET ST is the best option.
- PET refillable and glass ST are similar but sensibly higher than PET ST
- Glass refillable is the most expensive

Figure 8 : External costs



From an external cost perspective,

- For short distances (<193 km)
  - refillable PET is the best option, followed by refillable glass (20U), PET ST, refillable glass (5U) and sensibly higher, ST glass.
- For medium distances (>193 km)
  - PET ST (80% recycling) becomes better than refillable glass (20U) for a distance >193 km
  - PET ST (80% recycling) becomes better than refillable PET (5U) for a distance >413 km
- For long distances
  - ST glass (91% recycling) becomes better than refillable glass (5U) for a distance >1400km
- The external costs are very much dependent on the impacts caused by transport. In particular the toxicity of particulates & aerosols (PM10 equivalent) plays a decisive role (see Table 3). Here it should be noted that an average monetisation value has been used for particulates from classical combustion processes and diesel use for transport while particulates from transport have a 15 times higher monetisation value. So it is probable that the contribution of transport is still considerably higher than results show. Also if a correction is applied, the external costs would be as follows :

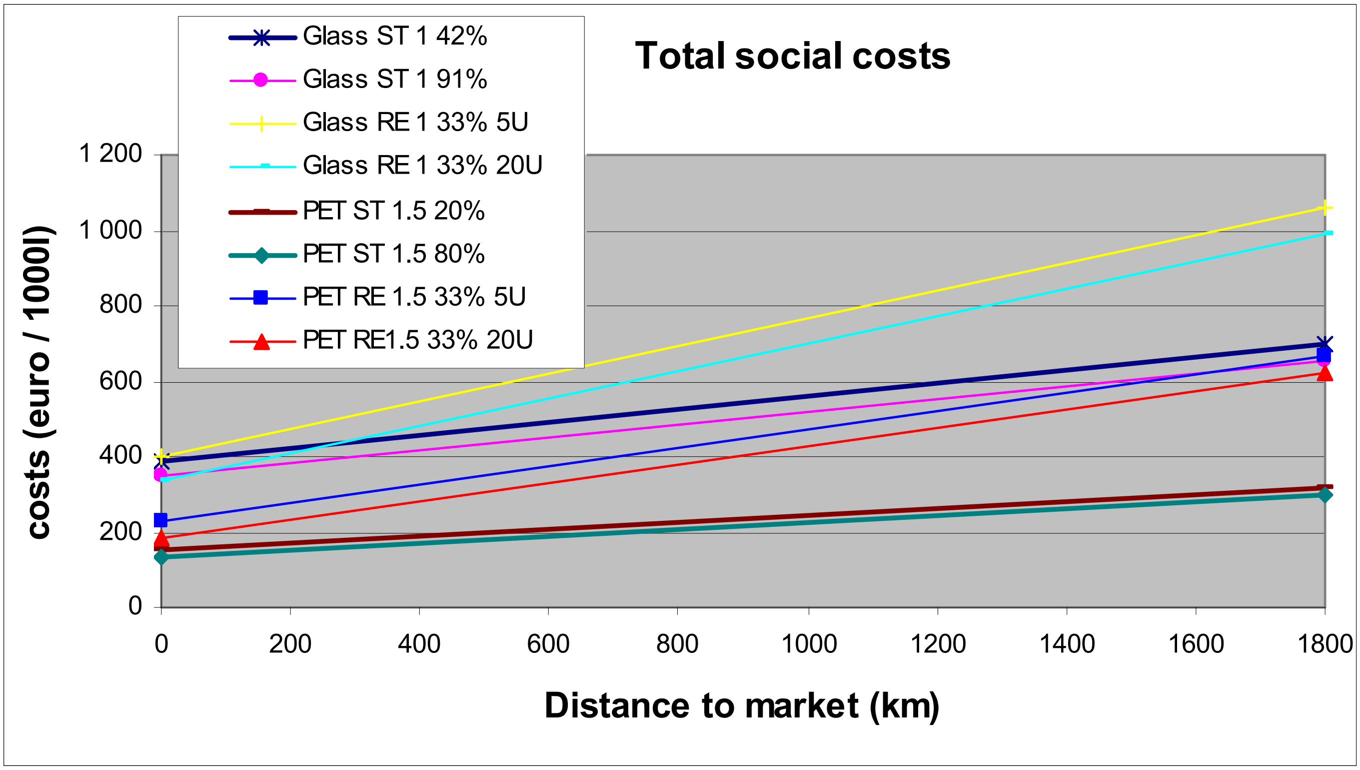
	Distance (km)		
	Min	Max	break even
	0	1800	11,646
refillable PET 5U	6,1	134,4	6,930
ST PET 80%	7,9	61,8	8,249
refillable glass 20 U	7	200	8,249
ST glass 91%	25	92	25,434

In this case the break even distance for refillable glass (20U) and ST PET (80%) becomes 8 km. The results are thus very sensible to the definition of the origin of particulates.

- Following table shows the main contributions to external costs for both PET and Glass bottles (refillable and single trip). Contribution to GWP increases when transport distances increase, but decrease when the number of uses and the recycling rates increase.

	Glass	Glass	Glass	Glass	Glass	Glass	Glass	Glass	PET	PET	PET	PET	PET	PET	PET	PET
Distance filling - distr. (km)	0	1800	0	1800	0	1800	0	1800	0	1800	0	1800	0	1800	0	1800
Recycling rate	42%	42%	91%	91%	33%	33%	33%	33%	20%	20%	80%	80%	33%	33%	33%	33%
# uses	1	1	1	1	5	5	20	20	1	1	1	1	5	5	20	20
Impact categories																
GWP (kg CO2 eq.)	3	5	3	4	1	6	0	5	1	3	1	2	1	4	0	3
Traffic Congestion	4	28	4	28	4	74	3	73	2	22	2	22	2	49	2	49
Disaminity	5	5	1	1	2	2	0	1	1	1	0	0	0	0	0	0

Figure 9 : Total social costs



For the total social costs :

- ST PET is the best option
- Refillable PET is the second best option
- ST and Refillable glass are less efficient.
- For very long distances (1800 km), ST glass is equivalent to Refillable PET and
- For medium distances (250-300 km), ST glass is better than Refillable glass.

Analysis of the reliability of the conclusions

From the analysis performed, it appears that non-refillable (PET) beverage packaging has the lowest total social cost, mainly due to the lower internal cost.

However the variability of some key parameters influencing the results is high for this case study on beverage packaging : the transport distance (see graph above), the number of uses and the internal cost figures (in particular for the deposit system management). So, as costs and benefits of refillable and non-refillable (PET) beverage packaging are in the same order of magnitude, the observations made from the case study may be non applicable in many individual cases. Therefore we conclude that there is no generally preferable system between those 2 types of beverage packaging systems.

The merit of this case study is to prove that the internal cost of a refillable system is considerably higher than of a non-refillable and that this more than compensates the refillable's sometimes lower environmental impacts for short distances. Therefore the general rule should not be to encourage refillable beverage packaging. If applied, a policy favouring refillables should be restricted to the cases where the general rule does not apply due to a particular set of key parameters.

Annex 13: Comments on comments

Integration of expert and stakeholder comments into the report *"Evaluation of costs and benefits for the achievement of reuse and recycling targets for the different packaging materials in the frame of the packaging waste directive 94/62/EC"*

Table of contents

0 Introduction

The objective of the current document is to answer as far as possible the remarks and comments provided by the stakeholders to the EC on the report « *Evaluation of costs and benefits for the achievement of reuse and recycling targets for the different packaging materials in the frame of the packaging waste directive 94/62/EC* ». The comments taken into account are those provided before July 31, 2001.

About 270 comments were identified within the 24 sets of comments received. Each stakeholder is identified by a letter (from A to X, see list in annex 13.1). Each comment is treated in this document, say directly (answer in this document) or indirectly (with reference to the main report). Where appropriate, changes were made in the main report. In these cases the answer refers to the page of the report where the explanation is given.

In a first step, all the comments (and sub-comments) were reviewed in order to classify them into five categories:

1. Political comments
2. Comments on the methodology
3. Comments on data and data sources
4. Specific requests for additional research works or calculations with other data
5. Specific requests for explanations and clarifications.

Each comment is quoted or summarised in this document. Many comments were made by different stakeholders; they are only quoted once. In the following, after each comment, a series of letters and numbers are given between brackets. The letter indicates the author(s) (see corresponding table in annex) and the number indicates the position of the comment in the stakeholders list.

In a second step, we answered the comments in this document or we revised the main report by providing additional information or making additional calculations. However revision was limited taking into account the delay and the budget. In agreement with the EC, political comments were not answered in this report.

1 Political comments

General remark : Those comments concern the scope of the study, the way the results should be interpreted and which political conclusions should be drawn from the study. As those elements are out of scope of the study, we do not answer those comments or simply make a short comment, when relevant.

1.1 Scope

(1) The conclusions are not robust enough, due to limitations and uncertainties [A1, C1, G9, I1, I7, M1, ~N1, N4, P1, Q5, S2, U2, U14, V1]

(2) The brief of the study was too wide, taking into account the allowed time and budget ➔ conclusions should be cautiously interpreted [C2, F1, P2, S2, U1, U14]

(3) "There is no generally valid relation of action between logistics, local facts and the efficiency of the service but the different local parameters influence each other reciprocally." [D1]

(4) A peer review of the results should be performed, in compliance with ISO 14040 or no reference to ISO 14040 [A5, B14, ~I8, M4, M6, X7, X11]

(5) The boundaries of the system should not be limited to waste management if the objective is to find ways to improve the environment impact, in relation with packaging [B1, ~M14]

(6) Out of scope of the study are effects (packaging design…) by the extended producer responsibility schemes. [I11]

(7) The cost/benefit expected from suggested "optimum" recycling rates should be compared with alternative ways for improving the environmental impact of packaging waste management [B2]

1.2 Interpretation of the results

(8) Comparisons of packaging materials based on LCA results (or CBA results) to derive "ecologically favourable packaging" are a very controversial issue. [A8, A9, F3c, N5]

(9) CBA is a powerful instrument, an aid to decision-making process, but does not provide quantitative answers. [B15, H1, J1, U14, X9]

(10) Optimum targets for plastics are unrealistic because the required growth rate for the recycling industry is not achievable [B17]

Answer: The transition time necessary to attain a stable optimised situation has not been analysed in thus study. So maybe there would be some problems to achieve the "optimum" recycling rates in a few years. We cannot provide a justified opinion on this question with the information gathered during the study.

(11) Conclusions of the study are not in line with those of the Argus study [E4]

(12) Reuse case studies: the results are quite different than those of the GUA study [O4] and those of the VITO and BBL studies [Q2]

Answer: Many of the difference can be explained by factors described in the studies. These include for example:

- The GUA study used very different assumptions :
  - Very short delivery distances (100 + 45 km)
  - Deposit system for non refillable bottles (which means a return trip for the trucks)
  - Very limited recycling : 65% collection rate, from which only one half (32.5%) is recycled mechanically (rest is thermal valorisation in blast furnaces), from which 10% is lost (remains 29.25%) and a 90% substitution ratio → 26.30% virgin PET is saved
- The VITO study only refers to (both refillable and non refillable) glass bottles and their conclusions are similar to ours for those packaging.
- The BBL study is a literature study and does not give own results.

(13) Conclusions of reuse case studies should be more qualitative (giving suggestion of tax, system promotion…) [Q4]

(14) Reuse results are not robust enough to take robust conclusions as those of the study. [Q3]

(15) In general conclusions are not soundly based [I12', M3, X5]

(16) The reliance of the study on data and assessments from industry associations constitutes a conservative bias [I4]

Answer: By definition, data always come from operators, directly or indirectly (through industry associations or literature). For the assessments, we did not rely on anybody. Those are the comments of the consultants.

1.3 Political conclusions

1.3.1 Recycling targets

(17) Due to the age of the data, current recovery and recycling targets should remain in place for another three years [C3, P3]

(18) Minimum common recycling target per material is requested and/or differentiated recycling targets should not be imposed [A12, E5]

(19) Material-specific recycling quotas are requested [D5]

(20) The revised directive should include both minimum and maximum recycling targets [F2]

(21) No maximum recycling targets should be specified in the revised directive, with regard to the results of the study [D4]

(22) The definition of recycling range instead of sole minimum targets should be favoured [R16]

(23) Conclusions support the increase of recycling rates that was earlier proposed by the European Commission [Q1]

(24) Feedstock recycling and Waste to Energy Incineration should be included as an integral part of any future recycling and recovery targets [P6]

(25) The models are too weakly based to give specific recycling targets for each MS (Conclusion 5) [I13]

(26) Stakeholder fears that the table on p.116 (conclusion 5) might be misused [E1]

1.3.2 Actions recommended by stakeholders to the EC

(27) Recycling definition should be revised [R17]

(28) Mechanisms at EU level which would help to create end-user markets for recycled materials within member states would be welcomed [C5, P7]

(29) The EC should adopt more consistency in the global waste management processes [R15]

2 Comments on the methodology

2.1 Choice of the case studies and the scenarios

General remark : There was no time and money to perform a case study for each packaging material application. Therefore, in agreement with the EC, criteria were selected and applied to select the case studies. (See pages 29-30).

(1) Choice of the case studies: PET and LDPE films are not representative, other plastic materials have a much wider application and are used to pack a wider variety of products [C4, J3, P4]

Answer: Not only PET and LDPE films were analysed.

For industrial packaging, also drums, jerricans, IBCs, EPS, sacks, pallets and crates were studied. The report explains how packaging for which no case study is performed is approached. (See pages 39-40).

For household applications, we assumed HDPE bottles and containers present similar costs and benefits as PET bottles. Therefore, when selective collection for recycling is (not) globally beneficial for PET bottles, it is assumed selective collection for recycling is (not) globally beneficial for HDPE bottles and containers.

Globally this assumption is valid as there are many similarities : same collection and sorting system, relatively similar benefits from recycling. However, there is a weak aspect in this assumption : the possible lack of available outlet market for recycled HDPE. This was not investigated.

(2) Choice of the case studies: conclusions for wood are not underpinned by case studies related to wood applications (especially other than pallets) [E2, F4]

(3) Case study related to wood packaging applications should be added [U4]

Answer (common to 2 & 3): No case study was performed for wood packaging because :

- there was a general consensus that high reuse and recovery (either recycling or energy recovery) rates should be achieved for wood pallets (see page 31 of the report). It appears to all concerned actors both economically and environmentally sound. Only for very long transport distance might the influence of the pallet weight on the truck fuel consumption compensate the advantages of the reuse system.
- there was a necessity to make a selection between the numerous potential case studies

- Moreover there is an informal recycling and energy recovery of wood that is difficult to quantify.

(4) Choice of the case studies: why is there no case study related to steel cans ? [H7b]

Answer: from the collection and incineration viewpoint, there is no difference between steel beverage cans and other steel household packaging. Both are collected together with the same collection rate and their behaviour in the incineration plant is the same. That is not the case for the aluminium packaging as beverage cans have different characteristics than other aluminium semi-rigid and flexible household packaging. Collection guidelines vary according to the type of packaging and their behaviour is not the same in the incineration plant, according to their thickness and ability to be oxidised.

(5) Side calculation for internal costs for HDPE should be carried out, on the basis of the internal and external costs of PET and using HDPE market price. [R4]

Answer : This could be an interesting exercise, as well as testing HDPE specific environmental, social and economic costs and benefits due to recycling and collection. However the budget and time do not allow us to perform it.

(6) Case study Liquid Beverage Cartons : scenarios should be revised in order to take into account other recycling routes such as cement kiln [T1]

Answer: see "*4.2.5 LBC from household sources*" page 96 and Annex 10, section 5

(7) Chemical recycling (especially TBI process for PET) is not included in the case studies [F5, R14]

Answer: Chemical recycling was taken into account in the sensitivity analysis. Results are given on pages 91 and 120 (conclusions).

(8) Reuse case studies should include aluminium beverage cans [H18, I14]

Answer: Indeed it should be interesting to include other non refillable beverage packaging material in the reuse case study. However, budget and time constraints did not allow this.

2.2 Models

2.2.1 General comments

(9) The bottom-up approach of the study constitutes one of the conservative bias of the study [I3]

Answer: The theoretical bias of the bottom-up approach is the fact the possible synergies (scale effect) or competitions (e.g. contradictory or complex communication) between actions are not taken into account. However the risk was rather limited with our approach due to the fact that the data we considered for the calculations largely originate from grouped systems, where, by definition, those potential synergies or competitions are reflected in their organisation and their cost.

(10) The wording "optimum" is challenged [A6, B16, M13, R2, U3, W9]

Answer: The optimum recycling rates that were calculated are of course the optimum values determined by the model used. If the model does not reflect the reality, then the optimum of the model might not be the optimum of the reality. But conceptually the approach is made to determine an optimum.

(11) The study does not sufficiently take operational practices in Europe into account (e.g. current best practices, technology standards, etc.), while handpicking is included, even if it is a questionable method from a social welfare viewpoint [V2, V6]

Answer: Our approach is motivated by 2 reasons :

- the lack of availability of environmental and economic data
- we were only using proven technologies. Many of the automated sorting systems had not been fully proven when we performed the study. If we were to repeat the work now, we might take a different view (if data are available).

(12) The study assumes that the collection systems cover 100% of the population, which is not the case in many collection schemes. Optimum recycling rates should take into account that achievable recycling rates do not concern 100% of the population. [X1]

Answer: Calculations were made for the case where there is selective collection and where there is not ➔ both cases are analysed. The calculations were made for 2 types of population density, high (> 200 inhab/km²; for the model we considered 500 inhab/km²) and low (< 200 inhab/km²; for the model we considered 50 inhab/km²). So the case of the areas with a very low population density (< 20 inhab/km²) was not studied. We assumed that only a very limited fraction of the population lives in this type of area. To a limited extent, it might however, play a role for some Member States like Finland, Spain etc.

(13) The collection systems modelled in the study do not necessarily represent those having the lowest collection costs. It would be advantageous to identify effective lower costs systems with less developed recycling infrastructures. [W5]

Answer: Indeed the collection systems modelled in the study do not necessarily represent those having the lowest collection costs. The study focuses on best practice as targets are calculated for 2006.

(14) "the lack of more comprehensive assessment of the relationship between recycling rates and costs is the most important weakness of the study" [G5]

Answer: Internal costs are calculated by tonne of packaging waste respectively incinerated, landfilled and recycled, in low and high population density areas. Internal costs for a specific recycling rate are calculated as balanced sum of recycling costs and incineration/landfilling costs.

In fact the **assessment** of the relationship between recycling rates and costs is **very comprehensive**, as we have analysed separately the different packaging materials and applications, the different situations concerning population density, cost of incineration… The situation presented in the report concerns only the "optimum" system as being the sum of many individual optimum systems.

(15) Costs do not linearly increase with recycling rates, as assumed in the study → marginal costs approach is required [A2, B5, D3, F6] + *see comment II.8*

Answer: The study did not assume that costs linearly increase with recycling rates. We basically assumed that a change in the recycling rate is mainly achieved by changing the fundaments of the systems, either :

- by changing the collection system (bring or kerbside selective collection),
- by adding other types of packaging that are collected selectively
- or by extending the collection to the less densely populated areas.

All those elements, which are the principal ways to modify the recycling rates, were taken into account. So the approach is very far from considering a linear relation between recycling cost and recycling rates. We used a sophisticated approach by taking those elements into account.

However, with similar systems, different recycling rates can be achieved according to other factors, which change the organisation of the systems : collection frequency, cost of MSW bag, communication. For those elements we assumed that the operators have largely optimised the presently running systems so that we could assume that their data correspond to an efficient system.

(16) There is no analyse of the cost differences between Member States [G4]

Answer: Indeed there was no detailed analysis of concrete conditions in the Member States and abstractions were necessary to be able to perform this study. However, many of the elements that influence the cost differences between Member States have been considered in the analysis, so that, indirectly, those differences were considered for the determination of the optimum rates. Those key influential elements are:

- packaging mix
- fraction of population living in high/low population density areas
- incineration rate for MSW

Concerning the general cost level (products are more expensive in Sweden than in Portugal), we considered that they essentially vary proportionally. So all costs and benefits vary proportionally and cost/benefit ratios and conclusions can be extrapolated from one MS to another one.

It is important to repeat here that the more detailed the results are, the more carefully they must be considered. So results for a specific MS are less reliable than the global results for the EC as a whole.

(17) There are variations in cost-benefit over time within the same area and between regions. Are they taken into account ? [E3]

Answer: No. The study is based on a long-term equilibrium. It is correct that many factors may vary over time. However, these changes will not alter the results in a major way, at least in the short to medium term.

(18) Does the study integrate data on the re-equipments of the German sorting plants and its consequences on recycling rate and costs ? [D2]

Answer: No, the study does not integrate them insofar the LCI data were not provided by DSD. On the other hand the re-equipment is not yet representative of a steady state system regarding internal costs.

(19) How does the study integrate private transport impacts ? [I18, N19]

Answer: private transport impacts are taken into account in external and in internal costs calculation. RDC performed an inquiry in Belgium and France in order to get data on the distance from home to a central collection place, e.g. bottle bank (bring scheme). The results are not (yet) published. LCI and internal costs data sources are mentioned in annex 7. The external costs of private transport to bring banks are considered. The impacts of private transport are rather limited.

2.2.2 Specific comments - recycling

(20) There is an inconsistency related to avoided production: costs of avoided primary production seem not to be considered. [O2]

Answer: This is not true. The revenue from the selling of the recycled material is taken into account. This revenue is the material value of the virgin material minus the quality loss premium. So both the costs of avoided primary production and the quality loss are taken into account.

(21) The relevance of having a common optimum collection system for both metallic packaging is challenged [A7]

Answer: the choice is basically motivated by the lack of ability of the consumers to distinguish aluminium from steel.

Moreover the available data concerned common collection systems for both metallic packaging. To model a separated collection scheme would be a difficult exercise.

(22) The impacts of moisture absorbed by packaging when mixed with MSW should not be allocated to the packaging (a.o. in the case of incineration). But of course the impacts of moisture contained in the packaging when it is thrown should be allocated to the packaging. [R7]

Answer: This is a relevant comment. The report was not clear for this point but the calculations were performed according to the rule suggested in this comment. For landfill, incineration and recycling operations, only the moisture content in the packaging materials when they are manufactured has been considered. The analysis does not consider moisture content absorbed by the packaging from the product it contains nor moisture absorbed by packaging when mixed with MSW.

(23) The study should take into account the existence of non recyclable fraction for household packaging waste [B11, F9, R1]

Answer: As we considered all packaging in the study, by definition we also included the so-called "*non recyclable fraction*". For those packaging the optimum recycling rate is 0% (at least if they really are non recyclable) and when calculating global optimum rates, those 0% rates are taken into account.

(24) Two points (i.e. 2 collection schemes) on the marginal cost curve for recycling are not enough to estimate the optimal recycling rate. [G2]

Answer: See 2.2.1, comment 14 p.187 and comment 15 p.188

2.2.3 Specific comments - reuse

(25) Reuse : conclusions are biased because the volumes are not the same [A10, B14', I14, N6, R12, U10]

Answer: We agree with this criticism (This was due to lack of data). Therefore we performed new calculations with similar volumes. See the reuse case study in the main report.

(26) Reuse case studies should compare the same material packaging applications and highlight the specific type of beverage taken into account [N8, R12]

Answer: The reuse case study was calculated again. See the reuse case study in the main report. We did not define the type of beverage because it has a limited impact on the models, the calculations and the results. Looking back at this element after performing the calculations, as it appears that impacts are rather similar, the possible technical limitations should not influence the conclusions drawn.

2.3 Classical LCA bottlenecks

(27) Incineration allocation rules should be challenged by another sound allocation choice (e.g. TNO) [R6]

Answer: indeed, it would be interesting to challenge the results with another incineration costs allocation rules. Due to lack of time this could not be performed.

(28) Internal collection costs allocation by weight instead of by volume is questionable and should be tested [H14, U9, W6]

Answer: We allocated the collection cost by volume (see page 69 of the report)

(29) Data sources are limited and data are sometimes (highly) controversial. According to LCA experts, results should differ at least by before concluding to significant differences between scenarios. How does the study manage the differences between scenarios? [B3, G6, X4]

Answer: The 20% significance threshold is an order of magnitude considered by some experts. But the significance threshold is very much dependant on different factors :

- data quality for the main contributions
- definition of process trees (if large parts are common to the different options, the significance threshold should be related to the non-common part)

- correlation between values of different systems (e.g. if transport cost or transport distance increases, it will increase the same way for the different materials and systems)

Secondly when the results are the addition of many small items, there may be a statistical compensation of the errors. So the statistical error is considerably smaller than the maximum error (sum of all error intervals). As the results of this study rely on a very large number of data and assumptions, there is for sure a large statistical compensation.

Moreover we do not consider that the individual results of the study (one application in one country) are reliable. In the analysis we considered even small differences as significant and when adding up all the optimum values (recycling rates) there is a statistical compensation. Therefore the global results (range of recycling rates per material in the EU) should be quite reliable even if they are the weighted average of less reliable results.

2.4 Other relevant factors not considered in the CBA

(30) Limit : The study did not include any consideration of the economic impact of different rates of growth of recycling. It considered "optimal" potentials without reference to the year 2006, when the recycling targets are to be met. To achieve a potential sooner rather than later will usually increase annual costs and may increase total cost. [N16]

Answer: The consultants recognise this as a limitation. The Constraints chapter is modified in the main report (p. 11-12).

(31) The study does not take into account limitations to the market for plastic recyclates and its economic implications [B7, J7, ~J8, U5]

Answer:

In light of the discussions with APME and their report "*Potential for Post User Plastic Waste Recycling*", it would appear that this criticism is justified.

However the present study comes to the conclusion that recycling should be the preferred option for only a limited number of household applications:

- PET bottles
- HDPE bottles and containers.

As close loop recycling is feasible for those applications, the market demand should not be a limitation to recycling.

This is also the case for the main industrial packaging applications : IBCs, jerricans,…

(32) Critical factors limiting recycling:

- Contamination of packaging materials with food is a general problem not only limited to specific categories [H17]
- For plastics: according to EUPC, "capacity/limitations", "supply/demand imbalances", and "resistance to the use of recyclate" and "colour" are today key factors that limit plastics recycling. [J9]
- Recycled material cannot be used for all applications, especially food applications [K1, ~J6]
- Constraints for LBC should take into account the complexity of the material and the characteristics of the existing recycling facilities [T3]

Answer: these limits are taken into account in annex 9.

(33) Consumer behaviour is not taken into account (e.g. : cleaning packaging, willingness to participate) [V9]

Answer: Consumer behaviour is not taken directly into account but it has been considered indirectly. The willingness to participate will vary from MS to MS and in function of the quality of the collection system and the communication. This has been reflected in the ranges of values considered (Table 5 p. 39).

(34) Social aspects: they are limited to employment in the sensitivity analysis and do not integrate int. al. consumer convenience, consumer needs satisfaction, consumer choice [B4, M5, U12, X12]

Answer: consumer convenience, consumer needs satisfaction and consumer choice were mentioned on pages 10-12. They were not taken into account because of lack of :

- time and money
- available data (representative of the European Union)
- existing methodology in the literature.

But for sure men should try to include them in future cost benefit studies.

3 Comments on data and data sources

3.1 Packaging mix

(1) Ratio Household/industrial plastic packaging waste amount should be revised according to the data collected by TN Sofres for APME [B11]

Answer: Indeed data (for 1997) published in 1999 by APME show different amounts of post user plastics packaging by origin (i.e. 73% of household packaging instead of 60% in the current study). It should be noted that APME data concern the year 1997 and the weight of household packaging decreased during the last years. This can partially explain the difference between both data sets.

However we analysed in the sensitivity analysis the effect of using the APME data on the global recycling targets. The change in plastic waste composition has been done in practice as follows : 13% industrial films (optimum recycling rate = 55-75%) become 13% household films (optimum recycling rate = 0%). The recycling rate per material for 2000 would be 21%-28% instead of 28%-38%. (see chapter 4.3.4).

(2) Do MS validate the packaging mix values ? [H16]

Answer: The packaging mix values were submitted to the Green Dot Associations and other national packaging recovery organisations, and to the European Material Associations for validation. Their comments were taken into account in the final version.

3.2 Recycling rates

(3) EPS is recyclable. It is a material and not a packaging. Table 6 should be revised [B9, L1, J4, J5]

Answer: information was collected and analysed. The main report was modified on page 42 to take into account the recyclability of EPS.

(4) Achievable recycling rates are sometimes surprising and should be further justified [J4, R10]

Answer: recycling rates are determined for systems working in steady state situation as described on page 37, and for areas where 100% of the population is covered by the same selective and non selective collection schemes. Therefore those data might look high when compared to figures achieved in MS where (much) less than 100% of the population is covered by a selective collection scheme. Considering 100% coverage is necessary for our approach because we analyse the situation commune per commune and within one commune only one system is applied (so it is either 100% or 0% coverage).

3.3 Environmental data

(5) Which are the emission standards for trucks ? [I18]

Answer: LCI data source for truck transport are given in annex 7

(6) The study should use a more realistic substitution ratio for recycled PET and for all material in general as the recycled material has a lower quality than the virgin material [B13, V7]

Answer: Indeed there is always a quality loss when a material is recycled. So for example, when PET bottle grade is recycled as PET fibre grade, the credit for the recycling is not equivalent to the initial impacts of the virgin material. Similarly, for other materials, the material saved can be similar to the original material but a bigger amount is used for the same application (thicker products). This is why in the study we used a save ratio (substitution ratio) 0.8 in the sensitivity analysis (p. 89-90).

3.4 Cost data

(7) There is no evidence on which internal costs data the case study Al cans is based. Results are surprising inside Al case studies [H6, H7]

Answer: internal costs for cans recycling, incineration and landfilling are considered to be equal to those of rigid and semi-rigid Al packaging. They are given in annex 3.

(8) The fact that separate collection costs are lower than those for MSW collection should be discussed [H14b, U7, W3] + *see comment V.9*

Answer (common to comments 8 & 10): an engineering Company, Beture Environnement determined costs data on basis of their own experience. The aim of the study was to work with data representative for the EU. The cost figures used can then be globally lower or higher than national figures. But it is important to note that those data sets used are coherent. The difference of costs can be explained a.o. by the collection frequency.

(9) Some of the economic values are questionable, e.g. some collection costs are too low [I19, O1]

Answer: an engineering office, Beture Environnement, on basis of their own experience, determined costs data. The aim of the study was to work with data representative of optimised systems in the EU. They can be too low with respect to (less optimised) national data (higher frequency, different organisation).

(10) In general, collection costs look very high and should be checked [R8]

Answer (common to comments 8 & 10): see comment 8 above (3.4 Cost data)

(11) Sorting costs are too high regarding the material quality. Sorting techniques are not state-of-the-art. [I16, R9]

see above (2.2.1, comment (11))

Answer: Sorting systems are based on steady state systems. They were discussed with and validate by the Green Dot Associations and other national packaging recovery associations. These Associations provided no LCI or economic data on state-of-the-art techniques.

(12) Case study LBC : internal costs data (475 EURO/t) relating to collection and sorting should be revised on the basis of the data included in the comment (88 to 105 EURO/t) [T5]

Answer: The suggested costs data are much lower than those used in the study.

The stakeholders have provided additional information on the internal costs of collection/sorting for different hybrid systems (LBCs collected together with waste paper & board), and the recycling rates that can be achieved by those systems. However,

- the data make no distinction between high and low population density,
- the recycling rate does not refer to systems covering 100% of the population of the considered area,
- the use of the data provided by the stakeholders requires a new definition of the case studies, in order to take into account the characteristics of the hybrid systems.

Assuming that the data are representative of high population density, and concern a system coherent with the optimised kerbside system defined in the study, we performed a sensitivity analysis with the following data :

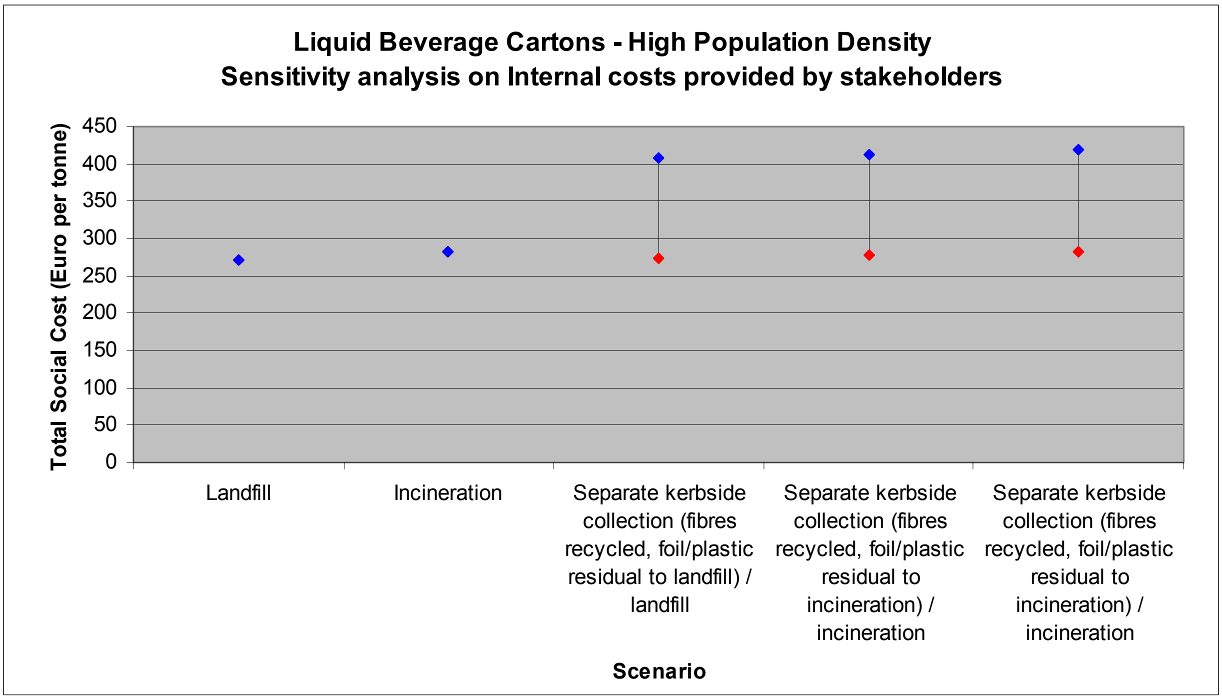
- collection and sorting costs : 100€/t LBC
- total internal costs : 139.1 €/t if rejects are landfilled and 157.9 €/t if rejects are incinerated.
- achievable recycling rate : 41%

The following results are achieved.

Collection method	N/A	N/A	Separate Kerbside (fibres recycled, foil/plastic residual to landfill)		Separate kerbside (fibres recycled, foil/plastic residual to incineration)		Separate kerbside and bring collection (fibres recycled, foil/plastic residual to incineration)	
Recycling rate	**0%**	**0%**	**41%**		**41%**		**41%**	
Residual waste management option	**Landfill**	**Incineration**	**Landfill**		**Landfill**		**Incineration**	
Exeternalities			**TetraPak**	**Study**	**TetraPak**	**Study**	**TetraPak**	**Study**
GWP (kg CO2 eq.)	24.1	20.9	21.3	21.3	24.7	24.7	22.8	22.8
Ozone depletion (kg CFC 11 eq.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acidification (Acid equiv.)	-0.1	-0.6	-0.2	-0.2	-0.3	-0.3	-0.6	-0.6
Toxicity Carcinogens (Cd equiv)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toxicity Gaseous (SO2 equiv.)	-0.4	-2.0	-0.5	-0.5	-0.9	-0.9	-1.8	-1.8
Toxicity Metals non carcinogens (Pb equiv.)	0.0	-0.2	0.0	0.0	-0.1	-0.1	-0.2	-0.2
Toxicity Particulates & aerosols (PM10 equiv)	5.8	-18.7	13.7	13.7	9.2	9.2	-5.2	-5.2
Toxicity Smog (ethylene equiv.)	1.4	0.0	0.8	0.8	0.8	0.8	0.0	0.0
Black smoke (kg dust eq.)	-0.2	-1.8	-0.7	-0.7	-1.0	-1.0	-2.0	-2.0
Fertilisation	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0
Traffic accidents (risk equiv.)	0.2	0.2	0.9	0.9	0.9	0.9	0.9	0.9
Traffic Congestion (car km equiv.)	8.2	7.6	39.7	39.7	39.7	39.7	39.3	39.3
Traffic Noise (car km equiv.)	0.2	0.2	1.0	1.0	1.0	1.0	1.0	1.0
Water Quality Eutrophication (P equiv.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Disaminity (kg LF waste equiv.)	37.0	11.7	25.9	25.9	23.3	23.3	8.3	8.3
TOTAL EXTERNALITIES	**75.9**	**17.1**	**101.7**	**101.7**	**97.1**	**97.1**	**62.3**	**62.3**
INTERNAL COSTS	**196.0**	**265.0**	**172.7**	**307.4**	**180.4**	**315.1**	**221.1**	**355.8**
TOTAL SOCIAL COSTS	**271.9**	**282.1**	**274.3**	**409.0**	**277.5**	**412.2**	**283.4**	**418.1**

Internal costs in blue are calculated based on the current study data.

Internal costs in red are calculated partially based on the data provided by stakeholders.



The preference between recycling and other options is much less clear when using the proposed collection and sorting costs.

If such a separate collection system can be applied, then the different systems should be considered as having similar cost-benefit balances. The conclusion would then be that both selective and non selective collection are optimum systems and the range of optimum recycling rate would vary between 0% and the recycling rate that can be achieved with this system (41%). However, as we did not have the opportunity to study the relevance of the data provided in the comment, this conclusion is made under reservation that the data presented are valid.

It is important to note that for all applications the results achieved may be different if alternative collection and sorting systems are studied. This has already been emphasised in our discussion on limitation, by inferring that local and regional circumstances may mean that optimal systems/recycling rates are different from those identified.

(13) Landfill costs are not representative for the UK ➔ optimum systems could be different taking into account UK prices [U8]

Answer: the study has to be representative of the EU situation, taking into account the effects of the Directive 99/31/EC on landfill.

(14) Internal costs data used in reuse case studies are questionable and should be checked [N14] + see comment IV.1

Answer: Internal costs data were checked and some data changed, a.o. concerning the transport cost that were too high. New calculations were done and included in the main report on pages 107-115 and in annex 12.

3.5 Monetisation of environmental impacts

(15) the economic evaluation of toxic and carcinogenic emissions is challenged. Some values are questionable and seem to be not supported by LCIA or Risk Assessment methods [X19]

Answer: In fact toxic and carcinogenic emissions have a double impact :

- a direct impact due to exposure of humans to them
- an indirect impact due to the loss of welfare as a consequence of people's perceptions and fears

In practice, the second impact may be much bigger than the first one due to the overestimation of the risks by the neighbours of emitting facilities. Those aspects of the economic valuations are thus not related to risk assessment or LCIA. Rather economic valuations are, wherever possible, based on willingness-to-pay to avoid a certain environmental effect. A major factor in the willingness-to-pay will be the perceptions of interviewees (where an environmental effect is perceived to be very bad then the economic valuation will be high). This perception does not have to relate to the reality of the impact. A good example of this is incineration in the UK, where the emissions (dioxins) are perceived to be extremely dangerous to health, hence the NIMBY attitude to incineration in the UK.

An economist will argue that the high economic valuation placed on these emissions is correct, even though it does not reflect the risk posed, as the perceived risk of the public is part of their wellbeing. If they perceive that there is a danger, they are not happy, and therefore their social welfare is damaged – this is part of the economic externality.

This may account for the differences between the economic valuations achieved and what we might expect from LCIA or risk assessment.

4 Specific requests for additional research works or calculations with other data

4.1 Suggested more up-to-date data for recycling case studies

(1) Calculation with the latest IISI LCI data for steel for packaging should be performed [A4]

Answer: MS (check the difference vs used data)

The data used for virgin production and recycling was of steel was derived from the latest IISL data. The reference provided in the original report may not be clear, and should be revised appropriately.

(2) Broader and more current input data is required to reach informed conclusions [U11, V5]

Answer: It is by definition always possible to go deeper in the analysis. However we opine that the data we had were sufficient to take the conclusions we took.

4.2 Suggested additional sensitivity analysis

Additional sensitivity analysis is requested on :

(3) population density (considering very low population density) [A2, F7]

(4) external costs (i.e. test each set of monetisation value) [A2, B12, F3b, H15, I5, I10, O3, R13,V3, X81, X14]

(5) packaging mix (i.e. forecast for 2006) [A2, B13, F10, J2]

(6) marginal collection costs [A2, B5, N17]

(7) market prices for raw and/or secondary materials [A2, B6, F8, R3, U13]

(8) the assumption that the collection rate for plastics industrial waste is 100% [B8, J6]

(9) Ratio Household/industrial plastic packaging waste, according to the data collected by TN Sofres for APME [B11]

(10) Ratio Household/industrial packaging waste for different materials [F4]

(11) Sorting system for Al packaging [H11]

(12) LBC recycling routes and data [T2, T4]

(13) Other environmental data sources in general, as it is commonly done in LCA [V4]

[1] + include a copy of the MPM report in annex

Answer: Here under we give a short comment on the possible influence of the data and parameters suggested to be analysed in the sensitivity analysis :

(3.) population density (considering very low population density)

For very low population density probably specific systems (bring, partial combination with delivery) would be the most efficient. It is difficult however to make a calculation without a new modelling.

It should also be noted that if the global collection frequency is not changed (a selective collection replaces a MSW collection) the global costs should not be very much affected.

It is also expected that the number of people living in areas with a very low population density is very small. Therefore specific results for this type of area should not have a significant influence on the global results at a MS level.

(4.) external costs (i.e. test each set of monetisation value)

The sensitivity to external costs has been checked and generally did not show a significant influence, a.o. due to the dominance of the internal cost in the total cost. However sensitivity analyses have been performed and are presented in annex 10. The reader will note that the presentation has been changed. The previous presentation showed large intervals, from minimum values of minimum impacts (highest recycling rate) to maximum values of maximum impacts (lowest recycling rate). The new presentation shows the results for both the minimum and maximum monetisation values separately.

(5.) packaging mix (i.e. forecast for 2006)

The sensitivity to the packaging mix was analysed. Results are provided on pages 104 to 106. The wording is reviewed in order to enhance the comprehension and the data.

(6.) marginal collection costs

see above (3.4, comments (8) and (10))

(7.) market prices for raw and/or secondary materials

see above (0.1.1, comment (20))

(8.) the assumption that the collection rate for plastics industrial waste is 100%

The collection rate for plastics industrial waste in the study is not 100%. Collection rates are taken into account in table 6 p. 41. They depend on the applications and have been discussed with EuPC members. Another value tested should be close to this one to be realistic. Therefore we do not expect any change in the conclusions.

(9.) Ratio Household/industrial plastic packaging waste, according to the data collected by TN Sofres for APME

see above (3.1, comment (1))

(10.) Lower Ratio Household/industrial packaging waste for different materials

see above (3.1, comment (1))

(11.) Sorting system for Al packaging can be cheaper with handpicking in small sorting plants

Indeed. This could have a favourable influence on the internal costs. This change would make Al recycling more attractive.

(12.) LBC recycling routes and data

No LCI data could be sourced to evaluate alternative recycling routes. However, the stakeholders provided some alternative cost and performance data for a hybrid collection system. This has been analysed and the potential implications are considered (see answer to 3.4, comment(12), p.196)

(13.) Other environmental data sources in general, as it is commonly done in LCA [V4]

Due to the large number of data, the sensitivity analysis is limited to a certain number of data and assumptions. We opine the potentially most sensible data and assumptions have been tested.

(14) Provide a thorough sensitivity analysis of different CBA methodologies (not just minimum and maximum values but each CBA approach separately) and a discussion of the impact on the final results [X14]

Answer: Please see limitation 3 (page 10) : we clearly state that data have come from limited number of sources and not always cross-checked due to resource constraints. This still applies. To use other LCI data for all systems would be a big task. See (4.)

4.3 Reuse

(15) Calculations should be done with up to date data from APME and FEVE (glass case studies: LCA data, weight…) [I17, N7, N10, N11, N12]

Answer: The reuse case study is reviewed with (a.o. those) up-to-date data. Results are given in Chapter 4.4 Reuse and in annex 12.

(16) Reuse : transport costs and number of uses should be revised [G1, I2, M9]

Answer: The reuse case study is reviewed with (a.o. those) up-to-date data. Results are given in Chapter 4.4 Reuse and in annex 12.

(17) Reuse : all transport costs are allocated to the packaging and not to the product itself [M9]

Answer: This is the only logic approach as the goal of this case study is to determine the influence of the choice of the packaging systems. So all the cost differences due to a switch from one system to another one are relevant and need to be taken into account in the calculations.

(18) Reuse models should include the EU average split between landfill and incineration instead of 50/50 [N13]

Answer: A dominance analysis has shown that the waste management stages of the life cycle have limited contribution to the total life cycle impacts identified. The dominant life cycle stages in terms of the environmental externalities are the production and conversion of the raw materials, the transport of packaging from manufacturer to filler, and the distribution of filled packaging (and for reuse, transport of returns). An alternative waste management split would not influence significantly the results achieved and would not have an effect on the conclusions drawn.

5 Specific requests for explanations and clarifications

(1) conclusions and executive summary should highlight shortcomings and limitations (int. al. effect of the sensitivity analysis, pack mix, …) of the study. No political conclusion should be drawn [I9, J2, M2, X2, X10]

Answer: executive summary is added taking into account the discussion of this comment.

(2) It should be clearly stated that :

❖ there are gaps in the availability of damage cost data [M11]

Answer: There are indeed gaps in the availability of damage cost data. This is a limitation of the study. This is made clear in the main report (p. 9-12) and in the executive summary.

❖ "Benefits transfer is not used" [M12]

Answer: The costs of undertaking an economic valuation exercise are prohibitive. Therefore, this study takes as a basis only monetisation factors available in the literature. However, economic valuations have not been conducted for each impact category in each Member State. The study therefore applies the principle of benefit transfer.

Benefit transfer is the practice of using monetisation factors from previous studies which may focus on a different region or time period.

Three alternative approaches to benefit transfer can be applied:

- Direct transference of mean values – this is a very simple approach, where values from the original study are directly applied to the new study
- Transference of adjusted unit values – this approach adjusts past estimates to correct for any original bias, or to take into account socio-economic characteristics of the particular project, the potential levels of damage reduction, regional and site characteristics and the availability of substitute goods
- Transference of a demand function – this approach takes demand functions from the previous studies and inputs new data relevant to the current project, then re-runs the analysis. This type of approach is preferable but difficult as the data needed to re-run the analysis is unlikely to be available.

This study applied only direct transference of mean values. No adjustments or demand functions have been considered. This is a limitation to the methodology, as it introduces uncertainties. However, the use of alternative monetisation factors in the sensitivity analysis gives some indication as to the sensitivity of the overall results achieved and conclusions drawn to the monetisation factors, and therefore gives some indication of how important the benefit transfer approach applied might be. It may have been interesting to further develop the benefit transfer approach and apply wider sensitivity analysis, but this was beyond the scope and constraints of the study.

(3) The draft is difficult to read, giving extensive but too general explanations. [I12]

Answer: this follow up contract aims at improving the readability of the study and adds an executive summary.

(4) The term "recycling" is used in place of "collection" in many part of the report. It should be clarified and taken into account in the recycling rates [J6, P5]

Answer: In this report, when recycling rates are suggested, they refer to a measurement of the recycled amount at the outlet of the sorting plant (or at the inlet of the recycling plant). So the amount collected is very close to the amount recycled. But the streams entering the recycling plants are not pure so that there will be by definition losses in the recycling plants.

(5) CBA results should be more clearly explained [S1]

Answer: This comment concerns the interpretation of the results. The CBA adds up the cost to the society (i.e. external, or environmental and social costs) and costs paid by the process operators (i.e. internal or economic costs). In the current study, the "optimum" system is the one that presents the lowest total social cost, i.e. the lowest sum of the internal and external costs. For the meaning of a significant difference and the limitations, please refer to p. 191, comment (29).

(6) Presentation of tables 30 (pack mix 2001) and 32 (pack mix 2006) should be revised in order to avoid confusion between results [N21]

Answer: Revision of the presentation was done. See report p. 100-103

(7) Conclusion 3 : should be replaced by "separate kerbside collection is preferable with notable exceptions" [N3]

Answer: We agree. This gives a more correct summary of the text explaining conclusion 3. See report p. 117.

(8) Chapter "conclusions" lacks references to which table supports the conclusion drawn. [S3]

Answer: References are added once conclusions are revised.

(9) Details of the collection costs calculated by Beture are requested. [W4]

Answer: Those data are based on their experience in many projects in different countries. They should be regarded as typical values but do not refer to a specific project or MS.

(10) For each limitation (list given in the comment) it should be specified to which degree it is reflected in the final proposition and what is its impact on the validity of the proposal. [X3]

Answer: In order to quantify the impacts of each of the limitations would require considerable efforts. Even if we had time for it, those efforts would be better used in further data collection. Therefore we suggest each reader makes his own estimation of the effect of the listed limitations. Our impression is that globally the conclusions are reliable.

(11) More transparent documentation of the extrapolation from the case studies to conclusions for the overall packaging mix [X13e]

Answer: The application of the CBA results (i.e. case studies results) to determine optimum recycling targets (i.e. conclusion for the overall packaging mix) is described in details in the main report in chapter 3.4 (pages 51 to 62).

(12) In Annex 10, 1.4.1.1 Choice of external valuations, it is not correct to delete "Graph 3 & 4 show that the results achieved and conclusions drawn are highly dependent upon the economic valuations applied to the environmental impacts. Applying the full range of available economic valuations make it impossible to distinguish an optimum system from the scenarios studied". [A11]

Answer: The sentence you refer to was written with preliminary results. When making the final calculations and analyses we came to different conclusions about the sensitivity of the results to the monetisation values. See report annex 10

(13) The study should provide more explanations and justifications for the plastics packaging mix selected for the year 2006 [B13]

Answer: the plastics packaging mix for the year 2006 is based on the following sources:

- APME, "Potential for Post-User Plastic Waste Recycling (Confidential), 1998
- APME, "A material of choice for packaging – Insight into consumption and recovery in Western Europe", Spring 1999
- Packaging in Germany, 2d edition, Pira International Market Report, 1999

(14) The assumptions of the two collection schemes are not properly described in the study and therefore, it is rather difficult to assess if the assumptions are reasonable. [G2b, I15]

Answer: (see Report Annex 1) A detailed description is already given in Annex 1. No further detail can be added, as the models were hypothetical only.

(15) The reason why, when there is a difference between the achievable recycling rates for high and low population density, the rates for low population density is the highest, should be further explained [G3]

Answer: The data used are the data from the practice, not assumptions. Possible (but not demonstrated) explanations are :

- Higher fraction of the population with social difficulties in cities. People with social difficulties show traditionally a lower participation grade.
- Lack of place for selective collection in cities, which implies a lower participation grade. This second reason might be one of the causes for the first reason (social factor).
- Different packaging consumption in cities (the measured rates always suppose a uniform purchase behaviour throughout the countries)

(16) The reason why when in some cases collection costs are lower in areas with low population density compared to areas with high population density should be explained [G8, U6, W1]

Answer: The basic reason is the difference in collection frequency. Due to the lack of space in areas with high population density the collection frequency must be set high. The time "lost" between to collection points in areas with low population density is more than compensated by the increase in amount collected per collection point.

(17) The method to allocate collection costs to single materials is unclear. [I15, U7, W2, W8]

Answer: Basically the collection frequency, the number of bags and the number of truck trips (correlated with the truck filling) all depend on the volume of the packaging. Therefore the collection costs were allocated to the volume taken by the packaging waste in the bags. So the cost allocated to Packaging X is proportional to the volume X occupied by Packaging X in the collection bag. This volume X = weight of collected Packaging X / density of Packaging X. Thus :

$$\text{Cost allocated to X} = \frac{\text{weight of X / density of X}}{\text{Sum (weight of } X_i \text{ / density of } X_i\text{)}}$$

(18) The description of plastic films applications should be revised to integrate other applications than shrink and stretch palletisation films (i.e. for 2000, 30 kt shrink films + 115 kt stretch films + 61 kt heavy duty sacks) [B10]

Answer: The comment refers only to industrial packaging and provided data are related to UK. No data has been collected to confirm the data given by the stakeholder. However the data used in the calculations (i.e. amounts of stretch & shrink films and bags) were provided by APME (Confidential report). Therefore no sensitivity calculation was performed.

The suggested wording for table 7 is taken into account.

(19) Choice of the case studies: Aluminium case studies should be further justified with regard to the other packaging materials and their specific case studies [H2]

Answer: See 2.1, comment (4)

(20) The description of kerbside collection in case of Al appears over simplistic [H10]

Answer: As all models, the models used are a simplified version of the reality.

(21) There is no evidence on how the study integrates common optimised collection practices in the Al case studies, defined per kind of Al applications [H4, H5]

Answer: the optimised collection practices relating to the aluminium case studies refer to the multimaterial recovery schemes, where the light packaging fraction is collected together, before to be sorted. The study takes this practice into account, as it is explained on pages 98-99. Optimal collection systems for metal packaging are determined taking into account the fraction of the different applications (i.e. steel, Aluminium cans and other rigid and semi-rigid aluminium applications).

(22) There is no indication of the recycling rates applied to the various Al applications [H9]

Answer: Indeed, the study does not mention optimum recycling rates for the various Al applications. The study is based on a bottom up approach : the more the results are detailed the less they are reliable. Therefore the study calculation were based on recycling rates specific to the different applications but results are only given for aluminium packaging in order to avoid misuse of detailed data.

(23) Scenarios modelled should be more clearly stated and indicate how the price revenue for cardboard is calculated [R5]

Answer: It is an average value over the last 5 years

(24) It is requested to provide detailed LCI results, in conformance with ISO 14040 [A3, G7, ~I9, R11, X13b]

Answer: this would be a big effort, and would not add value or change the results. When the data sources are public ISO 14040 does not require to provide the LCI data, but only the data sources. For the other LCI data, we have indicated the source and the values unless confidential. The confidential data can be checked by peer reviewers.

(25) Assumptions (especially those related to Al packaging recovery during incineration) should be further explained, because they are questionable / there is a request for more transparency [H12, H13, I17, N18]

Answer: see annex 2

(26) All data sources used for the LCA/CBA should be comprehensively detailed [M7, N18, X13a]

Answer: All original data sources are referenced in Annex 7 of the report, and as much clarity regarding the assumptions and manipulations applied to the data has been given as possible. To reproduce all data and calculations would provide little in terms of added value to the report.

(27) The same level of detail as in annex 2 (incineration) should be applied equally across the study to justify choices made at each stage of the life cycle [M8, X13c, X13d]

Answer: a detailed level of explanation of the incineration model was given as this was the only model where new research was made – all other models have been put together using publicly available and referenced LCI data sets, using the same assumptions/allocations made in the original references. All landfill data has been derived from the data available through the UK Environment Agency's Life cycle waste management programme, and is referenced in Annex 7 of the main report.

(28) A full list of the cost and benefits considered and measured in the report should be included. [M10]

Answer: Detailed internal and external costs are given respectively in annexes 3 and 10, for each of the selected case study. Moreover annex 10 provides results (i.e. internal, external and total social costs) of the sensitivity analysis. The costs and benefits included in the study are those related to the processes considered in each case study (see annex 1 : description of the case studies).

(29) Have environmental and cost data been checked for applicability to the glass container industry throughout the EU ? [N2]

Answer: for environmental data, we used a readily available LCI data source (see statement on Pages 9-12, Limitations of the data). Thus, no attempt was made to crosscheck this with other data sources, or to check directly with manufacturers that it is representative/applicable throughout EU. However, all trade associations had the opportunity to contribute with LCI data for use in the study – none was presented by the glass industry.

(30) Have not the figures for production cost per 1000 litres been inverted in the case of PET? [N15]

Answer: Data are checked and revised in the final report.

(31) Glass case study : The missing information for the recycling glass CBA should be provided in the report - together with sources. [N20]

Answer: Internal data costs for glass single trip case study are added in annex 3.

(32) The presentation of the final recycling targets does not represent the listed uncertainties and actual outcomes of the case studies. There could be misunderstandings. [V8]

Answer: See answer to comment (29) (chapter 2.3, p.191) concerning the global uncertainties.

(33) The apparent contradiction of the relative selective collection costs with those of refuse is raised. [W2]

Answer: See answer to comment (8) (chapter 3.4 Cost data, p.195).

(34) The assumption, that where costs were low for disposal the social values would be correspondingly low, was challenged. It should be put aside in the analysis unless evidence of a correlation between the costs of disposal and environmental awareness can be provided. [W7]

Answer: The assumption is not that there is a correlation between the costs of disposal and environmental awareness. The assumption is that there is a correlation between the costs of selective collection/sorting and the general cost level. Of course if the general cost level is lower, the willingness-to-pay will be lower. So implicitly the main assumption is that there is no difference in relative willingness-to-pay[2]. We agree that this assumption can be challenged but it still remains reasonable.

(35) The approach to determining different targets for individual MS takes into account EU wide values and allocates results according to population density and MSW treatment. The costs that would provide the differential across MS, for example the collection and disposal costs, are not accounted for by individual MS. How can this approach provide a sound basis on which to determine MS specific targets ? [W10]]

[2] a similar reasoning is also valid for the hedonic and damage values

Answer: See answer to comment (8) (chapter 3.4 Cost data, p.195).. The cost figures can vary from one MS to another due to

- different population density (this is taken into account)
- non optimised collection system (only optimised systems are considered for the long run)
- the general price level is different; in this case it can be assumed that all types of costs and benefits vary more or less the same way. Therefore the costs-benefit balances should not be very different from one to another MS (for similar population density and collection systems).

(36) The assumption of a ‘steady state’ situation regarding the recycling infrastructure (proposed final draft p. 10) seems to be unrealistic. [X6]

Answer: see report p.12.

(37) It is requested to provide more background discussion and justification for the choice of each of the factors for the economic values.[X15]

Answer: The justification for the monetisation values is largely given in the report's annex 4 concerning this aspect (derived from IVM's report). When different values were proposed, we tried to select the most recent, reliable or realistic one. In the report the figures used are clearly given. The tests made to analyse the sensitivity of the results provided some confidence in the robustness of the results when monetisation values change.

(38) A short description of each CBA method used in the sensitivity analysis (max. one page each) should be included in the Annex of the final report [X16]

(39) It is requested to compare CBA economic valuation figures of emissions/impacts with different LCIA methods and discuss relevant differences [X17]

(40) It is requested to determine the most relevant emissions according to the different approaches and discuss relevant differences between CBA and LCIA methods as well as relevant differences in between the used CBA methods. [X18]

Answer (common to comments 38, 39 and 40) : the comment is relevant but could not be addressed due to time and budget constraints.

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Part	N°	APEAL	APME	ADM	BDE	CEI Bois	CIAA	Danish EPA	EAA	EEB	EUPC	EUPET	EUMEPS	EUROPEN	FEVE	GUA	Institute of Packaging UK	IVCIE	Pro-Europe	Sweden	Tetra Pak	Valpak	VVAV	Julia Hummel	Rana Pant
1	1	x		x				x		x				x	x		x	x		x		x	x		
1	2			x			x										x			x		x			
1	3				x																				
1	4	x	x							x				x											x
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Part	N°	APEAL	APME	ADM	BDE	CEI Bois	CIAA	Danish EPA	EAA	EEB	EUPC	EUPET	EUMEPS	EUROPEN	FEVE	GUA	Institute of Packaging UK	IVCIE	Pro-Europe	Sweden	Tetra Pak	Valpak	VVAV	Julia Hummel	Rana Pant
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Part	N°	APEAL	APME	ADM	BDE	CEI Bois	CIAA	Danish EPA	EAA	EEB	EUPC	EUPET	EUMEPS	EUROPEN	FEVE	GUA	Institute of Packaging UK	IVCIE	Pro-Europe	Sweden	Tetra Pak	Valpak	VVAV	Julia Hummel	Rana Pant
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