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Life Cycle Assessment of Packaging Systems for Beer and Soft Drinks

Refillable PET Bottles

Ministry of Environment and Energy, Denmark
Danish Environmental Protection Agency

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Life Cycle Assessment of Packaging Systems for Beer and Soft Drinks

Refillable PET Bottles
Technical Report 5

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Contents

Summary

This report

This report is part of a life cycle assessment comparing the potential environmental impacts associated with different packaging systems for carbonated soft drinks filled and sold in Denmark. This report contains a short introduction, system descriptions, inventory analysis, impact assessment, and interpretation for packaging systems using refillable PET bottles.

Function / Functional unit

The function of the packaging systems is to facilitate distribution of carbonated soft drinks from the soft drink producers via retailers to the consumers. The functional unit in this report is the packaging of 1000 litres of beverage and the distribution of this beverage.

Processes included

The process tree is illustrated in Figure A.1 in annex A. Production of polyethylene terephthalate (PET) and PET preforms and bottles is included in the assessment. Production of low density polyethylene (LDPE), polypropylene (PP), cardboard, paper, glue and planks used in secondary packaging and transport packaging is also included in the assessment. The system also includes the filling and distribution of the beverage, as well as the cooling of the packaging in the refrigerator of the consumer. Finally, it includes waste management and recycling processes. Excluded processes and flows are described in the Main report.

Inventory

A quantitative description of the investigated systems and the results from the inventory analysis is given in Chapter 3. Data and calculations on the environmental inputs and outputs of the processes in the process tree are presented in annex A and B. For data on the environmental inputs and outputs of electricity production and transports, we refer to Technical report 7.

Most of the used bottles (98.5%) are assumed to be collected for recycling.

Impact assessment

The impact assessment method applied is the EDIP method (Wenzel *et al.* 1997). A short description can be found in the main report. Work environment and impacts from use and misuse of the products are not included in the study. This means also that the possible effects of littering and migration from the packaging to the beverage are not included. Impacts from noise, visual impacts and bodily harm due to accidents are not included in the study. Chapter 4 includes results from the impact assessment.

Interpretation

The interpretation of the LCA results includes a dominance analysis, sensitivity analyses, an assessment of data gaps and data quality, and conclusions from the LCA. It is reported in Chapter 5.

Important impacts

The packaging systems with refillable PET bottles contribute most to the following environmental impacts:

- Ecotoxicity, terrestrial, chronic (ETSC)
- Human toxicity, soil (HTS)

- Ecotoxicity, aquatic, chronic (ETWC)
- Human toxicity, water (HTW)
- Global warming (GWP)
- Human toxicity, air (HTA)

Waste and resources

The refillable PET bottle systems contribute less than 100 mPET for all waste categories and less than 1 mPR for the depletion of all resources.

Important processes

The most important processes for the refillable PET bottle system are:

- Distribution of beverage
- Washing & filling
- PET-resin production

Sensitivity analyses

The following sensitivity analyses were performed:

- Collection rate: 90 %
- Share of discarded bottles at the soft drink producer
- Bottle weight: +20 %
- Allocation methods (PET recycling)
- Distribution of beverage (light truck)
- Electricity production (fragmented markets and European base load)

It is clear from the results that the assumption regarding the collection rate is important. An increased share of discarded bottles at the soft drink producer has similar effects as the decrease of collection rate.

The bottle weight appears to be of minor importance especially since the bottle weight increase of 20 % is excessive. In the recycling of discarded PET bottles it is assumed that 50 % of the PET replaces virgin raw materials and that 50 % replaces recycled material from other products. This assumption is important for the LCA results.

When using data for light truck in the distribution of beverage the environmental impacts were increased, especially concerning NO_x and CO_2.

The electricity data used in the base case represent coal marginal. Two sensitivity analysis were performed for electricity production (long term base load at fragmented markets and European base load average). It is clear from the results that the assumption regarding the electricity production is important.

Data gaps and omissions

The most important data gaps are:

- There are no information available concerning the share of material scrap lost in the preform/bottle and PET-recycling processes.
- There are no information about potential water emissions in the washing and filling process.
- The most important non-elementary inflow is sodium hydroxide (NaOH) used in the washing and filling process. When including the production of

NaOH the total energy demand in the packaging system would increase by approximately 3 %.
- Production of materials for secondary packagings (multipacks), transport packaging (pallets and plastic ligature) and cap inserts is included in the LCA, but the actual packaging production - conversion, nailing etc. - is not included.
- There are important data gaps in the characterisation of human toxicity in air and soil, as well as of chronic terrestrial and aquatic ecotoxicity.

Uncertainties

The data quality for the two most important processes (distribution and washing & filling) is assessed to have medium uncertainty, fair completeness and good representativity.

The uncertainties in the normalisation of toxicity impacts are large. However, this does not affect the comparisons between the systems.

1 Introduction

The study

This report is part of a series of 8 reports from a life cycle assessment (LCA) comparing the potential environmental impacts associated with different packaging systems for beer and carbonated soft drinks filled and sold in Denmark.

Main report

Main report: Goal and scope definition, including description and discussions on methodology. Summary of the LCA of the different packaging systems. Comparisons of the different packaging systems. Comparison of the previous and the updated study.

Individual systems

Technical report 1: Refillable glass bottles: including description of the system, data, inventory analysis, impact assessment, and interpretation.

Technical report 2: Disposable glass bottles: including description of the system, data, inventory analysis, impact assessment, and interpretation.

Technical report 3: Aluminium cans: including description of the system, data, inventory analysis, impact assessment, and interpretation.

Technical report 4: Steel cans: including description of the system, data, inventory analysis, impact assessment, and interpretation.

Technical report 5: Refillable PET bottles: including description of the system, data, inventory analysis, impact assessment, and interpretation.

Technical report 6: Disposable PET bottles: including description of the system, data, inventory analysis, impact assessment, and interpretation.

Energy and transports

Technical report 7: Energy and transport scenarios, including energy and transport data, sensitivity analysis and data quality assessment.

Commissioner and practitioner

The study was financed by the Danish Environmental Protection Agency (DEPA). It was performed by Chalmers Industriteknik (CIT), Göteborg, Sweden and Institute for Product Development (IPU), Lyngby, Denmark.

Critical review

This report has been peer reviewed following the procedure outlined in the Main report, section 2.15.

Project framework

This report was produced during the period December 1997 to May 1998. The entire project was scheduled for May 1997 to May 1998.

Adherence to ISO

We adhere to the requirements of the standards ISO 14040 and ISO 14041. Several of the requirements and recommendations presented in the ISO documents need to be interpreted. We present our interpretations where applicable.

2 System descriptions

2.1 The systems investigated

The packaging systems

In this report we present the LCA of packaging systems with 50 cl and 150 cl refillable PET bottles. The packaging systems include the life cycles of the primary packaging - the PET bottles - polypropylene (PP) for bottle caps, paper and glue for labels and secondary packaging: high density polyethylene DPE) crates and trays, cardboard and low density polyethylene (LDPE) multipacks. The systems also include the life cycles of the transport packaging: wooden pallets and plastic ligature. The discussion below refers to the detailed process tree illustrated in annex A. In Figure 3.1 a simplified process tree is presented.

PET-resin production

PET-resin production include all process steps from extraction of feedstock resources (crude oil and natural gas) to solid state polymerisation.

Primary packaging

The production of primary packaging includes the two steps preform and bottle manufacturing.

Washing and filling

Refillable bottles are returned to the soft drink producer, where the bottles are washed and filled. A small share (3.5 %) of the bottles are discarded for quality reasons. The production of sodium hydroxide (NaOH) used for washing is not included.

Caps and inserts

The bottle caps are produced from polypropylene (PP) and the cap inserts are made of low density polyethylene (LDPE). The production of caps are included in the study while the production of inserts is not included. The production of raw materials for caps and inserts (PP and LDPE) is included and covers all process steps from extraction of feedstock resources (crude oil and natural gas) to polymerisation.

Secondary packaging

The secondary packaging consists of cardboard and LDPE multipacks and high density polyethylene (HDPE) crates and trays. The production of multipacks is not included in the study. The manufacturing of crates and trays is represented by two steps, grinding into granulate and production of new crates from the recovered granulate by injection moulding. The production of LDPE include all process steps from extraction of feedstock resources (crude oil and natural gas) to polymerisation. The production of cardboard covers all processes from wood harvesting to the board mill.

Labels and glue

The production of paper for labels, label printing as well as the glue for labels are included in the study. The paper production covers all processes from wood harvesting to the paper mill. The process "Glue production" only includes the glue factory, not the raw material manufacturing.

Transport packaging	The production of transport packaging (pallets and plastic ligature) is not included in the study, but the production of raw materials (wood and LDPE) is included.
PET recycling	The system investigated was expanded to include the parts of other life cycles affected by the outflow of recycled PET bottles. It is difficult to state whether this recycled PET replaces virgin or recycled material. The recycled PET has been assumed to replace equal amounts of virgin PET and PET recycled from other products (see Main report, section 2.7.5). The large uncertainty in this assumption has a significant effect on the results (see also chapter 5). It should be noted that 35 % of the recycled material is used for producing new PET bottles in Sweden today. In the future, new technic will probably increase this figure to 85 % (Andersson R 1998). The following processes have been included in the study (see process tree in annex A): bailing of used bottles, production of recycled PET-resin from used bottles, avoided production of virgin PET-resin, avoided production of recycled PET-resin from other products and landfilling of other products. The manufacturing of new products from recycled PET bottles and the manufacturing of other products are not included.
PP recycling	The recycling of PP caps is treated the same way as the recycling of PET bottles above. The recycled PP has been assumed to replace equal amounts of virgin PP and PP recycled from other products. The PP recycling involves production of recycled PP from used caps, avoided production of virgin PP, avoided production of recycled PP from other products and landfilling of other products. The manufacturing of new products from recycled PP caps and the manufacturing of other products are not included.
Distribution of beverage	The distribution of the beverage covers the transport of all packaging (incl. beverage) from the soft drink producer to the retailer, and the return transport of empty packagings.
Retailer	The handling of the PET bottles at the retailer is not included in the study.
Use	The study does not include the consumption of the beverage, but only the cooling of bottles in the refrigerator of the consumer.
Waste management	The waste management includes incineration of wood pallets and label paper discarded at the soft drink producer as well as consumer waste (PP caps, PET bottles, cardboard multipacks, PE multipacks and plastic ligature). The systems are expanded to include parts of other life cycles that are affected by the energy recovery at waste incineration. The recovered energy is assumed to replace a mix of light fuel oil and natural gas. This is represented by the processes "Energy production" and "Alternative energy production" in the detailed process tree.

2.2 Allocation procedures

Adherence to ISO

For a general description of the allocation procedure used in this project, see Main report.

Avoiding allocation

As indicated above, we avoided allocation by system expansion in the following cases:

- Waste incineration with energy recovery
- Recycling of PET bottles and PP caps after use

Closed-loop procedure

A closed-loop procedure was used for the recycling of HDPE crates and trays: the crates and trays that are recycled after use is assumed to be used in the production of new crates and trays.

Cut-off at recycling

Cardboard multipacks and LDPE ligature are recycled in smaller amounts (less than 0.1% of the weight of the PET bottles). These outflows are non-elementary outflows from the system. We have not credited the investigated systems any benefits for delivering these materials to recycling, nor have the investigated systems been allocated any part of the final waste handling. The effects of this on the total LCA results are clearly small. First, these non-elementary outflows are very small. Second, the system investigated does include primary production of cardboard and LDPE.

Aggregated data

Data on production of PET, PP and LDPE are literature data from Association of Plastics Manufacturers in Europe (APME; Boustead 1993 and 1995). These are given as allocated data using allocation based on physical properties of the products (Boustead 1992) and not adequately disaggregated to allow recalculation according to the ISO procedure. In spite of this, we find it preferable to use these data than to use older, disaggregated data from other sources. The effects on the total LCA results can be significant.

2.3 Reporting

The report series

As stated above (chapter 1), this report is one out of a series of 8 from the LCA project.

Structure of this report

Each of the subsequent chapters deals with one of the LCA phases. Chapter 3 includes a quantitative description of the systems investigated and results from the inventory analysis. Data and calculations on the environmental inputs and outputs of the processes in the process tree are presented in annex A and B. For data on the environmental inputs and outputs of electricity production and transports, we refer to Technical report 7. Chapter 4 includes results from the impact assessment. Chapter 5, finally, includes an interpretation of the results and conclusions from the LCA.

Limitations for other applications

While some of the data in this study may also be useful for other purposes, the nature of the data needed when making a comparison is not necessarily identical to that needed for other applications such as environmental declarations or for identifying improvements options within the studied systems. In particular, it can be noted that the calculations on the distribution takes not only the packagings but also the beverage into account. Consequently, the results for the individual packaging systems should not be used to identify the main impacts in the life cycle of the packaging, without adjusting for the included beverage. In general, any conclusions of this study outside its original context should be avoided.

3 Inventory analysis

3.1 50 cl refillable PET bottles

The life cycle

The process tree of the packaging system is illustrated in Figure A.1 in annex A. A simplified process tree is presented in Figure 3.1. The 50 cl refillable PET bottle is produced from preforms produced from polyethylene terephthalate (PET). To distribute 1000 litres of beverage 2000 50 cl PET bottles (1000/0.50) are needed. The weight of one 50 cl refillable PET bottle is 0.053 kilograms.

Most of the used bottles (98.5%) are collected for recycling (see Table 3.1). The remaining 1.5% end up in waste incineration where they absorb energy from other incinerated wastes. A small share (3.5%) are discarded at the washing and filling processes. The discarded bottles are recycled into other systems (see Main report, section 2.5).

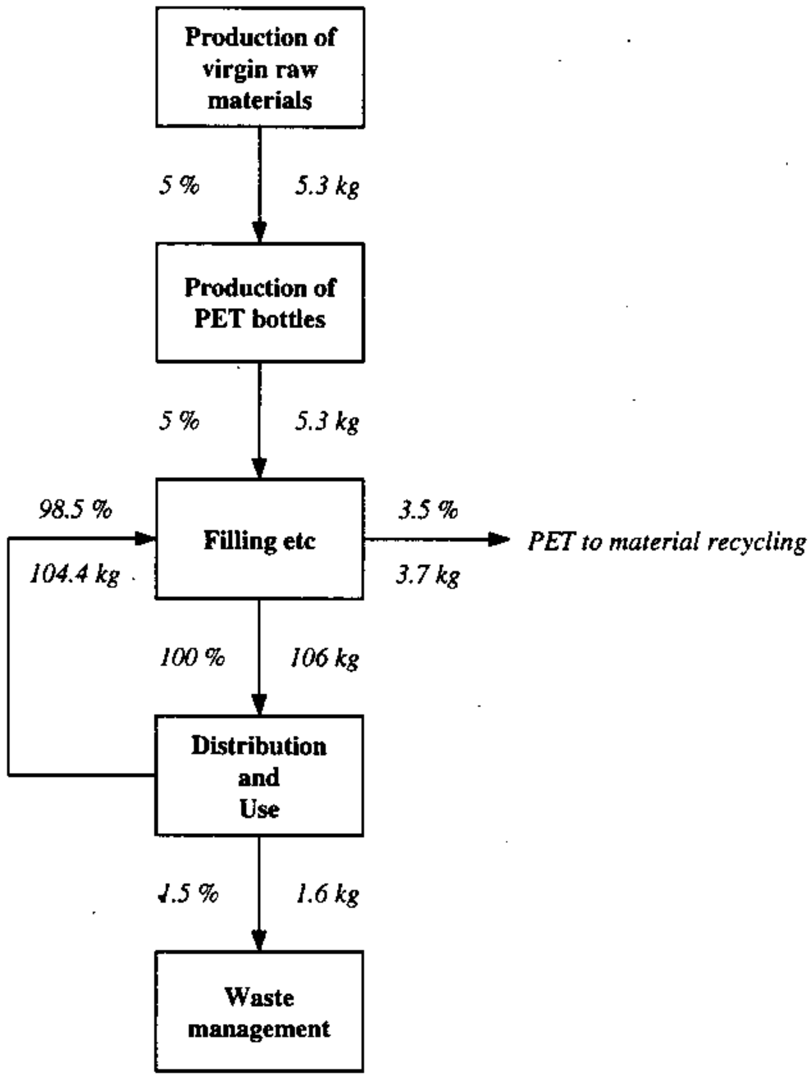

Figure 3.1
Flows of 50 cl refillable PET bottles per 1000 litres of beverage. (Flows of labels, caps, secondary packaging and transport packaging are not included).

Input data

The secondary packagings and transport packagings are quantitatively described by the system parameters in Table 3.1. Data and calculations on the environmental inputs and outputs of the processes in the process tree are presented in annex A. Data on the environmental inputs and outputs of transports and on the production of fuels and electricity are presented in Technical report 7.

Table 3.1
System parameters for the packaging system with 50 cl refillable PET bottles. The mass presented refers to the weight of a single item, i.e., one bottle or one tray. The market shares of the secondary packaging do not add up to 100% as they may be combined in different ways.

	Name	Mass [g]	Market share	Material	Degree of reuse	Material to recycling	Degree of disposal
Primary packaging	PET bottle (50 cl)	53	100 %	PET	95 %	3.5 %	1.5 %
	Cap	2.0	100 %	PP	0 %	85 %	15 %
	Insert	0.2	100 %	LDPE	0 %	85 %	15 %
	Label	0.6	100 %	Paper	0 %	0 %	100 %
	Glue	0.2	100 %	Casein/urea/H_2O	0 %	0 %	100 %
Secondary packaging	Crate (24 bottles)	1550	90 %	HDPE	99.4 %	0.6 %	0 %
	Tray (48 bottles)	1800	10 %	HDPE	99.4 %	0.6 %	0 %
	Multipack (6 bottles)	18	5 %	Cardboard	0 %	20 %	80 %
	Multipack (6 bottles)	15	5 %	LDPE	0 %	0 %	100 %
Transport packaging	Pallet (960 bottles)	22000	100 %	Wood	95 %	0 %	5 %
	Plastic ligature (960 bottles)	20	100 %	LDPE	0 %	70 %	30 %

Table 3.2

Energy demand at final use for the packaging system with 50 cl refillable PET bottles. These energy flows are not flows across the system boundary but internal flows within the system. Functional unit: packaging and distribution of 1000 litres.

	Unit	Packaging system	Effects on other life cycles	Total
Electricity, total	kWh	4.07E+01	-3.39	3.73E+01
Electricity	*kWh*	*3.24*	*-2.62*	*6.12E-01*
Electricity, coal marginal	*kWh*	*3.65E+01*	*-6.15E-02*	*3.64E+01*
Hydro power	*kWh*	*1.00*	*-7.03E-01*	*3.00E-01*
Fossil fuel, total	MJ	1.29E+03	-4.26E+02	8.61E+02
Coal	*MJ*	*2.93E+01*	*-1.03E+01*	*1.90E+01*
Coal, feedstock	*MJ*	*9.93E-02*	*-3.72E-02*	*6.21E-02*
Diesel, heavy & medium truck (highway)	*MJ*	*9.75E+01*	*1.74*	*9.92E+01*
Diesel, heavy & medium truck (rural)	*MJ*	*9.55E+01*	*0*	*9.55E+01*
Diesel, heavy & medium truck (urban)	*MJ*	*8.05E+01*	*1.30E-01*	*8.06E+01*
Diesel, ship (4-stroke)	*MJ*	*6.10E-01*	*0*	*6.10E-01*
Fuel, unspecified [MJ]	*MJ*	*2.53E-04*	*-4.14E-07*	*2.53E-04*
Hard coal	*MJ*	*7.12E+01*	*0*	*7.12E+01*
Natural gas (>100 kW)	*MJ*	*1.12E+02*	*-5.02E+01*	*6.16E+01*
Natural gas	*MJ*	*1.36E+02*	*-4.78E+01*	*8.84E+01*
Natural gas, feedstock	*MJ*	*1.40E+02*	*-4.70E+01*	*9.27E+01*
Oil	*MJ*	*1.23E+02*	*-4.09E+01*	*8.17E+01*
Oil, feedstock	*MJ*	*3.93E+02*	*-1.53E+02*	*2.40E+02*
Oil, heavy fuel	*MJ*	*6.75*	*0*	*6.75*
Oil, light fuel	*MJ*	*6.88E-01*	*-7.85E+01*	*-7.78E+01*
Peat	*MJ*	*1.26*	*0*	*1.26*
Renewable fuel, total	MJ	4.39	0	4.39
Bark	*MJ*	*4.39*	*0*	*4.39*
Heat etc., total	MJ	-4.93	0	-4.93
Heat	*MJ*	*-1.02E-01*	*0*	*-1.02E-01*
Steam	*MJ*	*-4.52*	*0*	*-4.52*
Warm water	*MJ*	*-3.07E-01*	*0*	*-3.07E-01*

Table 3.3
Inventory results for the packaging system with 50 cl refillable PET bottles. Functional unit: packaging and distribution of 1000 litres.

	Unit	Packaging system	Effects on other life cycles	Total
Resources				
Al	g	2.53E-02	-4.14E-05	2.53E-02
Bauxite	g	3.43	-1.32	2.11
Biomass	g	2.07E-01	-2.10E-10	2.07E-01
Brown coal	g	2.88E+02	-3.19E+01	2.56E+02
$CaCO_3$	g	4.44E-02	-6.99E-05	4.43E-02
Clay	g	1.49E-01	-5.79E-02	9.08E-02
Coal	g	1.05E+03	-3.68E+02	6.81E+02
Coal, feedstock	g	3.54	-1.33	2.22
Crude oil	g	1.02E+04	-2.93E+03	7.29E+03
Crude oil, feedstock	g	9.22E+03	-3.59E+03	5.63E+03
Fe	g	2.63E-02	-4.05E-05	2.63E-02
Ferromanganese	g	5.94E-03	-1.85E-03	4.09E-03
Ground water	g	5.71E-04	-9.55E-07	5.70E-04
Hard coal	g	2.09E+04	-6.96E+01	2.08E+04
Hydro power-water	g	2.94E+09	-2.15E+04	2.94E+09
Iron ore	g	4.22	-1.58	2.64
Land use	m^2*year	6.74E+01	0	6.74E+01
Limestone	g	2.32	-8.73E-01	1.45
Manganese	g	2.62E-01	-9.27E-02	1.69E-01
Metallurgical coal	g	1.21	-4.26E-01	7.80E-01
Mn	g	1.50E-04	-2.59E-07	1.49E-04
NaCl	g	5.13E+01	-1.84E+01	3.29E+01
Natural gas	g	5.08E+03	-2.01E+03	3.08E+03
Natural gas, feedstock	g	2.58E+03	-8.70E+02	1.71E+03
Phosphate rock	g	1.57E-01	-5.56E-02	1.01E-01
Sand	g	1.05E-01	-3.71E-02	6.79E-02
Softwood	g	5.78	-8.76E-03	5.77
Surface water	g	1.31E+05	-1.90E-08	1.31E+05
Uranium (as pure U)	g	5.93E-02	-2.79E-02	3.14E-02
Water	g	5.10E+06	2.99E+04	5.13E+06
Wood	g	6.95	-1.94	5.01
Non-elementary inflows				
Alum	g	1.11	0	1.11
Auxiliary materials	g	1.16E+01	0	1.16E+01
Bark	g	2.58E+02	0	2.58E+02

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	Unit	Packaging system	Effects on other life cycles	Total
Binders	g	9.78E+01	0	9.78E+01
Biocides	g	6.00E-03	0	6.00E-03
$Ca(OH)_2$	g	6.12E+01	4.60E+01	1.07E+02
$CaCO_3$	g	9.29E-01	0	9.29E-01
CaO	g	2.46	0	2.46
Corrugated board	g	3.79E+01	0	3.79E+01
Defoamer	g	3.60E-01	0	3.60E-01
Dry strength additives	g	4.15E+01	0	4.15E+01
Fillers	g	4.42E+02	0	4.42E+02
H_2SO_4	g	5.86E+01	0	5.86E+01
HCl	g	1.80E-02	0	1.80E-02
Ink	g	2.84E+01	0	2.84E+01
Lacquer, various	g	5.68	0	5.68
Lacquer, water	g	1.70E+01	0	1.70E+01
Lubricants	g	7.79E-02	0	7.79E-02
Na_2SO_4	g	1.47	0	1.47
$NaClO_3$	g	5.65E+01	0	5.65E+01
Na_2CO_3	g	5.10E-01	0	5.10E-01
NaOH	g	2.96E+03	0	2.96E+03
Nitrogen	g	0	3.43E-02	3.43E-02
O_2	g	5.08E+01	0	5.08E+01
Other additives	g	1.74E+02	0	1.74E+02
Peat	g	6.00E+01	0	6.00E+01
Pigment	g	3.71E+01	0	3.71E+01
Polymer filter screens	g	0	2.78	2.78
Retention agents	g	6.00E-01	0	6.00E-01
Sizing agents	g	1.77	0	1.77
SO_2	g	3.97E+01	0	3.97E+01
Starch	g	4.80E-01	0	4.80E-01
Steel strappings	g	0	1.11E+01	1.11E+01
Sulphur	g	6.00E-02	0	6.00E-02
Emissions to air				
Acetaldehyde	g	1.12E-04	4.26E-02	4.28E-02
Acetylene	g	2.42E-05	-3.14E-03	-3.12E-03
Aldehydes	g	3.97E-04	-6.87E-07	3.97E-04
Alkanes	g	4.28E-03	-7.85E-02	-7.42E-02
Alkenes	g	4.82E-05	-6.28E-03	-6.23E-03
Aromates (C9-C10)	g	6.78E-03	-6.28E-03	5.02E-04
As	g	5.69E-04	-3.60E-05	5.34E-04
B	g	4.79E-02	-8.35E-05	4.78E-02

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	Unit	Packaging system	Effects on other life cycles	Total
Benzo(a)pyrene	g	1.82E-06	-5.03E-07	1.32E-06
Benzene	g	5.00E-02	-2.64E-02	2.36E-02
Butane	g	7.81E-02	-3.51E-02	4.30E-02
Ca	g	4.91E-04	0	4.91E-04
Cd	g	5.46E-04	-6.87E-05	4.77E-04
CH_4	g	1.88E+02	5.50E+01	2.43E+02
CN^-	g	5.53E-05	-5.45E-07	5.47E-05
Co	g	3.46E-04	-2.46E-07	3.46E-04
CO	g	2.07E+02	-1.48E+01	1.92E+02
CO_2 (bio)	g	6.36E+03	3.62E+02	6.72E+03
CO_2	g	8.69E+04	-9.64E+03	7.72E+04
Cr	g	6.74E-04	-6.58E-05	6.08E-04
Cr^{3+}	g	2.67E-04	-4.65E-07	2.67E-04
Cu	g	1.16E-02	4.28E-05	1.16E-02
Dioxin	g	6.13E-08	1.94E-08	8.07E-08
Dust	g	4.00E+01	0	4.00E+01
Ethane	g	4.82E-05	-6.28E-03	-6.23E-03
Ethene	g	1.21E-04	-1.57E-02	-1.56E-02
Fe	g	1.11E-03	0	1.11E-03
Formaldehyde	g	1.40E-02	-6.91E-03	7.06E-03
H_2O	g	1.84E+03	1.98E+03	3.81E+03
H_2S	g	7.43E-02	-1.91E-02	5.52E-02
HC	g	2.86E+02	-9.84E+01	1.88E+02
HCl	g	4.61	-3.02E-01	4.30
Heavy metals	g	1.55E-15	-2.70E-18	1.55E-15
HF	g	7.09E-02	-4.14E-03	6.67E-02
Hg	g	2.39E-03	-5.45E-05	2.34E-03
Metals	g	7.63E-02	-2.78E-02	4.85E-02
Mg	g	3.35E-02	-5.90E-05	3.35E-02
Mn	g	3.97E-04	-6.87E-07	3.96E-04
Mo	g	2.60E-04	-3.23E-07	2.59E-04
N_2O	g	8.42E-01	-1.75E-02	8.24E-01
Na	g	4.60E-03	0	4.60E-03
NH_3	g	6.25E-02	-2.11E-04	6.23E-02
Ni	g	1.68E-02	-3.24E-03	1.35E-02
NMVOC	g	5.62E+01	-1.58E+01	4.05E+01
NMVOC, diesel engines	g	3.03E+01	1.61E-01	3.04E+01
NMVOC, el-coal	g	6.10E-01	-9.36E-04	6.09E-01
NMVOC, oil combustion	g	1.56	0	1.56
NMVOC, petrol engines	g	1.18E-10	-1.91E-13	1.18E-10

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... Table 3.3 continued from previous page.

	Unit	Packaging system	Effects on other life cycles	Total
NMVOC, power plants	g	2.95E-01	-4.52E-04	2.94E-01
NO_x	g	4.98E+02	-6.20E+01	4.36E+02
Organics	g	4.93E+01	-1.74E+01	3.19E+01
PAH	g	1.12E-03	-5.38E-04	5.86E-04
Particulates	g	5.83E+01	-1.40E+01	4.43E+01
Pb	g	2.02E-03	-2.83E-04	1.74E-03
Pentane	g	1.34E-01	-6.03E-02	7.37E-02
Propane	g	2.26E-02	-1.95E-02	3.09E-03
Propene	g	4.82E-05	-6.28E-03	-6.23E-03
Radioactive emissions	kBq	2.56E+06	-2.09E+08	-2.06E+08
Sb	g	4.88E-05	-8.93E-08	4.87E-05
Se	g	3.64E-03	-5.74E-06	3.63E-03
Sn	g	5.49E-05	-9.09E-08	5.48E-05
SO_2	g	3.50E+02	-7.42E+01	2.75E+02
Sr	g	2.74E-04	-4.90E-07	2.74E-04
Th	g	2.44E-05	-4.14E-08	2.44E-05
Tl	g	1.22E-05	-2.02E-08	1.22E-05
Toluene	g	2.25E-02	-1.32E-02	9.33E-03
Tot-P	g	2.44E-03	-4.14E-06	2.44E-03
TRS	g	8.80E-01	0	8.80E-01
U	g	1.82E-05	-2.89E-08	1.82E-05
V	g	1.63E-02	-5.88E-07	1.63E-02
VOC	g	1.14	0	1.14
VOC, coal combustion	g	1.59E-02	-2.51E-05	1.59E-02
VOC, diesel engines	g	4.38E-01	-7.59E-04	4.38E-01
VOC, natural gas combustion	g	1.24E-09	-2.01E-12	1.24E-09
Zn	g	8.21E-03	9.71E-07	8.21E-03
Emissions to water				
Acid as H^+	g	1.34	-5.02E-01	8.43E-01
Al	g	2.34E-01	-6.20E-02	1.72E-01
AOX	g	3.17E-01	0	3.17E-01
Aromates (C9-C10)	g	1.82E-03	-3.07E-06	1.81E-03
As	g	7.45E-04	-2.02E-04	5.43E-04
BOD	g	5.64	-1.97	3.67
BOD-5	g	1.80	-8.97E-03	1.79
BOD-7	g	1.57E+01	0	1.57E+01
Cd	g	4.12E-04	-1.13E-04	2.99E-04
Chlorate	g	2.21	0	2.21
Cl^-	g	3.89E+02	-5.66E+01	3.32E+02
ClO_3^-	g	1.07E-01	-1.97E-04	1.07E-01

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... Table 3.3 continued from previous page.

	Unit	Packaging system	Effects on other life cycles	Total
CN^-	g	1.70E-03	-4.76E-04	1.22E-03
Co	g	1.40E-03	-1.22E-04	1.28E-03
COD	g	2.60E+01	-5.28	2.08E+01
Cr	g	5.36E-03	-1.49E-03	3.86E-03
Cr^{3+}	g	1.62E-04	0	1.62E-04
Cu	g	1.76E-03	-4.91E-04	1.27E-03
Detergent/oil	g	1.05E-01	-3.71E-02	6.79E-02
Dissolved organics	g	6.83E+01	-2.42E+01	4.42E+01
Dissolved solids	g	1.66E+01	-1.47	1.52E+01
F^-	g	4.81E-02	-2.32E-03	4.58E-02
Fe	g	2.52E-02	-4.20E-05	2.52E-02
H^+	g	9.49E-03	-1.65E-05	9.48E-03
H_2S	g	5.58E-05	-1.56E-05	4.01E-05
HC	g	3.37	-1.30	2.07
Metals	g	2.00	-7.82E-01	1.22
Mn	g	1.26E-02	-2.22E-05	1.26E-02
Na^+	g	7.87	-2.78	5.09
NH_4^+	g	4.34E-02	-1.87E-02	2.47E-02
NH_4-N	g	1.01E-02	-1.67E-05	1.01E-02
Ni	g	3.50E-03	-6.08E-04	2.89E-03
Nitrates	g	8.33E-02	-3.73E-02	4.60E-02
Nitrogen	g	4.07E-03	-7.59E-06	4.06E-03
NO_3-N	g	9.24E-05	-1.54E-07	9.23E-05
Oil	g	7.05	-1.90	5.15
Organics	g	5.61	-1.52	4.08
Other nitrogen	g	5.21E-02	-2.06E-02	3.16E-02
Other organics	g	9.98E-01	-4.67E-01	5.31E-01
Pb	g	2.88E-03	-7.81E-04	2.10E-03
Phenol	g	2.07E-12	-3.13E-15	2.07E-12
Phosphate	g	1.00E-01	-4.20E-02	5.83E-02
Phosphate (as P_2O_5)	g	5.24E-02	-1.85E-02	3.39E-02
PO_4^{3-}	g	5.40E-04	0	5.40E-04
Radioactive emissions	kBq	2.44E+04	-1.96E+06	-1.93E+06
Salt	g	2.52	-3.91E-03	2.52
Sb	g	6.10E-06	-1.70E-06	4.40E-06
Sn	g	4.78E-01	-1.33E-01	3.45E-01
SO_4^{2-}	g	1.66E+01	-2.20	1.43E+01
Sr	g	6.31E-02	-1.10E-04	6.29E-02
Suspended solids	g	1.19E+01	-1.49	1.04E+01
TOC	g	1.51E-04	-1.96E-02	-1.94E-02

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... Table 3.3 continued from previous page.

	Unit	Packaging system	Effects on other life cycles	Total
Tot-N	g	2.18	-4.32E-01	1.75
Tot-P	g	7.98E-02	0	7.98E-02
V	g	1.43E-03	-3.99E-04	1.03E-03
Water	g	0	6.51E+04	6.51E+04
Water to WWTP	g	8.44E+02	6.35E+02	1.48E+03
Zn	g	9.60E-03	-1.69E-03	7.91E-03
Waste				
Bulk waste, total	g	1.58E+04	6.14E+02	1.64E+04
Elementary waste, solid	*g*	*0*	*3.63E+03*	*3.63E+03*
Waste, bulky	*g*	*6.63E+03*	*-1.12E+01*	*6.62E+03*
Waste, industrial	*g*	*6.98E+03*	*-2.96E+03*	*4.02E+03*
Waste, inert chemicals	*g*	*9.97*	*-3.52*	*6.44*
Waste, inorganic sludges	*g*	*4.71*	*0*	*4.71*
Waste, mineral	*g*	*7.14E+02*	*-8.17E+01*	*6.33E+02*
Waste, mixed industrial	*g*	*1.94E+01*	*-6.49*	*1.29E+01*
Waste, non toxic chemicals	*g*	*3.25E+01*	*-1.49E+01*	*1.76E+01*
Waste, organic sludges	*g*	*7.79E-01*	*0*	*7.79E-01*
Waste, other	*g*	*8.52*	*0*	*8.52*
Waste, other rejects	*g*	*3.24*	*0*	*3.24*
Waste, paper	*g*	*5.97E+02*	*0*	*5.97E+02*
Waste, paper production	*g*	*1.76E+02*	*0*	*1.76E+02*
Waste, PE-dust	*g*	*1.47E+01*	*0*	*1.47E+01*
Waste, polymer	*g*	*0*	*2.78E+01*	*2.78E+01*
Waste, PP-dust	*g*	*0*	*3.73E+01*	*3.73E+01*
Waste, PP	*g*	*1.84E+02*	*0*	*1.84E+02*
Waste, rubber	*g*	*7.71E-03*	*-1.33E-05*	*7.69E-03*
Waste, sludge	*g*	*5.30E-09*	*-8.82E-12*	*5.29E-09*
Glue to waste water treatment plant	*g*	*4.00E+02*	*0*	*4.00E+02*
Hazardous waste, total	g	1.05E+03	-3.80E+02	6.69E+02
Waste, chemical	*g*	*5.09E-02*	*-8.41E-05*	*5.08E-02*
Waste, hazardous	*g*	*1.05E+03*	*-3.80E+02*	*6.66E+02*
Waste, ink	*g*	*2.84*	*0*	*2.84*
Waste, pigment	*g*	*4.26E-02*	*0*	*4.26E-02*
Waste, regulated chemicals	*g*	*6.82E-01*	*-2.41E-01*	*4.41E-01*
Waste, toxic chemicals	*g*	*1.90E-01*	*-5.60E-02*	*1.34E-01*
Slags & ashes, total	g	5.10E+02	2.48E+01	5.35E+02
Waste, ashes	*g*	*7.83E+01*	*-2.71E+01*	*5.12E+01*
Waste, slags & ashes (energy prod.)	*g*	*1.79E+02*	*-3.04E-01*	*1.78E+02*

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	Unit	Packaging system	Effects on other life cycles	Total
Waste, slags & ashes (waste incin.)	*g*	*9.86E-05*	*-1.65E-07*	*9.85E-05*
Waste, slags & ashes	*g*	*2.53E+02*	*5.23E+01*	*3.05E+02*
Nuclear waste, total	g	8.69	7.44E-02	8.76
Waste, highly radioactive	*g*	*8.65*	*7.44E-02*	*8.73*
Waste, radioactive	*g*	*3.54E-02*	*-6.02E-05*	*3.53E-02*
Co-products				
Multipac-CB	g	5.98E+01	0	5.98E+01
Paper	g	5.75	0	5.75
Paper, fuel	g	1.96E+02	0	1.96E+02
Paper, recycling	g	1.00E+02	0	1.00E+02
Plastic ligature	g	2.92E+01	0	2.92E+01
Tall oil	g	5.32E+01	0	5.32E+01

3.2 150 cl refillable PET bottles

The life cycle

The process tree of the packaging system is illustrated in Figure A.1 in annex A. A simplified process tree is presented in Figure 3.2. The 150 cl refillable PET bottle is produced from preforms produced from polyethylene terephthalate (PET). To distribute 1000 litres of beverage 667 150 cl PET bottles (1000/1.50) are needed. The weight of one 150 cl refillable PET bottle is 0.105 kilograms.

Most of the used bottles (98.5%) are collected for recycling (see Table 3.1). The remaining 1.5% end up in waste incineration where they absorb energy from other incinerated wastes. A small share (3.5%) are discarded at the washing and filling processes. The discarded bottles are recycled into other systems (see Main report, section 2.5).

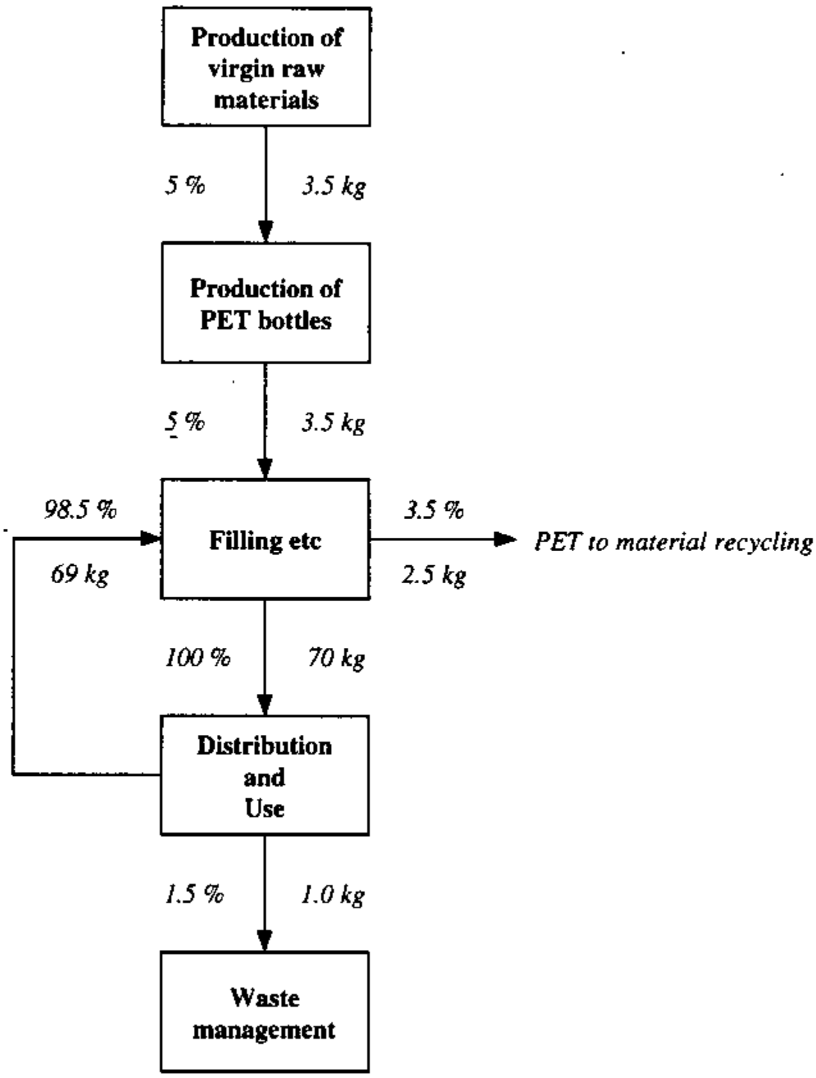

Figure 3.2
Flows of 150 cl refillable PET bottles per 1000 litres of beverage. (Flows of labels, caps, secondary packaging and transport packaging are not included).

Input data

The secondary packagings and transport packagings are quantitatively described by the system parameters in Table 3.4. Data and calculations on the environmental inputs and outputs of the processes in the process tree are presented in annex B. Data on the environmental inputs and outputs of transports and on the production of fuels and electricity are presented in Technical report 7.

Table 3.4

System parameters for the packaging system with 150 cl refillable PET bottles. The mass presented refers to the weight of a single item, i.e., one bottle or one tray. The market shares of the secondary packaging do not add up to 100% as they may be combined in different ways.

	Name	Mass [g]	Market share	Material	Degree of reuse	Material to recycling	Degree of disposal
Primary packaging	PET bottle (150 cl)	105	100 %	PET	95 %	3.5 %	1.5 %
Caps	Cap	2.0	100 %	PP	0 %	85 %	15 %
	Insert	0.2	100 %	LDPE	0 %	85 %	15 %
Labels	Label	0.8	100 %	Paper	0 %	0 %	100 %
	Glue	0.3	100 %	Casein/urea/H_2O	0 %	0 %	100 %
Secondary packaging	Crate (11 bottles) (1)	2017	90 %	HDPE	99.4 %	0.6 %	0 %
	Tray (24 bottles)	1550	10 %	HDPE	99.4 %	0.6 %	0 %
	Multipack (3 bottles)	18	5 %	Cardboard	0 %	20 %	80 %
	Multipack (3 bottles)	15	5 %	LDPE	0 %	0 %	100 %
Transport packaging	Pallet (240 bottles)	22000	100 %	Wood	95 %	0 %	5 %
	Plastic ligature (240 bottles)	20	100 %	LDPE	0 %	70 %	30 %

(1) There are two crates (A: 12 bottles, 45 % market share, 2200 g and B; 10 bottles, 45 % market share, weight unknown). An average of these two have been made [(A+B)/2]: 11 bottles, 90 % market share, 2017 g (using the same weight per bottle (183.33 g) for the 10-bottle crate).

Table 3.5
Energy demand at final use for the packaging system with 150 cl refillable PET bottles. These energy flows are not flows across the system boundary but internal flows within the system. Functional unit: packaging and distribution of 1000 litres.

	Unit	Packaging system	Effects on other life cycles	Total
Electricity, total	kWh	3.53E+01	-2.28	3.31E+01
Electricity	*kWh*	*1.19*	*-1.33*	*-1.44E-01*
Electricity, coal marginal	*kWh*	*3.38E+01*	*-6.16E-01*	*3.32E+01*
Hydro power	*kWh*	*3.54E-01*	*-3.28E-01*	*-2.67-E02*
Fossil fuel, total	MJ	8.47E+02	-2.49E+02	5.98E+02
Coal	*MJ*	*1.69E+01*	*-5.81*	*1.11E+01*
Coal, feedstock	*MJ*	*5.18E-02*	*-1.85E-02*	*3.33E-02*
Diesel, heavy & medium truck (highway)	*MJ*	*9.30E+01*	*1.15*	*9.41E+01*
Diesel, heavy & medium truck (rural)	*MJ*	*9.28E+01*	*0*	*9.28E+01*
Diesel, heavy & medium truck (urban)	*MJ*	*7.88E+01*	*6.47E-02*	*7.89E+01*
Diesel, ship (4-stroke)	*MJ*	*4.85E-01*	*0*	*4.85E-01*
Fuel, unspecified	*MJ*	*2.35E-04*	*-4.28E-06*	*2.31E-04*
Hard coal	*MJ*	*4.73E+01*	*0*	*4.73E+01*
Natural gas (>100 kW)	*MJ*	*9.71E+01*	*-3.93E+01*	*5.78E+01*
Natural gas	*MJ*	*7.72E+01*	*-2.61E+01*	*5.12E+01*
Natural gas, feedstock	*MJ*	*7.26E+01*	*-2.34E+01*	*4.93E+01*
Oil	*MJ*	*7.32E+01*	*-2.34E+01*	*4.98E+01*
Oil, feedstock	*MJ*	*1.93E+02*	*-7.11E+01*	*1.22E+02*
Oil, heavy fuel	*MJ*	*3.11*	*0*	*3.11*
Oil, light fuel	*MJ*	*8.47E-01*	*-6.10E+01*	*-6.02E+01*
Peat	*MJ*	*5.62E-01*	*0*	*5.62E-01*
Renewable fuel, total	MJ	5.28	0	5.28
Bark	*MJ*	*5.28*	*0*	*5.28*
Heat etc., total	MJ	-2.19	0	-2.19
Heat	*MJ*	*-6.83E-02*	*0*	*-6.83E-02*
Steam	*MJ*	*-1.99*	*0*	*-1.99*
Warm water	*MJ*	*-1.35E-01*	*0*	*-1.35E-01*

Table 3.6
Inventory results for the packaging system with 150 cl refillable PET bottles. Functional unit: packaging and distribution of 1000 litres.

	Unit	Packaging system	Effects on other life cycles	Total
Resources				
Al	g	2.35E-02	-4.28E-04	2.31E-02
Bauxite	g	1.72	-6.29E-01	1.09
Biomass	g	9.51E-02	-2.06E-09	9.51E-02
Brown coal	g	2.70E+02	-2.76E+01	2.42E+02
$CaCO_3$	g	4.11E-02	-7.50E-04	4.04E-02
Clay	g	5.95E-02	-2.01E-02	3.94E-02
Coal	g	6.07E+02	-2.07E+02	3.99E+02
Coal, feedstock	g	1.85	-6.59E-01	1.19
Crude oil	g	8.80E+03	-2.10E+03	6.70E+03
Crude oil, feedstock	g	4.53E+03	-1.67E+03	2.86E+03
Fe	g	2.44E-02	-4.43E-04	2.39E-02
Ferromanganese	g	3.84E-03	-1.23E-03	2.61E-03
Ground water	g	5.30E-04	-9.63E-06	5.20E-04
Hard coal	g	1.93E+04	-3.80E+02	1.89E+04
Hydro power-water	g	1.50E+09	-1.68E+04	1.50E+09
Iron ore	g	2.39	-8.62E-01	1.53
Land use	m^2*year	6.95E+01	0	6.95E+01
Limestone	g	1.26	-4.56E-01	8.06E-01
Manganese	g	1.74E-01	-6.13E-02	1.13E-01
Metallurgical coal	g	8.02E-01	-2.82E-01	5.20E-01
Mn	g	1.38E-04	-2.52E-06	1.36E-04
NaCl	g	2.66E+01	-9.12	1.75E+01
Natural gas	g	3.69E+03	-1.36E+03	2.33E+03
Natural gas, feedstock	g	1.34E+03	-4.32E+02	9.11E+02
Phosphate rock	g	1.05E-01	-3.68E-02	6.82E-02
Sand	g	6.97E-02	-2.45E-02	4.52E-02
Softwood	g	5.36	-9.75E-02	5.26
Surface water	g	5.76E+04	-1.97E-07	5.76E+04
Uranium (as pure U)	g	3.34E-02	-1.43E-02	1.91E-02
Water	g	4.57E+06	-4.16E+04	4.53E+06
Wood	g	6.73	-1.52	5.21
Non-elementary inflows				
Alum	g	7.43E-01	0	7.43E-01
Auxiliary materials	g	5.12	0	5.12
Bark	g	3.11E+02	0	3.11E+02

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	Unit	Packaging system	Effects on other life cycles	Total
Binders	g	4.30E+01	0	4.30E+01
Biocides	g	4.02E-03	0	4.02E-03
$Ca(OH)_2$	g	6.31E+01	2.77E+01	9.08E+01
$CaCO_3$	g	6.22E-01	0	6.22E-01
CaO	g	1.65	0	1.65
Corrugated board	g	1.67E+01	0	1.67E+01
Defoamer	g	2.41E-01	0	2.41E-01
Dry strength additives	g	1.83E+01	0	1.83E+01
Fillers	g	1.94E+02	0	1.94E+02
H_2SO_4	g	2.67E+01	0	2.67E+01
HCl	g	1.20E-02	0	1.20E-02
Ink	g	1.25E+01	0	1.25E+01
Lacquer, various	g	2.50	0	2.50
Lacquer, water	g	7.50	0	7.50
Lubricants	g	5.22E-02	0	5.22E-02
Na_2SO_4	g	9.84E-01	0	9.84E-01
$NaClO_3$	g	2.48E+01	0	2.48E+01
Na_2CO_3	g	3.41E-01	0	3.41E-01
NaOH	g	9.68E+02	0	9.68E+02
Nitrogen	g	0	2.27E-02	2.27E-02
O_2	g	2.23E+01	0	2.23E+01
Other additives	g	8.72E+01	0	8.72E+01
Peat	g	2.68E+01	0	2.68E+01
Pigment	g	1.24E+01	0	1.24E+01
Polymer filter screens	g	0	1.84	1.84
Retention agents	g	4.02E-01	0	4.02E-01
Sizing agents	g	1.19	0	1.19
SO_2	g	1.75E+01	0	1.75E+01
Starch	g	3.21E-01	0	3.21E-01
Steel strappings	g	0	7.36	7.36
Sulphur	g	4.02E-02	0	4.02E-02
Emissions to air				
Acetaldehyde	g	9.69E-05	2.82E-02	2.83E-02
Acetylene	g	3.25E-05	-2.44E-03	-2.41E-03
Aldehydes	g	3.68E-04	-6.70E-06	3.61E-04
Alkanes	g	2.43E-03	-6.10E-02	-5.86E-02
Alkenes	g	6.47E-05	-4.88E-03	-4.82E-03
Aromates (C9-C10)	g	5.85E-03	-4.99E-03	8.59E-04
As	g	4.92E-04	-3.35E-05	4.58E-04
B	g	4.43E-02	-8.10E-04	4.35E-02

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	Unit	Packaging system	Effects on other life cycles	Total
Benzo(a)pyrene	g	1.53E-06	-4.01E-07	1.13E-06
Benzene	g	4.13E-02	-2.06E-02	2.07E-02
Butane	g	6.78E-02	-2.74E-02	4.04E-02
Ca	g	2.16E-04	0	2.16E-04
Cd	g	4.15E-04	-5.40E-05	3.61E-04
CH_4	g	1.75E+02	1.70E+01	1.92E+02
CN^-	g	2.64E-05	-4.26E-07	2.60E-05
Co	g	2.22E-04	-2.42E-06	2.20E-04
CO	g	1.71E+02	-1.14E+01	1.59E+02
CO_2 (bio)	g	6.55E+03	2.49E+02	6.80E+03
CO_2	g	7.24E+04	-7.85E+03	6.45E+04
Cr	g	6.01E-04	-5.17E-05	5.49E-04
Cr^{3+}	g	2.44E-04	-4.36E-06	2.40E-04
Cu	g	1.10E-02	1.92E-05	1.10E-02
Dioxin	g	6.10E-08	1.05E-08	7.15E-08
Dust	g	2.51E+01	0	2.51E+01
Ethane	g	6.47E-05	-4.88E-03	-4.82E-03
Ethene	g	1.62E-04	-1.22E-02	-1.20E-02
Fe	g	4.86E-04	0	4.86E-04
Formaldehyde	g	1.09E-02	-5.39E-03	5.54E-03
H_2O	g	1.89E+03	1.09E+03	2.98E+03
H_2S	g	3.68E-02	-6.52E-03	3.03E-02
HC	g	1.72E+02	-5.72E+01	1.15E+02
HCl	g	3.63	-2.14E-01	3.41
Heavy metals	g	1.43E-15	-2.61E-17	1.41E-15
HF	g	4.67E-02	-2.40E-03	4.43E-02
Hg	g	2.22E-03	-7.89E-05	2.14E-03
Metals	g	4.36E-02	-1.54E-02	2.82E-02
Mg	g	3.10E-02	-5.66E-04	3.05E-02
Mn	g	3.68E-04	-6.70E-06	3.61E-04
Mo	g	1.93E-04	-2.73E-06	1.90E-04
N_2O	g	7.98E-01	-1.69E-02	7.81E-01
Na	g	2.03E-03	0	2.03E-03
NH_3	g	6.04E-02	-2.45E-04	6.02E-02
Ni	g	1.39E-02	-2.53E-03	1.14E-02
NMVOC	g	5.44E+01	-1.23E+01	4.21E+01
NMVOC, diesel engines	g	2.93E+01	8.85E-02	2.94E+01
NMVOC, el-coal	g	5.65E-01	-1.02E-02	5.55E-01
NMVOC, oil combustion	g	7.19E-01	0	7.19E-01
NMVOC, petrol engines	g	1.10E-10	-2.00E-12	1.08E-10

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... Table 3.6 continued from previous page.

	Unit	Packaging system	Effects on other life cycles	Total
NMVOC, power plants	g	2.73E-01	-4.97E-03	2.68E-01
NO_x	g	4.06E+02	-3.76E+01	3.69E+02
Organics	g	3.28E+01	-1.15E+01	2.12E+01
PAH	g	9.72E-04	-4.21E-04	5.51E-04
Particulates	g	4.39E+01	-8.50	3.54E+01
Pb	g	1.73E-03	-2.31E-04	1.49E-03
Pentane	g	1.16E-01	-4.72E-02	6.89E-02
Propane	g	1.96E-02	-1.52E-02	4.40E-03
Propene	g	6.47E-05	-4.88E-03	-4.82E-03
Radioactive emissions	kBq	2.96E+06	-1.62E+08	-1.59E+08
Sb	g	4.51E-05	-8.24E-07	4.43E-05
Se	g	3.34E-03	-5.90E-05	3.28E-03
Sn	g	5.09E-05	-9.31E-07	4.99E-05
SO_2	g	2.37E+02	-4.40E+01	1.93E+02
Sr	g	2.54E-04	-4.63E-06	2.50E-04
Th	g	2.27E-05	-4.13E-07	2.23E-05
Tl	g	1.13E-05	-2.06E-07	1.11E-05
Toluene	g	1.95E-02	-1.03E-02	9.21E-03
Tot-P	g	2.27E-03	-4.13E-05	2.23E-03
TRS	g	3.87E-01	0	3.87E-01
U	g	1.69E-05	-3.09E-07	1.66E-05
V	g	7.34E-03	-5.86E-06	7.34E-03
VOC	g	5.00E-01	0	5.00E-01
VOC, coal combustion	g	1.47E-02	-2.69E-04	1.45E-02
VOC, diesel engines	g	4.07E-01	-7.41E-03	4.00E-01
VOC, natural gas combustion	g	1.15E-09	-2.10E-11	1.13E-09
Zn	g	7.75E-03	-3.04E-05	7.72E-03
Emissions to water				
Acid as H^+	g	7.68E-01	-2.77E-01	4.91E-01
Al	g	2.26E-01	-4.86E-02	1.77E-01
AOX	g	1.40E-01	0	1.40E-01
Aromates (C9-C10)	g	1.68E-03	-3.06E-05	1.65E-03
As	g	7.10E-04	-1.57E-04	5.52E-04
BOD	g	3.65	-1.26	2.38
BOD-5	g	1.22	-7.00E-03	1.21
BOD-7	g	6.90	0	6.90
Cd	g	3.93E-04	-8.78E-05	3.05E-04
Chlorate	g	9.72E-01	0	9.72E-01
Cl^-	g	3.63E+02	-4.63E+01	3.17E+02
ClO_3^-	g	9.89E-02	-1.81E-03	9.71E-02

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... Table 3.6 continued from previous page.

	Unit	Packaging system	Effects on other life cycles	Total
CN^-	g	1.64E-03	-3.71E-04	1.27E-03
Co	g	1.19E-03	-9.48E-05	1.09E-03
COD	g	1.70E+01	-3.75	1.32E+01
Cr	g	5.18E-03	-1.17E-03	4.02E-03
Cr^{3+}	g	7.43E-05	0	7.43E-05
Cu	g	1.71E-03	-3.83E-04	1.32E-03
Detergent/oil	g	6.97E-02	-2.45E-02	4.52E-02
Dissolved organics	g	4.54E+01	-1.60E+01	2.94E+01
Dissolved solids	g	1.41E+01	-1.05	1.30E+01
F^-	g	4.39E-02	-2.40E-03	4.15E-02
Fe	g	2.34E-02	-4.26E-04	2.29E-02
H^+	g	8.80E-03	-1.59E-04	8.65E-03
H_2S	g	5.40E-05	-1.22E-05	4.18E-05
HC	g	1.84	-6.78E-01	1.16
Metals	g	9.09E-01	-3.34E-01	5.75E-01
Mn	g	1.17E-02	-2.12E-04	1.15E-02
Na^+	g	5.23	-1.84	3.39
NH_4^+	g	1.52E-02	-6.23E-03	8.94E-03
NH_4-N	g	9.34E-03	-1.71E-04	9.17E-03
Ni	g	3.30E-03	-4.95E-04	2.81E-03
Nitrates	g	2.86E-02	-1.25E-02	1.61E-02
Nitrogen	g	3.77E-03	-6.88E-05	3.70E-03
NO_3-N	g	8.56E-05	-1.56E-06	8.40E-05
Oil	g	6.56	-1.45	5.11
Organics	g	5.36	-1.19	4.17
Other nitrogen	g	2.04E-02	-7.46E-03	1.30E-02
Other organics	g	3.35E-01	-1.56E-01	1.79E-01
Pb	g	2.74E-03	-6.10E-04	2.13E-03
Phenol	g	1.92E-12	-3.52E-14	1.88E-12
Phosphate	g	4.50E-02	-1.62E-02	2.88E-02
Phosphate (as P_2O_5)	g	3.49E-02	-1.23E-02	2.26E-02
PO_4^{3-}	g	2.49E-04	0	2.49E-04
Radioactive emissions	kBq	2.82E+04	-1.52E+06	-1.49E+06
Salt	g	2.33	-4.26E-02	2.29
Sb	g	5.90E-06	-1.33E-06	4.57E-06
Sn	g	4.63E-01	-1.04E-01	3.59E-01
SO_4^{2-}	g	1.55E+01	-1.84	1.37E+01
Sr	g	5.84E-02	-1.06E-03	5.74E-02
Suspended solids	g	6.30	-8.65E-01	5.44
TOC	g	2.02E-04	-1.53E-02	-1.51E-02

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... Table 3.6 continued from previous page.

	Unit	Packaging system	Effects on other life cycles	Total
Tot-N	g	1.78	-3.37E-01	1.44
Tot-P	g	3.51E-02	0	3.51E-02
V	g	1.38E-03	-3.11E-04	1.07E-03
Water	g	0	4.30E+04	4.30E+04
Water to WWTP	g	8.71E+02	3.83E+02	1.25E+03
Zn	g	9.15E-03	-1.38E-03	7.78E-03
Waste				
Bulk waste, total	g	1.34E+04	-6.45E+02	1.27E+04
Elementary waste, solid	*g*	*0*	*1.80E+03*	*1.80E+03*
Waste, bulky	*g*	*6.13E+03*	*-1.12E+02*	*6.02E+03*
Waste, industrial	*g*	*6.13E+03*	*-2.31E+03*	*3.82E+03*
Waste, inert chemicals	*g*	*6.62*	*-2.33*	*4.29*
Waste, inorganic sludges	*g*	*3.15*	*0*	*3.15*
Waste, mineral	*g*	*4.54E+02*	*-4.55E+01*	*4.08E+02*
Waste, mixed industrial	*g*	*1.29E+01*	*-4.29*	*8.61*
Waste, non toxic chemicals	*g*	*1.10E+01*	*-4.98*	*6.00*
Waste, organic sludges	*g*	*5.22E-01*	*0*	*5.22E-01*
Waste, other	*g*	*3.75*	*0*	*3.75*
Waste, other rejects	*g*	*2.17*	*0*	*2.17*
Waste, paper	*g*	*2.62E+02*	*0*	*2.62E+02*
Waste, paper production	*g*	*7.72E+01*	*0*	*7.72E+01*
Waste, PE-dust	*g*	*1.38E+01*	*0*	*1.38E+01*
Waste, polymer	*g*	*0*	*1.84E+01*	*1.84E+01*
Waste, PP-dust	*g*	*0*	*1.25E+01*	*1.25E+01*
Waste, PP	*g*	*6.15E+01*	*0*	*6.15E+01*
Waste, rubber	*g*	*7.15E-03*	*-1.31E-04*	*7.02E-03*
Waste, sludge	*g*	*4.91E-09*	*-8.93E-11*	*4.82E-09*
Glue to waste water treatment plant	*g*	*2.00E+02*	*0*	*2.00E+02*
Hazardous waste, total	g	9.23E+02	-3.01E+02	6.22E+02
Waste, chemical	*g*	*4.71E-02*	*-8.53E-04*	*4.62E-02*
Waste, hazardous	*g*	*9.21E+02*	*-3.00E+02*	*6.20E+02*
Waste, ink	*g*	*1.25*	*0*	*1.25*
Waste, pigment	*g*	*1.43E-02*	*0*	*1.43E-02*
Waste, regulated chemicals	*g*	*4.53E-01*	*-1.59E-01*	*2.94E-01*
Waste, toxic chemicals	*g*	*7.55E-02*	*-1.87E-02*	*5.68E-02*
Slags & ashes, total	g	4.28E+02	1.36E+01	4.42E+02
Waste, ashes	*g*	*4.45E+01*	*-1.49E+01*	*2.96E+01*
Waste, slags & ashes (energy prod.)	*g*	*1.66E+02*	*-3.02*	*1.62E+02*

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... Table 3.6 continued from previous page.

	Unit	Packaging system	Effects on other life cycles	Total
Waste, slags & ashes (waste incin.)	*g*	*9.13E-05*	*-1.67E-06*	*8.96E-05*
Waste, slags & ashes	*g*	*2.18E+02*	*3.15E+01*	*2.49E+02*
Nuclear waste, total	g	8.22	6.11E-02	8.29
Waste, highly radioactive	*g*	*8.19*	*6.17E-02*	*8.25*
Waste, radioactive	*g*	*3.23E-02*	*-5.83E-04*	*3.17E-02*
Co-products				
Multipac-CB	g	4.00E+01	0	4.00E+01
Paper	g	2.68	0	2.68
Paper, fuel	g	8.62E+01	0	8.62E+01
Paper, recycling	g	4.40E+01	0	4.40E+01
Plastic ligature	g	3.90E+01	0	3.90E+01
Tall oil	g	2.34E+01	0	2.34E+01

4 Impact assessment

4.1 Classification and characterisation

Table 4.1

Classification and characterisation for the packaging system with 50 cl refillable PET bottles. The unit of the characterisation factor is g equivalent per g emission. Functional unit: packaging and distribution of 1000 litres.

NP [kg NO_3^--equivalents]	Characterisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
NH_3	3.64 E-03	2.28E-04	-7.67E-07	2.27E-04
NO_x	1.35 E-03	6.72E-01	-8.37E-02	5.89E-01
Emissions to water				
CN^-	2.38E-03	4.05E-06	-1.13E-06	2.92E-06
NH_4^+	3.44E-03	1.49E-04	-6.43E-05	8.49E-05
NH_4-N	4.42E-03	4.46E-05	-7.36E-08	4.45E-05
Nitrates	1.00E-03	8.33E-05	-3.73E-05	4.60E-05
NO_3-N	4.43E-03	4.09E-07	-6.80E-10	4.09E-07
Phosphate	3.20E-02	3.21E-03	-1.35E-03	1.87E-03
PO_4^{3-}	1.05E-02	5.64E-06	0	5.64E-06
Tot-N	4.43E-03	9.66E-03	-1.92E-03	7.75E-03
Tot-P	3.20E-02	2.56E-03	0	2.56E-03
Total		**6.88E-01**	**-8.71E-02**	**6.01E-01**

POCP [kg C_2H_4-equivalents]	Characterisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
Acetylene	2.00E-04	4.84E-09	-6.28E-07	-6.23E-07
Aldehydes	5.00E-04	1.99E-07	-3.44E-10	1.98E-07
Alkanes	4.00E-04	1.71E-06	-3.14E-05	-2.97E-05
Alkenes	9.00E-04	4.34E-08	-5.65E-06	-5.61E-06
Aromates (C9-C10)	8.00E-04	5.43E-06	-5.03E-06	4.01E-07
Benzene	2.00E-04	1.00E-05	-5.27E-06	4.72E-06

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... *Table 4.1 continued from previous page.*

POCP [kg C_2H_4-equivalents]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
CH_4	7.00E-06	1.32E-03	3.85E-04	1.70E-03
CO	3.00E-05	6.20E-03	-4.45E-04	5.76E-03
Ethane	1.00E-04	4.82E-09	-6.28E-07	-6.23E-07
Ethene	1.00E-03	1.21E-07	-1.57E-05	-1.56E-05
Formaldehyde	4.00E-04	5.59E-06	-2.76E-06	2.83E-06
HC	6.00E-04	1.72E-01	-5.90E-02	1.13E-01
NMVOC	4.00E-04	2.25E-02	-6.30E-03	1.62E-02
NMVOC, diesel engines	6.00E-04	1.82E-02	9.69E-05	1.83E-02
NMVOC, el-coal	8.00E-04	4.88E-04	-7.49E-07	4.87E-04
NMVOC, oil combustion	3.00E-04	4.68E-04	0	4.68E-04
NMVOC, petrol engines	6.00E-04	7.11E-14	-1.14E-16	7.10E-14
NMVOC, power plants	5.00E-04	1.47E-04	-2.26E-07	1.47E-04
Pentane	4.00E-04	5.36E-05	-2.41E-05	2.95E-05
Propane	4.00E-04	9.02E-06	-7.79E-06	1.24E-06
Propene	1.00E-03	4.82E-08	-6.28E-06	-6.23E-06
Toluene	6.00E-04	1.35E-05	-7.91E-06	5.60E-06
VOC, coal combustion	5.00E-04	7.94E-06	-1.25E-08	7.93E-06
VOC, diesel engines	6.00E-04	2.63E-04	-4.56E-07	2.63E-04
VOC, natural gas combustion	2.00E-04	2.48E-13	-4.02E-16	2.47E-13
Total		**2.21E-01**	**-6.54E-02**	**1.56E-01**

AP [kg SO_2-equivalents]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
H_2S	1.88E-03	1.40E-04	-3.59E-05	1.04E-04
HCl	8.80E-04	4.05E-03	-2.66E-04	3.79E-03
HF	1.60E-03	1.13E-04	-6.63E-06	1.07E-04
NH_3	1.88E-03	1.18E-04	-3.96E-07	1.17E-04
NO_x	7.00E-04	3.49E-01	-4.34E-02	3.05E-01
SO_2	1.00E-03	3.50E-01	-7.42E-02	2.75E-01
Emissions to water				
Acid as H^+	3.20E-02	4.30E-02	-1.61E-02	2.70E-02
H^+	3.20E-02	3.04E-04	-5.27E-07	3.03E-04
H_2S	1.88E-03	1.05E-07	-2.94E-08	7.54E-08

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... Table 4.1 continued from previous page.

AP [kg SO_2-equivalents]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
NH_4^+	3.56E-03	1.54E-04	-6.66E-05	8.79E-05
NH_4-N	4.58E-03	4.62E-05	-7.63E-08	4.61E-05
Total		**7.46E-01**	**-1.34E-01**	**6.12E-01**

GWP [kg CO_2-equivalents]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
CH_4	2.50E-02	4.70	1.38	6.08
CO	2.00E-03	4.14E-01	-2.97E-02	3.84E-01
CO_2	1.00E-03	8.69E+01	-9.64	7.72E+01
HC	3.00E-03	8.59E-01	-2.95E-01	5.63E-01
N_2O	0.32	2.69E-01	-5.59E-03	2.64E-01
Total		**9.31E+01**	**-8.59**	**8.45E+01**

HTA [m^3 air]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	9.50E+06	5.41E+03	-3.42E+02	5.07E+03
Benzo(a)pyrene	5.00E+07	9.09E+01	-2.51E+01	6.58E+01
Benzene	1.00E+07	5.00E+05	-2.64E+05	2.36E+05
Cd	1.10E+08	6.00E+04	-7.56E+03	5.25E+04
CO	830	1.72E+05	-1.23E+04	1.59E+05
Cr	1.00E+06	6.74E+02	-6.58E+01	6.08E+02
Cr^{3+}	1.00E+06	2.67E+02	-4.65E-01	2.67E+02
Cu	570	6.61	2.44E-02	6.63
Dioxin	2.90E+10	1.78E+03	5.62E+02	2.34E+03
Fe	3.70E+04	4.11E+01	0	4.11E+01
Formaldehyde	1.30E+07	1.82E+05	-8.99E+04	9.18E+04
H_2S	1.10E+06	8.17E+04	-2.10E+04	6.07E+04
Hg	6.70E+06	1.60E+04	-3.65E+02	1.57E+04
Mn	2.50E+06	9.93E+02	-1.72	9.91E+02
Mo	1.00E+05	2.60E+01	-3.23E-02	2.59E+01

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... Table 4.1 continued from previous page.

HTA [m^3 air]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
N_2O	2.00E+03	1.68E+03	-3.49E+01	1.65E+03
Ni	6.70E+04	1.12E+03	-2.17E+02	9.07E+02
NMVOC, diesel engines	9.80E+05	2.97E+07	1.58E+05	2.98E+07
NMVOC, el-coal	3.80E+05	2.32E+05	-3.56E+02	2.31E+05
NO_x	8.60E+03	4.28E+06	-5.33E+05	3.75E+06
Pb	1.00E+08	2.02E+05	-2.83E+04	1.74E+05
Sb	2.00E+04	9.76E-01	-1.79E-03	9.74E-01
Se	1.50E+06	5.46E+03	-8.61	5.45E+03
SO_2	1.30E+03	4.55E+05	-9.64E+04	3.58E+05
Tl	5.00E+05	6.10	-1.01E-02	6.09
Toluene	2.50E+03	5.63E+01	-3.30E+01	2.33E+01
V	1.40E+05	2.29E+03	-8.23E-02	2.29E+03
Total		**3,59E+07**	**-8,95E+05**	**3,50E+07**

ETWC [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	380	2.16E-01	-1.37E-02	2.03E-01
Benzene	4.00	2.00E-01	-1.05E-01	9.45E-02
Cd	2.40E+04	1.31E+01	-1.65	1.14E+01
Cr	130	8.77E-02	-8.56E-03	7.91E-02
Cr^{3+}	130	3.48E-02	-6.05E-05	3.47E-02
Cu	2.50E+03	2.90E+01	1.07E-01	2.91E+01
Dioxin	5.60E+08	3.43E+01	1.09E+01	4.52E+01
Fe	20	2.22E-02	0	2.22E-02
Formaldehyde	24	3.35E-01	-1.66E-01	1.70E-01
Hg	4.00E+03	9.57	-2.18E-01	9.35
Mn	71	2.82E-02	-4.88E-05	2.82E-02
Mo	400	1.04E-01	-1.29E-04	1.04E-01
Ni	130	2.18	-4.22E-01	1.76
NMVOC, diesel engines	62	1.88E+03	1.00E+01	1.89E+03
NMVOC, el-coal	11.4	6.95	-1.07E-02	6.94
Pb	400	8.08E-01	-1.13E-01	6.94E-01
Se	4.00E+03	1.46E+01	-2.30E-02	1.45E+01
Sr	2.00E+03	5.48E-01	-9.80E-04	5.47E-01
Tl	670	8.17E-03	-1.35E-05	8.16E-03

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... Table 4.1 continued from previous page.

ETWC [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Toluene	4.00	9.00E-02	-5.27E-02	3.73E-02
V	40	6.53E-01	-2.35E-05	6.53E-01
Zn	200	1.64	1.94E-04	1.64
Emissions to water				
As	1.90E+03	1.42	-3.84E-01	1.03
Cd	1.20E+05	4.94E+01	-1.35E+01	3.59E+01
Cr	670	3.59	-1.00	2.59
Cr^{3+}	670	1.08E-01	0	1.08E-01
Cu	1.30E+04	2.29E+01	-6.38	1.65E+01
Fe	1.00E+02	2.52	-4.20E-03	2.52
H_2S	6.70E+03	3.74E-01	-1.05E-01	2.69E-01
Mn	360	4.53	-8.00E-03	4.53
Ni	670	2.34	-4.08E-01	1.94
Pb	2.00E+03	5.77	-1.56	4.21
Phenol	44	9.11E-11	-1.38E-13	9.10E-11
Sr	1.00E+04	6.31E+02	-1.10	6.29E+02
V	200	2.86E-01	-7.99E-02	2.06E-01
Zn	1.00E+03	9.60	-1.69	7.91
Total		**2.72E+03**	**-8.05**	**2.72E+03**

HTW [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	7.4	4.21E-03	-2.66E-04	3.95E-03
Benzene	2.3	1.15E-01	-6.06E-02	5.43E-02
Cd	560	3.06E-01	-3.85E-02	2.67E-01
Cr	3.6	2.43E-03	-2.37E-04	2.19E-03
Cr^{3+}	3.6	9.63E-04	-1.67E-06	9.61E-04
Cu	3.4	3.94E-02	1.46E-04	3.95E-02
Dioxin	2.20E+08	1.35E+01	4.27	1.77E+01
Fe	9.60E-03	1.07E-05	0	1.07E-05
Formaldehyde	2.20E-05	3.07E-07	-1.52E-07	1.55E-07
H_2S	8.10E-04	6.02E-05	-1.55E-05	4.47E-05
Hg	1.10E+05	2.63E+02	-6.00	2.57E+02
Mn	5.30E-03	2.11E-06	-3.64E-09	2.10E-06
Mo	5.30E-02	1.38E-05	-1.71E-08	1.37E-05

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... Table 4.1 continued from previous page.

HTW [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Ni	3.70E-03	6.21E-05	-1.20E-05	5.01E-05
NMVOC, diesel engines	4.60E-02	1.39	7.43E-03	1.40
NMVOC, el-coal	7.30E-04	4.45E-04	-6.83E-07	4.44E-04
Pb	53	1.07E-01	-1.50E-02	9.20E-02
Sb	64	3.12E-03	-5.72E-06	3.12E-03
Se	28	1.02E-01	-1.61E-04	1.02E-01
Tl	1.30E+04	1.59E-01	-2.63E-04	1.58E-01
Toluene	4.00E-03	9.00E-05	-5.27E-05	3.73E-05
V	3.70E-02	6.04E-04	-2.18E-08	6.04E-04
Emissions to water				
As	37	2.76E-02	-7.47E-03	2.01E-02
Cd	2.80E+03	1.15	-3.15E-01	8.38E-01
Cr	18	9.64E-02	-2.69E-02	6.95E-02
Cr^{3+}	18	2.91E-03	0	2.91E-03
Cu	17	3.00E-02	-8.35E-03	2.16E-02
F	1.20E-02	5.78E-04	-2.79E-05	5.50E-04
Fe	4.80E-02	1.21E-03	-2.02E-06	1.21E-03
H_2S	4.10E-03	2.29E-07	-6.41E-08	1.65E-07
Mn	2.70E-02	3.40E-04	-6.00E-07	3.39E-04
Ni	1.90E-02	6.65E-05	-1.16E-05	5.49E-05
Pb	260	7.50E-01	-2.03E-01	5.47E-01
Phenol	3.40E-02	7.04E-14	-1.06E-16	7.03E-14
Sb	3.20E+02	1.95E-03	-5.44E-04	1.41E-03
V	0.19	2.71E-04	-7.59E-05	1.95E-04
Total		**2.81E+02**	**-2.40**	**2.79E+02**

ETSC [m^3 soil]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	0.27	1.54E-04	-9.71E-06	1.44E-04
Benzene	3.6	1.80E-01	-9.49E-02	8.50E-02
Cd	1.8	9.82E-04	-1.24E-04	8.59E-04
Cr	1.00E-02	6.74E-06	-6.58E-07	6.08E-06
Cr^{3+}	1.00E-02	2.67E-06	-4.65E-09	2.67E-06
Cu	2.00E-02	2.32E-04	8.56E-07	2.33E-04
Dioxin	1.20E+04	7.35E-04	2.33E-04	9.68E-04

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... Table 4.1 continued from previous page.

ETSC [m^3 soil]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Fe	0.53	5.88E-04	0	5.88E-04
Formaldehyde	2.00E+02	2.79	-1.38	1.41
Hg	5.3	1.27E-02	-2.89E-04	1.24E-02
Mn	1.9	7.55E-04	-1.31E-06	7.53E-04
Mo	3.9	1.01E-03	-1.26E-06	1.01E-03
Ni	5.00E-02	8.39E-04	-1.62E-04	6.77E-04
NMVOC, diesel engines	580	1.76E+04	9.36E+01	1.77E+04
NMVOC, el-coal	92	5.61E+01	-8.61E-02	5.60E+01
Pb	1.00E-02	2.02E-05	-2.83E-06	1.74E-05
Se	106	3.86E-01	-6.08E-04	3.85E-01
Sr	53	1.45E-02	-2.60E-05	1.45E-02
Tl	17.7	2.16E-04	-3.58E-07	2.16E-04
Toluene	0.97	2.18E-02	-1.28E-02	9.05E-03
V	0.34	5.55E-03	-2.00E-07	5.55E-03
Zn	5.00E-03	4.10E-05	4.85E-09	4.10E-05
Total		**1.76E+04**	**9.21E+01**	**1.77E+04**

ETWA [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to water				
As	190	1.42E-01	-3.84E-02	1.03E-01
Cd	1.20E+04	4.94	-1.35	3.59
Cr	67	3.59E-01	-1.00E-01	2.59E-01
Cr^{3+}	67	1.08E-02	0	1.08E-02
Cu	1.30E+03	2.29	-6.38E-01	1.65
Fe	10	2.52E-01	-4.20E-04	2.52E-01
H_2S	3.30E+03	1.84E-01	-5.16E-02	1.32E-01
Mn	36	4.53E-01	-8.00E-04	4.53E-01
Ni	67	2.34E-01	-4.08E-02	1.94E-01
Pb	200	5.77E-01	-1.56E-01	4.21E-01
Phenol	22	4.56E-11	-6.89E-14	4.55E-11
Sr	1.00E+03	6.31E+01	-1.10E-01	6.29E+01
V	20	2.86E-02	-7.99E-03	2.06E-02
Zn	100	9.60E-01	-1.69E-01	7.91E-01
Total		**7.35E+01**	**-2.67**	**7.08E+01**

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HTS [m^3 soil]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	100	5.69E-02	-3.60E-03	5.34E-02
Benzene	14	7.00E-01	-3.69E-01	3.31E-01
Cd	4.5	2.46E-03	-3.09E-04	2.15E-03
Cr	1.1	7.42E-04	-7.24E-05	6.69E-04
Cr^{3+}	1.1	2.94E-04	-5.12E-07	2.94E-04
Cu	4.00E-03	4.64E-05	1.71E-07	4.65E-05
Dioxin	1.40E+04	8.58E-04	2.72E-04	1.13E-03
Fe	0.77	8.55E-04	0	8.55E-04
Formaldehyde	5.80E-03	8.11E-05	-4.01E-05	4.10E-05
H_2S	0.26	1.93E-02	-4.96E-03	1.44E-02
Hg	81	1.94E-01	-4.42E-03	1.89E-01
Mn	0.42	1.67E-04	-2.89E-07	1.67E-04
Mo	1.5	3.89E-04	-4.84E-07	3.89E-04
Ni	0.12	2.01E-03	-3.89E-04	1.62E-03
NMVOC, diesel engines	0.28	8.48	4.52E-02	8.52
NMVOC, el-coal	2.50E-04	1.52E-04	-2.34E-07	1.52E-04
Pb	8.30E-02	1.68E-04	-2.35E-05	1.44E-04
Sb	17	8.29E-04	-1.52E-06	8.28E-04
Se	4.40E-02	1.60E-04	-2.53E-07	1.60E-04
Tl	10	1.22E-04	-2.02E-07	1.22E-04
Toluene	1.00E-03	2.25E-05	-1.32E-05	9.33E-06
V	0.96	1.57E-02	-5.65E-07	1.57E-02
Total		**9.47**	**-3.37E-01**	**9.13**

Table 4.2
Classification and characterisation for the packaging system with 150 cl refillable PET bottles. The unit of the characterisation factor is g equivalent per g emission. Functional unit: packaging and distribution of 1000 litres.

NP [kg NO_3^--equivalents]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
NH_3	3.64 E-03	2.20E-04	-8.91E-07	2.19E-04
NO_x	1.35 E-03	5.48E-01	-5.07E-02	4.98E-01
Emissions to water				
CN^-	2.38E-03	3.91E-06	-8.84E-07	3.03E-06
NH_4^+	3.44E-03	5.22E-05	-2.14E-05	3.07E-05
NH_4-N	4.42E-03	4.13E-05	-7.56E-07	4.05E-05
Nitrates	1.00E-03	2.86E-05	-1.25E-05	1.61E-05
NO_3-N	4.43E-03	3.79E-07	-6.90E-09	3.72E-07
Phosphate	3.20E-02	1.44E-03	-5.19E-04	9.23E-04
PO_4^{3-}	1.05E-02	2.60E-06	0	2.60E-06
Tot-N	4.43E-03	7.87E-03	-1.49E-03	6.38E-03
Tot-P	3.20E-02	1.12E-03	0	1.12E-03
Total		**5.59E-01**	**-5.28E-02**	**5.06E-01**

POCP [kg C_2H_4-equivalents]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
Acetylene	2.00E-04	6.50E-09	-4.88E-07	-4.82E-07
Aldehydes	5.00E-04	1.84E-07	-3.35E-09	1.81E-07
Alkanes	4.00E-04	9.72E-07	-2.44E-05	-2.34E-05
Alkenes	9.00E-04	5.82E-08	-4.39E-06	-4.33E-06
Aromates (C9-C10)	8.00E-04	4.68E-06	-3.99E-06	6.87E-07
Benzene	2.00E-04	8.26E-06	-4.12E-06	4.14E-06
CH_4	7.00E-06	1.23E-03	1.19E-04	1.34E-03
CO	3.00E-05	5.12E-03	-3.41E-04	4.77E-03
Ethane	1.00E-04	6.47E-09	-4.88E-07	-4.82E-07
Ethene	1.00E-03	1.62E-07	-1.22E-05	-1.20E-05
Formaldehyde	4.00E-04	4.37E-06	-2.16E-06	2.21E-06
HC	6.00E-04	1.03E-01	-3.43E-02	6.90E-02
NMVOC	4.00E-04	2.18E-02	-4.92E-03	1.68E-02

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POCP [kg C_2H_4-equivalents]		Charact-erisation factor	Packaging system	Effects on other life cycles	Total
NMVOC, diesel engines		6.00E-04	1.76E-02	5.31E-05	1.76E-02
NMVOC, el-coal		8.00E-04	4.52E-04	-8.19E-06	4.44E-04
NMVOC, oil combustion		3.00E-04	2.16E-04	0	2.16E-04
NMVOC, petrol engines		6.00E-04	6.58E-14	-1.20E-15	6.46E-14
NMVOC, power plants		5.00E-04	1.36E-04	-2.48E-06	1.34E-04
Pentane		4.00E-04	4.64E-05	-1.89E-05	2.75E-05
Propane		4.00E-04	7.83E-06	-6.07E-06	1.76E-06
Propene		1.00E-03	6.47E-08	-4.88E-06	-4.82E-06
Toluene		6.00E-04	1.17E-05	-6.18E-06	5.53E-06
VOC, coal combustion		5.00E-04	7.37E-06	-1.35E-07	7.24E-06
VOC, diesel engines		6.00E-04	2.44E-04	-4.44E-06	2.40E-04
VOC, natural gas combustion		2.00E-04	2.30E-13	-4.19E-15	2.25E-13
	Total		**1.50E-01**	**-3.95E-02**	**1.11E-01**

AP [kg SO_2-equivalents]		Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air					
H_2S		1.88E-03	6.92E-05	-1.23E-05	5.69E-05
HCl		8.80E-04	3.19E-03	-1.88E-04	3.00E-03
HF		1.60E-03	7.48E-05	-3.84E-06	7.10E-05
NH_3		1.88E-03	1.14E-04	-4.60E-07	1.13E-04
NO_x		7.00E-04	2.84E-01	-2.63E-02	2.58E-01
SO_2		1.00E-03	2.37E-01	-4.40E-02	1.93E-01
Emissions to water					
Acid as H^+		3.20E-02	2.46E-02	-8.86E-03	1.57E-02
H^+		3.20E-02	2.82E-04	-5.09E-06	2.77E-04
H_2S		1.88E-03	1.02E-07	-2.29E-08	7.86E-08
NH_4^+		3.56E-03	5.40E-05	-2.22E-05	3.18E-05
NH_4-N		4.58E-03	4.28E-05	-7.83E-07	4.20E-05
	Total		**5.50E-01**	**-7.94E-02**	**4.71E-01**

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GWP [kg CO_2-equivalents]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
CH_4	2.50E-02	4.38	4.26E-01	4.80
CO	2.00E-03	3.41E-01	-2.27E-02	3.18E-01
CO_2	1.00E-03	7.24E+01	-7.85	6.45E+01
HC	3.00E-03	5.17E-01	-1.72E-01	3.45E-01
N_2O	0.32	2.55E-01	-5.42E-03	2.50E-01
Total		**7.79E+01**	**-7.62**	**7.03E+01**

HTA [m^3 air]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	9.50E+06	4.67E+03	-3.18E+02	4.35E+03
Benzo(a)pyrene	5.00E+07	7.66E+01	-2.00E+01	5.66E+01
Benzene	1.00E+07	4.13E+05	-2.06E+05	2.07E+05
Cd	1.10E+08	4.56E+04	-5.94E+03	3.97E+04
CO	830	1.42E+05	-9.43E+03	1.32E+05
Cr	1.00E+06	6.01E+02	-5.17E+01	5.49E+02
Cr^{3+}	1.00E+06	2.44E+02	-4.36	2.40E+02
Cu	570	6.26	1.10E-02	6.27
Dioxin	2.90E+10	1.77E+03	3.05E+02	2.07E+03
Fe	3.70E+04	1.80E+01	0	1.80E+01
Formaldehyde	1.30E+07	1.42E+05	-7.01E+04	7.20E+04
H_2S	1.10E+06	4.05E+04	-7.18E+03	3.33E+04
Hg	6.70E+06	1.49E+04	-5.29E+02	1.43E+04
Mn	2.50E+06	9.20E+02	-1.67E+01	9.03E+02
Mo	1.00E+05	1.93E+01	-2.73E-01	1.90E+01
N_2O	2.00E+03	1.60E+03	-3.39E+01	1.56E+03
Ni	6.70E+04	9.30E+02	-1.70E+02	7.61E+02
NMVOC, diesel engines	9.80E+05	2.87E+07	8.67E+04	2.88E+07
NMVOC, el-coal	3.80E+05	2.15E+05	-3.89E+03	2.11E+05
NO_x	8.60E+03	3.49E+06	-3.23E+05	3.17E+06
Pb	1.00E+08	1.73E+05	-2.31E+04	1.49E+05
Sb	2.00E+04	9.03E-01	-1.65E-02	8.86E-01
Se	1.50E+06	5.01E+03	-8.85E+01	4.92E+03
SO_2	1.30E+03	3.09E+05	-5.72E+04	2.52E+05

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HTA [m^3 air]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Tl	5.00E+05	5.65	-1.03E-01	5.55
Toluene	2.50E+03	4.88E+01	-2.58E+01	2.30E+01
V	1.40E+05	1.03E+03	-8.20E-01	1.03E+03
Total		**3.37E+07**	**-6.21E+05**	**3.31E+07**

ETWC [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	380	1.87E-01	-1.27E-02	1.74E-01
Benzene	4.00	1.65E-01	-8.25E-02	8.28E-02
Cd	2.40E+04	9.96	-1.30	8.66
Cr	130	7.81E-02	-6.72E-03	7.14E-02
Cr^{3+}	130	3.17E-02	-5.67E-04	3.12E-02
Cu	2.50E+03	2.75E+01	4.81E-02	2.75E+01
Dioxin	5.60E+08	3.41E+01	5.89	4.00E+01
Fe	20	9.72E-03	0	9.72E-03
Formaldehyde	24	2.62E-01	-1.29E-01	1.33E-01
Hg	4.00E+03	8.88	-3.16E-01	8.56
Mn	71	2.61E-02	-4.76E-04	2.56E-02
Mo	400	7.72E-02	-1.09E-03	7.61E-02
Ni	130	1.81	-3.29E-01	1.48
NMVOC, diesel engines	62	1.82E+03	5.49	1.82E+03
NMVOC, el-coal	11.4	6.44	-1.17E-01	6.32
Pb	400	6.90E-01	-9.26E-02	5.98E-01
Se	4.00E+03	1.34E+01	-2.36E-01	1.31E+01
Sr	2.00E+03	5.09E-01	-9.26E-03	5.00E-01
Tl	670	7.58E-03	-1.38E-04	7.44E-03
Toluene	4.00	7.81E-02	-4.12E-02	3.68E-02
V	40	2.94E-01	-2.34E-04	2.94E-01
Zn	200	1.55	-6.09E-03	1.54
Emissions to water				
As	1.90E+03	1.35	-2.99E-01	1.05
Cd	1.20E+05	4.72E+01	-1.05E+01	3.66E+01
Cr	670	3.47	-7.81E-01	2.69
Cr^{3+}	670	4.98E-02	0	4.98E-02
Cu	1.30E+04	2.22E+01	-4.98	1.72E+01

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ETWC [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Fe	1.00E+02	2.34	-4.26E-02	2.29
H_2S	6.70E+03	3.62E-01	-8.18E-02	2.80E-01
Mn	360	4.20	-7.63E-02	4.13
Ni	670	2.21	-3.32E-01	1.88
Pb	2.00E+03	5.49	-1.22	4.27
Phenol	44	8.45E-11	-1.55E-12	8.29E-11
Sr	1.00E+04	5.84E+02	-1.06E+01	5.74E+02
V	200	2.77E-01	-6.21E-02	2.15E-01
Zn	1.00E+03	9.15	-1.38	7.78
Total		**2.61E+03**	**-2.17E+01**	**2.59E+03**

HTW [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	7.4	3.64E-03	-2.48E-04	3.39E-03
Benzene	2.3	9.50E-02	-4.74E-02	4.76E-02
Cd	560	2.32E-01	-3.03E-02	2.02E-01
Cr	3.6	2.16E-03	-1.86E-04	1.98E-03
Cr^{3+}	3.6	8.78E-04	-1.57E-05	8.63E-04
Cu	3.4	3.73E-02	6.54E-05	3.74E-02
Dioxin	2.20E+08	1.34E+01	2.31	1.57E+01
Fe	9.60E-03	4.67E-06	0	4.67E-06
Formaldehyde	2.20E-05	2.40E-07	-1.19E-07	1.22E-07
H_2S	8.10E-04	2.98E-05	-5.28E-06	2.45E-05
Hg	1.10E+05	2.44E+02	-8.68	2.35E+02
Mn	5.30E-03	1.95E-06	-3.55E-08	1.91E-06
Mo	5.30E-02	1.02E-05	-1.45E-07	1.01E-05
Ni	3.70E-03	5.14E-05	-9.37E-06	4.20E-05
NMVOC, diesel engines	4.60E-02	1.35	4.07E-03	1.35
NMVOC, el-coal	7.30E-04	4.12E-04	-7.47E-06	4.05E-04
Pb	53	9.15E-02	-1.23E-02	7.92E-02
Sb	64	2.89E-03	-5.28E-05	2.84E-03
Se	28	9.36E-02	-1.65E-03	9.19E-02
Tl	1.30E+04	1.47E-01	-2.68E-03	1.44E-01
Toluene	4.00E-03	7.81E-05	-4.12E-05	3.68E-05
V	3.70E-02	2.72E-04	-2.17E-07	2.72E-04

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HTW [m³ water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to water				
As	37	2.63E-02	-5.82E-03	2.04E-02
Cd	2.80E+03	1.10	-2.46E-01	8.55E-01
Cr	18	9.33E-02	-2.10E-02	7.23E-02
Cr^{3+}	18	1.34E-03	0	1.34E-03
Cu	17	2.90E-02	-6.51E-03	2.25E-02
F^-	1.20E-02	5.27E-04	-2.88E-05	4.98E-04
Fe	4.80E-02	1.12E-03	-2.04E-05	1.10E-03
H_2S	4.10E-03	2.21E-07	-5.00E-08	1.71E-07
Mn	2.70E-02	3.15E-04	-5.73E-06	3.09E-04
Ni	1.90E-02	6.27E-05	-9.41E-06	5.33E-05
Pb	260	7.13E-01	-1.59E-01	5.55E-01
Phenol	3.40E-02	6.53E-14	-1.20E-15	6.41E-14
Sb	3.20E+02	1.89E-03	-4.25E-04	1.46E-03
V	0.19	2.63E-04	-5.90E-05	2.04E-04
Total		**2.62E+02**	**-6.90**	**2.55E+02**

ETSC [m³ soil]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	0.27	1.33E-04	-9.04E-06	1.24E-04
Benzene	3.6	1.49E-01	-7.42E-02	7.45E-02
Cd	1.8	7.47E-04	-9.73E-05	6.50E-04
Cr	1.00E-02	6.01E-06	-5.17E-07	5.49E-06
Cr^{3+}	1.00E-02	2.44E-06	-4.36E-08	2.40E-06
Cu	2.00E-02	2.20E-04	3.85E-07	2.20E-04
Dioxin	1.20E+04	7.32E-04	1.26E-04	8.58E-04
Fe	0.53	2.58E-04	0	2.58E-04
Formaldehyde	2.00E+02	2.19	-1.08	1.11
Hg	5.3	1.18E-02	-4.18E-04	1.13E-02
Mn	1.9	6.99E-04	-1.27E-05	6.86E-04
Mo	3.9	7.53E-04	-1.07E-05	7.42E-04
Ni	5.00E-02	6.94E-04	-1.27E-04	5.68E-04
NMVOC, diesel engines	580	1.70E+04	5.13E+01	1.71E+04
NMVOC, el-coal	92	5.20E+01	-9.42E-01	5.10E+01
Pb	1.00E-02	1.73E-05	-2.31E-06	1.49E-05

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ETSC [m^3 soil]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Se	106	3.54E-01	-6.25E-03	3.48E-01
Sr	53	1.35E-02	-2.46E-04	1.32E-02
Tl	17.7	2.00E-04	-3.64E-06	1.97E-04
Toluene	0.97	1.89E-02	-9.99E-03	8.93E-03
V	0.34	2.50E-03	-1.99E-06	2.50E-03
Zn	5.00E-03	3.87E-05	-1.52E-07	3.86E-05
Total		**1.71E+04**	**4.92E+01**	**1.71E+04**

ETWA [m^3 water]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to water				
As	190	1.35E-01	-2.99E-02	1.05E-01
Cd	1.20E+04	4.72	-1.05	3.66
Cr	67	3.47E-01	-7.81E-02	2.69E-01
Cr^{3+}	67	4.98E-03	0	4.98E-03
Cu	1.30E+03	2.22	-4.98E-01	1.72
Fe	10	2.34E-01	-4.26E-03	2.29E-01
H_2S	3.30E+03	1.78E-01	-4.03E-02	1.38E-01
Mn	36	4.20E-01	-7.63E-03	4.13E-01
Ni	67	2.21E-01	-3.32E-02	1.88E-01
Pb	200	5.49E-01	-1.22E-01	4.27E-01
Phenol	22	4.22E-11	-7.74E-13	4.15E-11
Sr	1.00E+03	5.84E+01	-1.06	5.74E+01
V	20	2.77E-02	-6.21E-03	2.15E-02
Zn	100	9.15E-01	-1.38E-01	7.78E-01
Total		**6.84E+01**	**-3.08**	**6.53E+01**

HTS [m^3 soil]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Emissions to air				
As	100	4.92E-02	-3.35E-03	4.58E-02
Benzene	14	5.78E-01	-2.89E-01	2.90E-01

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HTS [m^3 soil]	Charact-erisation factor	Packaging system	Effects on other life cycles	Total
Cd	4.5	1.87E-03	-2.43E-04	1.62E-03
Cr	1.1	6.61E-04	-5.69E-05	6.04E-04
Cr^{3+}	1.1	2.68E-04	-4.80E-06	2.64E-04
Cu	4.00E-03	4.39E-05	7.70E-08	4.40E-05
Dioxin	1.40E+04	8.53E-04	1.47E-04	1.00E-03
Fe	0.77	3.74E-04	0	3.74E-04
Formaldehyde	5.80E-03	6.34E-05	-3.13E-05	3.21E-05
H_2S	0.26	9.57E-03	-1.70E-03	7.88E-03
Hg	81	1.80E-01	-6.39E-03	1.73E-01
Mn	0.42	1.55E-04	-2.81E-06	1.52E-04
Mo	1.5	2.90E-04	-4.10E-06	2.86E-04
Ni	0.12	1.67E-03	-3.04E-04	1.36E-03
NMVOC, diesel engines	0.28	8.21	2.48E-02	8.24
NMVOC, el-coal	2.50E-04	1.41E-04	-2.56E-06	1.39E-04
Pb	8.30E-02	1.43E-04	-1.92E-05	1.24E-04
Sb	17	7.67E-04	-1.40E-05	7.53E-04
Se	4.40E-02	1.47E-04	-2.59E-06	1.44E-04
Tl	10	1.13E-04	-2.06E-06	1.11E-04
Toluene	1.00E-03	1.95E-05	-1.03E-05	9.21E-06
V	0.96	7.05E-03	-5.62E-06	7.05E-03
Total		**9.04**	**-2.76E-01**	**8.77**

4.2 Normalisation

Table 4.3
Normalisation results for the packaging system with 50 cl refillable PET bottles. Functional unit: packaging and distribution of 1000 litres.

Normalisation: Environmental impact categories	Normalisation reference (1)	Packaging system [PE_{WDK90}] (2)	Effects on other life cycles [PE_{WDK90}] (2)	Total [PE_{WDK90}] (2)
Environmental impacts				
Global warming (GWP)	8700	1.07E-02	-9.88E-04	9.71E-03
Photochemical ozone formation (POCP)	20	1.11E-02	-3.27E-03	7.80E-03
Acidification (AP)	124	6.02E-03	-1.08E-03	4.94E-03
Nutrient enrichment (NP)	298	2.31E-03	-2.92E-04	2.02E-03
Human toxicity, water (HTW)	59000	4.76E-03	-4.07E-05	4.72E-03
Human toxicity, soil (HTS)	310	3.06E-02	-1.09E-03	2.95E-02
Ecotoxicity, aquatic, chronic (ETWC)	470000	5.80E-03	-1.71E-05	5.78E-03
Ecotoxicity, terrestrial, chronic (ETSC)	30000	5.87E-01	3.07E-03	5.90E-01
Ecotoxicity, aquatic, acute (ETWA)	48000	1.53E-03	-5.55E-05	1.48E-03
Human toxicity, air (HTA)	9.20E+09	3.90E-03	-9.73E-05	3.80E-03
Waste				
Bulk waste (non-hazardous)	1350	1.14E-02	4.55E-04	1.18E-02
Hazardous waste	20.7	5.07E-02	-1.84E-02	3.23E-02
Slag and ashes	320	1.46E-03	7.09E-05	1.53E-03
Nuclear waste	0.159	5.46E-02	4.68E-04	5.51E-02
Resources				
Oil	590	3.30E-02	-1.11E-02	2.19E-02
Coal	570	2.35E-02	-4.72E-04	2.31E-02
Brown coal	250	1.15E-03	-1.28E-04	1.03E-03
Natural gas	310	2.47E-02	-9.27E-03	1.54E-02
Aluminium	3.1	2.86E-04	-1.07E-04	1.79E-04
Lead	0.64	0	0	0
Iron	100	1.53E-06	-4.74E-07	1.06E-06
Copper	1.7	0	0	0
Manganese	1.8	1.46E-04	-5.15E-05	9.41E-05
Nickel	0.18	0	0	0
Tin	0.04	0	0	0
Zinc	1.4	0	0	0

(1) The normalisation references have the following units: characterisation equivalent/pers/year (for environmental impacts), kg/pers/year (for waste) m^3/pers/year (for wood) and kg/pers/year (for other resources).

(2) PE_{WDK90}: person equivalent based on emission levels, waste levels and resource demand in the year 1990.

Table 4.4

Normalisation results for the packaging system with 150 cl refillable PET bottles. Functional unit: packaging and distribution of 1000 litres.

Normalisation: Environmental impact categories	Normalisation reference (1)	Packaging system [PE_{WDK90}] (2)	Effects on other life cycles [PE_{WDK90}] (2)	Total [PE_{WDK90}] (2)
Environmental impacts				
Global warming (GWP)	8700	8.95E-03	-8.76E-04	8.08E-03
Photochemical ozone formation (POCP)	20	7.51E-03	-1.98E-03	5.53E-03
Acidification (AP)	124	4.44E-03	-6.41E-04	3.80E-03
Nutrient enrichment (NP)	298	1.88E-03	-1.77E-04	1.70E-03
Human toxicity, water (HTW)	59000	4.43E-03	-1.17E-04	4.32E-03
Human toxicity, soil (HTS)	310	2.92E-02	-8.90E-04	2.83E-02
Ecotoxicity, aquatic, chronic (ETWC)	470000	5.55E-03	-4.61E-05	5.50E-03
Ecotoxicity, terrestrial, chronic (ETSC)	30000	5.69E-01	1.64E-03	5.70E-01
Ecotoxicity, aquatic, acute (ETWA)	48000	1.43E-03	-6.41E-05	1.36E-03
Human toxicity, air (HTA)	9.20E+09	3.67E-03	-6.75E-05	3.60E-03
Waste				
Bulk waste (non-hazardous)	1350	9.76E-03	-4.78E-04	9.28E-03
Hazardous waste	20.7	4.46E-02	-1.45E-02	3.00E-02
Slag and ashes	320	1.22E-03	3.89E-05	1.26E-03
Nuclear waste	0.159	5.17E-02	3.84E-04	5.21E-02
Resources				
Oil	590	2.26E-02	-6.39E-03	1.62E-02
Coal	570	2.14E-02	-6.32E-04	2.08E-02
Brown coal	250	1.08E-03	-1.10E-04	9.69E-04
Natural gas	310	1.62E-02	-5.78E-03	1.04E-02
Aluminium	3.1	1.47E-04	-5.11E-05	9.57E-05
Lead	0.64	0	0	0
Iron	100	9.60E-07	-2.63E-07	6.97E-07
Copper	1.7	0	0	0
Manganese	1.8	9.67E-05	-3.41E-05	6.27E-05
Nickel	0.18	0	0	0
Tin	0.04	0	0	0
Zinc	1.4	0	0	0

(1) The normalisation references have the following units: characterisation equivalent/pers/year (for environmental impacts), kg/pers/year (for waste) m^3/pers/year (for wood) and kg/pers/year (for other resources).

(2) PE_{WDK90}: person equivalent based on emission levels, waste levels and resource demand in the year 1990.

4.3 Weighting

Table 4.5
Weighting results for the packaging system with 50 cl refillable PET bottles. Functional unit: packaging and distribution of 1000 litres.

Weighting: Environmental impact categories	Weighting factor	Packaging system	Effects on other life cycles	Total
Environmental impacts	[$PET_{WDK2000}$ /PE_{WDK90}] (1)	[$PET_{WDK2000}$]	[$PET_{WDK2000}$]	[$PET_{WDK2000}$]
Global warming (GWP)	1.3	1.39E-02	-1.28E-03	1.26E-02
Photochemical ozone formation (POCP)	1.2	1.33E-02	-3.93E-03	9.36E-03
Acidification (AP)	1.3	7.82E-03	-1.41E-03	6.42E-03
Nutrient enrichment (NP)	1.2	2.77E-03	-3.51E-04	2.42E-03
Human toxicity, water (HTW)	3.1	1.48E-02	-1.26E-04	1.46E-02
Human toxicity, soil (HTS)	2.3	7.03E-02	-2.50E-03	6.78E-02
Ecotoxicity, aquatic, chronic (ETWC)	2.6	1.51E-02	-4.45E-05	1.50E-02
Ecotoxicity, terrestrial, chronic (ETSC)	1.9	1.12	5.83E-03	1.12
Ecotoxicity, aquatic, acute (ETWA)	2.6	3.98E-03	-1.44E-04	3.84E-03
Human toxicity, air (HTA)	2.8	1.09E-02	-2.72E-04	1.06E-02
Waste	[$PET_{WDK2000}$/PE_{WDK90}]	[$PET_{WDK2000}$]	[$PET_{WDK2000}$]	[$PET_{WDK2000}$]
Bulk waste (non-hazardous)	1.1	1.25E-02	5.00E-04	1.30E-02
Hazardous waste	1.1	5.58E-02	-2.02E-02	3.56E-02
Slag and ashes	1.1	1.60E-03	7.80E-05	1.68E-03
Nuclear waste	1.1	6.01E-02	5.15E-04	6.06E-02
Resources	[PR_{W90}/PE_{WDK90}]	[PR_{W90}] (2)	[PR_{W90}]	[PR_{W90}]
Oil	2.30E-02	7.58E-04	-2.54E-04	5.04E-04
Coal	5.80E-03	1.36E-04	-2.74E-06	1.34E-04
Brown coal	2.60E-03	3.00E-06	-3.32E-07	2.67E-06
Natural gas	1.60E-02	3.95E-04	-1.48E-04	2.47E-04
Aluminium	5.10E-03	1.46E-06	-5.47E-07	9.11E-07
Lead	4.80E-02	0	0	0
Iron	8.50E-03	1.30E-08	-4.03E-09	8.97E-09
Copper	2.80E-02	0	0	0
Manganese	1.20E-02	1.75E-06	-6.18E-07	1.13E-06
Nickel	1.90E-02	0	0	0
Tin	3.70E-02	0	0	0
Zinc	5.00E-02	0	0	0

(1) $PET_{WDK2000}$: person equivalent based on target emissions in the year 2000.
PE_{WDK90}: person equivalent based on emission levels in the year 1990.

(2) PR_{W90}: person-reserve, *i.e.*, the fraction of known global reserves per person, in 1990.

Table 4.6
Weighting results for the packaging system with 150 cl refillable PET bottles. Functional unit: packaging and distribution of 1000 litres.

Weighting: Environmental impact categories	Weighting factor	Packaging system	Effects on other life cycles	Total
Environmental impacts	[$PET_{WDK2000}$ /PE_{WDK90}] (1)	[$PET_{WDK2000}$]	[$PET_{WDK2000}$]	[$PET_{WDK2000}$]
Global warming (GWP)	1.3	1.16E-02	-1.14E-03	1.05E-02
Photochemical ozone formation (POCP)	1.2	9.01E-03	-2.37E-03	6.64E-03
Acidification (AP)	1.3	5.77E-03	-8.33E-04	4.94E-03
Nutrient enrichment (NP)	1.2	2.25E-03	-2.13E-04	2.04E-03
Human toxicity, water (HTW)	3.1	1.37E-02	-3.63E-04	1.34E-02
Human toxicity, soil (HTS)	2.3	6.71E-02	-2.05E-03	6.50E-02
Ecotoxicity, aquatic, chronic (ETWC)	2.6	1.44E-02	-1.20E-04	1.43E-02
Ecotoxicity, terrestrial, chronic (ETSC)	1.9	1.08	3.12E-03	1.08
Ecotoxicity, aquatic, acute (ETWA)	2.6	3.71E-03	-1.67E-04	3.54E-03
Human toxicity, air (HTA)	2.8	1.03E-02	-1.89E-04	1.01E-02
Waste	[$PET_{WDK2000}/PE_{WDK90}$]	[$PET_{WDK2000}$]	[$PET_{WDK2000}$]	[$PET_{WDK2000}$]
Bulk waste (non-hazardous)	1.1	1.07E-02	-5.26E-04	1.02E-02
Hazardous waste	1.1	4.90E-02	-1.60E-02	3.30E-02
Slag and ashes	1.1	1.34E-03	4.28E-05	1.39E-03
Nuclear waste	1.1	5.69E-02	4.23E-04	5.73E-02
Resources	[PR_{W90}/PE_{WDK90}]	[PR_{W90}] (2)	[PR_{W90}]	[PR_{W90}]
Oil	2.30E-02	5.20E-04	-1.47E-04	3.73E-04
Coal	5.80E-03	1.24E-04	-3.66E-06	1.20E-04
Brown coal	2.60E-03	2.81E-06	-2.87E-07	2.52E-06
Natural gas	1.60E-02	2.60E-04	-9.25E-05	1.67E-04
Aluminium	5.10E-03	7.49E-07	-2.61E-07	4.88E-07
Lead	4.80E-02	0	0	0
Iron	8.50E-03	8.16E-09	-2.24E-09	5.93E-09
Copper	2.80E-02	0	0	0
Manganese	1.20E-02	1.16E-06	-4.09E-07	7.52E-07
Nickel	1.90E-02	0	0	0
Tin	3.70E-02	0.00	0	0.00
Zinc	5.00E-02	0	0	0

(1) PETWDK2000: person equivalent based on target emissions in the year 2000.
PEWDK90: person equivalent based on emission levels in the year 1990.

(2) PRW90: person-reserve, *i.e.*, the fraction of known global reserves per person, in 1990.

5 Interpretation

5.1 Dominance Analysis

Important impacts

The normalisation and weighting results indicate that the packaging systems with refillable PET bottles contribute most to the following environmental impacts (see Tables 4.3-4.6):

- Ecotoxicity, terrestrial, chronic (ETSC)
- Human toxicity, soil (HTS)
- Ecotoxicity, aquatic, chronic (ETWC)
- Human toxicity, water (HTW)
- Global warming (GWP)
- Human toxicity, air (HTA)

However, the uncertainties in the normalisation and weighting results for toxicity and ecotoxicity impacts are very large. There are large uncertainties and possibly important data gaps in the inventory results regarding toxic emissions (see, *e.g.*, sections 2.1 and 3.3 in Technical report 7). There are large data gaps in the characterisation of toxicity and ecotoxicity impacts (see section 5.3 below). Furthermore, there are large uncertainties in the reference flows used in the normalisation of these impacts (see section 5.4.3).

It should also be noted that the fact that an environmental impact gets a high score in the normalisation and weighting does not necessarily imply that the impact is important. The normalisation and weighting results shows how much the packaging system contributes to an environmental impact, compared to current impact levels or targets levels. But the normalisation and weighting do not take into account the fact that different target levels may not be equally important.

Waste and resources

The refillable PET bottle systems contribute less than 100 mPET for all waste categories and less than 1 mPR for the depletion of all resources.

Important processes

The processes contributing most to the environmental impacts of the 50 cl refillable PET bottle system are identified in Table 5.1. This table also presents processes or parts of the system investigated were the packaging system results in significant environmental gains. Such gains can be caused by, *e.g.*, the use of recycled material from the packaging system.

The results of a dominance analysis of the 150 cl bottle system would be similar to the results presented in Table 5.1. The reason is that the structure of the two systems is quite similar. The systems mainly differ with respect to the mass flows, the washing and filling process and the distribution of beverage.

Table 5.1
The processes most important for the environmental impacts of the 50 cl refillable PET bottle system. The figures are given in % of the net total potential environmental impact.

	GWP	POCP	AP	NP	HTW	HTS	ETWC	ETSC	ETWA	HTA
1. PET-resin production	17	83	39	24						
3. Bottle production	14		20							
4. Washing & filling	31		11	12	53	10	15		51	
6. Caps & inserts production					19				19	
7. PP-production		20	14							
Trp 21. Distribution of beverage	27	26	28	48		86	69	92	12	85
28. PET-production (avoided)		-29	-14							

PET-resin production

The largest contribution to POCP and AP is caused by hydro carbon emissions (POCP) and emissions of SO_2 and NO_x (AP) from the PET-resin production. The production of PET-resin also contributes to NP mainly ue to NO_x emissions.

Bottle production

The production of bottles mainly contributes to AP, which is caused by SO_2 emissions.

Washing & filling

The largest contributions to HTW, ETWA and GWP are caused by mercury emissions to air (HTW), strontium emissions to water (ETWA) and CO_2 emissions (GWP) from the washing and filling process at the soft drink producer. The Hg emissions originate from combustion of coal, *e.g.*, at electricity production. The Sr is emitted at coal extraction and at other processes associated with electricity production.

PP-production

The production of polypropylene mainly contributes to POCP, which is caused by hydro carbon emissions.

Distribution of beverage

The largest contributions to ETSC, HTS, HTA, ETWC, and NP are caused by the distribution of beverage. The main contributing parameters are emissions of NMVOC from diesel engines for ETSC, HTS, HTA and ETWC as well as NO_x for NP. The distribution of beverage also contributes to AP, POCP and GWP, which is caused by emissions of NO_x (AP), emissions of NMVOC and NMVOC from diesel engines (POCP) and CO_2 emissions.

PET-production (avoided)

The avoided PET-production mainly contributes to avoided impacts for POCP because of avoided hydro carbon emissions.

5.2 Sensitivity Analysis

5.2.1 Non-elementary inflows

Amounts

Non-elementary inflows are auxiliary materials and other material flows that are not traced back all the way to the boundary between technosphere and nature. Many non-elementary inflows are documented in this LCA (see Tables 3.3 and 3.6) but they are all relatively small. The total amount of non-elementary inflows to the 50 cl system is 4.5 kg per 1000 litres (the inflows to the 150 cl system are 1.9 kg). This corresponds to approx. 2 % of the weight of the total packaging. The largest non-elementary inflows are:

- Sodium hydroxide (NaOH) (washing & filling), 3.0 kg/1000 l.
- Fillers (paper), 0.4 kg/1000 litres.
- Bark (cardboard, paper and planks), 0.3 kg/1000 l.
- Other additives (glue), 0.2 kg/1000 l.
- Calcium hydroxide ($Ca(OH)_2$) (waste incineration), 0.1 kg/1000 l.
- Binders (paper), 0.1 kg/1000 l.

NaOH

The largest non-elementary inflow (1 % of total packaging weight) is sodium hydroxide (NaOH) used in the washing and filling process at the soft drink producer. The production of NaOH demands approx. 10.6 MJ/kg. This means the production would increase the total energy demand in the packaging system by 3 %.

Environmental significance

The other non-elementary inflows are used in very small amounts (< 0.2 % of the total packaging weight). They are used in paper production (fillers and bark), cardboard and planks production (bark), glue production (other additives), waste incineration ($Ca(OH)_2$) and paper production (binders).

The effect of the production of these materials on total LCA results is likely to be small since the flows are small. This is particularly true for energy related emissions such as CO_2, SO_2, NO_x and VOC.

5.2.2 Non-elementary outflows

Co-products

Non-elementary outflows are waste and co-products that are not traced all the way to the boundary between technosphere and nature. The non-elementary outflows are documented in Tables 3.3 and 3.6. The effects of the co-products depend on for what purpose the co-products are used, and what, if anything, they can replace. However, we estimate the effects to be relatively minor since these outflows are all small. The total amount of non-elementary co-product outflows from the 50 cl system is 0.4 kg per 1000 litres (the outflows from the 150 cl system are smaller). This corresponds to approx. 0.2 % of the weight of the total packaging.

Bulk waste

The total non-elementary waste flows from the 50 cl system amount to 13 kg. However, most of this waste is bulk waste. The energy demanded for management of bulk waste is small (Tillman *et al.* 1992). We also estimate most of this waste to cause little environmental impacts in the landfill because it is relatively inert.

Hazardous waste

The amount of hazardous waste from the 50 cl system is 0.7 kg. It mainly consists of unspecified hazardous waste from the production of natural gas and electricity. The environmental impacts of the management of this waste are unknown, *i.e.*, no information has been available within the project.

5.2.3 Excluded unit processes

As stated above (section 2.1), production of materials for secondary packagings (multipacks), transport packaging (pallets and plastic ligature) and cap inserts is included in the LCA, but the actual packaging production - conversion, nailing etc. - is not included. The retailer is not included as well.

Multi-pack production

Multipack production includes cutting and folding. We estimate the environmental impacts of these processes to be negligible. Multipack production may also include printing. We estimate the energy related environmental impacts of print production and printing processes to be small. However, the toxicity impacts and the depletion of scarce resources are unknown.

Pallet production

Since 95% of the pallets are reused, the demand for new pallets is only 0.10 pieces per 1000 litres (for the 50 cl system). The energy demand for pallet production has been given as 7 kWh electricity and 0.3 kg oil per 25 kg pallet (IDEMAT database 1995 referred to by RDC 1997). This means the energy demand for pallet production is well below 1% of total energy demand in the packaging system.

Pallet production also causes emissions of approximately 130 g sawdust per 1000 litres (IDEMAT 1995 via RDC 1997). This is the same order of magnitude as the emissions of particulates from the packaging system, but the sawdust is estimated to be much less environmentally hazardous.

Plastic ligature production

The amount of plastic ligature corresponds to 0.1 % of the weight of the total packaging. The production of plastic ligature could therefore be considered as negligible.

Cap inserts

The amount of cap inserts corresponds to 0.01 % of the weight of the total packaging. The production of cap inserts could therefore be considered as negligible.

Retailer

In the base case the retailer was excluded. When including these data in the base case the emissions of CO_2, NO_x, SO_2 and total VOC increases by about 1 % for each of these emissions.

Consumer transports

Transports between retailer and the residence of the consumer are also excluded from the analysis. The effect of the beverage packaging on the fuel demand for this transport is estimated to be 8 MJ per 1000 litres or less (see

Technical report 7). This is less than 1% of the total energy demand of the packaging system.

5.2.4 Other factors

Table 5.2
Results of sensitivity analyses.

Parameters	Base case	90 % collection rate	Bottle weight (+ 20 %)	Distribution (light truck)	Electricity, fragmented markets	Electricity, European base-load average
	[g/1000 l beverage]	[% of base case]	[% of base case]	[% of base case]	[% of base case]	[% of base case]
CO_2	7,73E+04	156	110	119	89	83
SO_2	2,75E+02	235	113	106	86	132
NO_x	4,36E+02	155	106	131	92	93
VOC, total	5,06E+02	169	109	112	76	80

Collection rate

The collection rate is 98.5 % in the base case. A sensitivity analysis regarding the collection rate was performed. The collection rate was decreased from 98.5 % (as in the base case) to 90 %. The results for some of the important inventory parameters are shown in table 5.2. It is clear from the results that the assumption regarding the collection rate is important.

Bottle weight

The bottle weight is 53 g in the base case. This could be compared to 52 g in the previous study. A sensitivity scenario corresponding to an increase of the bottle weight by 20 % (64 g) was performed. The results for some of the important inventory parameters are shown in table 5.2. The bottle weight appears to be of minor importance especially since the bottle weight increase of 20 % is excessive.

Discarded bottles

An increased share of discarded bottles at the soft drink producer (the share of discarded bottles is 3.5 % in the base case) has similar effects as the decrease of collection rate above.

Allocation methods

In the recycling of discarded PET bottles and PP caps it is assumed that 50 % of the PET and PP replaces virgin raw materials and that 50 % replaces recycled material from other products. A sensitivity scenario is calculated in Technical report 6, in which the recycled PET bottles and PP caps were assumed to replace 100 % virgin material. The results indicate that this assumption is important for the LCA results. The most important difference between the sensitivity scenario and the base case scenario is that avoided PET production is doubled. For the refillable PET bottle this is particularly important for POCP and AP, as indicated by the dominance analysis above (see Table 5.1).

Use of recycled PET

If recycled PET is used in the production of PET bottles, the increased demand for recycled PET would affect other systems. The effect on other systems depend on what is the alternative fate of the recycled material: waste disposal or recycling into other products (see Main report, section 2.6.2). To be consistent with the base case assumption that recycled PET from the packaging systems replaces 50% virgin raw materials and 50% recycled materials form other systems, we here assume that the alternative fate of the recycled PET is 50% waste disposal and 50% recycling into other products.

The use of 1 ton recycled material in PET bottles would reduce the primary PET production in the packaging system by nearly 1 ton. However, under the 50/50 assumption discussed above, the primary PET production in other systems would be increased by approximately 0.5 ton. The net effect is that primary production is reduced by approximately 0.5 ton. As indicated by the dominance analysis, this would have a significant effect on the POCP and AP results.

Distribution of beverage

A sensitivity analysis regarding the distribution of beverage was performed. When using data for light truck the environmental impacts were increased especially concerning NO_x and CO_2 (table 5.2).

Electricity production

The electricity data used in the base case represent coal marginal. Two sensitivity analyses were performed for electricity production (long term base load at fragmented markets and European base load average). It is clear from the results (table 5.2) that the assumption regarding the electricity production is important.

5.3 Assessment of data gaps

Inventory

The data used for bottle production are aggregated and include both preform and bottle production. There are no information available concerning the share of material scrap lost in the process. This material waste is very small according to some bottle producers (PETCORE and Constar 1997) and the material is recycled for production of PET film and similar products.

There are no data available concerning water emissions from the washing and filling process.

For the grinding of crates to granulate and for the production of new crates, there are no information available concerning the share of material lost in these processes.

The production of PET flakes (between bottle bailing and PET recycling) is not included. The recycling data is valid for production of PET-resin from 75 % of virgin PET and 25 % of clean PET-flakes from recycled PET-bottles. In this case the raw material is only recycled PET-bottles, but these data are assumed to be a good approximation. Furthermore, there are no information available concerning the share of material lost in the process.

Characterisation

There are no known data gaps in the characterisation of global warming, photochemical ozone formation, acidification and nutrification. However, it should be noted that emissions measured as BOD or COD are not considered in the characterisation. These emissions have oxygen depleting impacts similar to those of nutrifying chemicals, but they do not contribute significantly to nutrification or any other environmental impact considered in this study.

There are large data gaps in the characterisation of most toxicity impacts since a large share of the hydrocarbon and NMVOC emissions have an unspecified composition. The characterisation indicates that hydrocarbons and NMVOCs are important for human toxicity in air and soil, and for chronic terrestrial and aquatic ecotoxicity. No characterisation factors were available for the unspecified emissions.

Normalisation

Reference values for the normalisation are available for all environmental impact categories covered by this LCA. Reference values are missing for the depletion of some of the resources, *e.g.*, dolomite, feldspar and uranium. We estimate the effects of these data gaps on the conclusions of the LCA to be small. The demand for uranium is small in this LCA, since the nuclear share of electricity production is small. It should really be zero. The reason why any uranium demand is reported in the LCA is that we have not used marginal data for electricity that is used in production of plastics and fuel.

Weighting

The data gaps in the weighting are similar to those in the normalisation.

5.4 Assessment of data quality

5.4.1 Overview

Marginal/average

In order to assess the environmental consequences of choosing a packaging system with PET bottles, we should ideally have used data representing the specific processes and transports actually affected by such a choice. As stated in the main report (section 2.9), the ideal data should be recent and relevant for actual or potential Danish packaging systems. They should reflect the technologies actually affected by a change in the packaging systems. For many processes, this is the long-term marginal technology.

In practice, we used specific data for the distribution of the beverage. We explicitly used long-term marginal data for electricity production and for waste management. Marginal thinking was also applied to the transports between retailer and consumer residence, and to the refrigeration of the beverage container. For most other processes and transports, marginal data were not available and average or site specific data were used instead. This reduces the quality of these data with respect to the goal of this study.

5.4.2 Specific processes

Quality aspects

The data quality of the most important processes is summarised in Table 5.3. The uncertainty, completeness and representativity of the data are considered. The data uncertainty includes uncertainties in measurements, calculations and estimations. The uncertainty is estimated to be small, medium or large compared to what is common in LCAs.

The assessment of data completeness includes considerations of how large share of the relevant industries etc. that are presented in the data. It also includes considerations of whether the data reflects yearly averages or single measurements. The completeness is estimated to be good, fair or poor compared to what is common in LCAs.

The representativity reflects an assessment of how well the data set represents the industries etc. that are really relevant for the study. The representativity assessment also includes considerations of the time-related, geographical and technological representativity of the data. The completeness is estimated to be good, fair or poor compared to what is common in LCAs.

Table 5.3
Assessment of the data quality for the most important processes.

	Uncertainty	Completeness	Representativity
1. PET-resin production	Small	Good	Fair
3. Bottle production	Small	Good	Fair
4. Washing & filling	Medium	Fair	Good
6. Caps & inserts production	Medium	Fair	Good
7. PP-production	Small	Good	Fair
Trp 21. Distribution of beverage	Medium	Good	Good
28. PET-production (avoided)	Small	Good	Fair

PET-resin production etc.

For the production of PET-resin (and avoided PET production), bottles and PP, we used APME data. They represent a large share of the PET producers. These data are assessed to have small uncertainty and good completeness because they represent European averages. As indicated above, the most relevant data reflect marginal technology. Since the APME data represent average technology, the representativity is only fair.

Washing & filling

Data on washing and filling represent soft drink producers that are likely to be affected. About 50 % of the soft drink market share is covered by our data. The uncertainty in the most important parameters - CO_2 and VOC - is low and high respectively.

Distribution of beverage

Data on distribution represent the transport activities affected by a choice of packaging system. We used data on actual transport distances and truck sizes (Jacobsen 1997). The fuel demand is based on data on the relevant vehicles from Volvo (Rydberg 1997). Most of the emissions are calculated using standardised emission factors from CORINAIR (1996). Hence, there is a significant uncertainty in the emissions. For further details, see Technical report 7.

5.4.3 Impact assessment

Characterisation

The characterisation models the potential environmental impacts of the packaging systems. As such, we estimate the characterisation factors to be fairly accurate. Most of them rely on chemical reactions. For this reason, the relations between the amount of chemical substances emitted and the potential environmental impacts are fairly certain. An exception is the characterisation of photochemical ozone formation caused by unspecified VOC and hydrocarbon emissions. Here, we estimate the uncertainty to be approximately 50%.

It should be noted that the actual environmental impacts of the packaging systems can be quite different from the potential impacts. It is not certain that the substances emitted will actually react according to the chemical reactions in the characterisation models. This depends, *e.g.*, on the place and time duration of the emission.

Normalisation

The normalisation references are based on statistics. The uncertainties are sometimes very large. We estimate the uncertainties in the normalisation references to be a factor 2-4 for toxicity and 10-25% for other environmental impacts. Large errors in the normalisation references are important for the normalisation and weighting results of the individual packaging systems. However, the comparisons between systems are not affected, because the same normalisation references are applied to each individual system.

Weighting

Weighting factors should in principle not have any uncertainty as they express political goals.

5.5 Known errors

There are no known errors in this LCA.

6 References

Andersson, R (1998) Personal communication. AB Svenska Returpack, Stockholm, Sweden.

Boustead, I. (1992) Eco-balance methodology for commodity thermoplastics, Association of plastics manufacturers in Europe (APME). Brussels.

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Boustead, I. (1995) Eco-profiles of the European plastics industry - Report 8: Polyethylene terephthalate (PET), Association of plastics manufacturers in Europe (APME). Brussels.

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Tillman A-M, Baumann H, Eriksson E, Rydberg T (1992) Packaging and the Environment. Offprint from SOU 1991:77. Chalmers Industriteknik. Gothenburg.

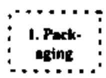
Wenzel H, Hauschild M, Alting L. (1997). Environmental assessment of products. Vol. I: Methodology, tools, and case studies in product development. Chapman & Hall. London.

Annex A:

Description of the input data in annex A and B

Detailed process trees

The detailed process tree of the two systems are presented in figure A.1 in annex A. The systems (50 cl and 150 cl) are identical, which is why there is no process tree in annex B.



In some cases the boxes with dotted lines represent processes for which we have no data. However, in many cases these boxes do not represent any processes. These are only modules used to facilitate the calculations.

Transports are represented by an arrow containing an oval and "Trp X".

Input data

The input data of the life cycle systems are presented in printouts from the LCA software *LCA inventory Tool (LCAiT)*.

Annex A contains the input data for the 50 cl system. Annex B, which contains the input data for the 150 cl system, has been reduced to contain only data that is not identical to the 50 cl system.

The data presentation is explained in the beginning of the annex A printout.

The processes and transports have the same number in the process tree as in the data printout.

50 cl refillable PET bottles

File: 50CL-RE.LCA **Printed:** Fri 98-05-29 11:15

Energy carrier:
All energy demand presented under the heading "Energy carrier" describes energy at final use in the processes and transports of the system. Most of these parameters are internal parameters, i.e. they describe flows that do not cross the boundary of the system investigated. They make it possible to calculated, e.g., how much electricity is used in the system.

Parameter names:
Some parameters appear in both of the two categories air- and water emissions. To be able to separate these parameters in the inventory profile, the emissions to water have been given the name: parameter (aq) e.g. Cu (aq). Resources have in the same way been called resource (r) e.g. crude oil (r). Non-elementary inflows and outflows have been given the name parameter (in) and (out) respectively.

Calculation procedures - process cards:
The data are entered in most process cards as g or MJ per kg total outflow from the process card. In some cases, the data are entered as g or MJ per kg of total inflow to the process card. Whether the data refer to the outflow or inflow is stated immediately below the data. The magnitude of the total outflow (or inflow) is also stated here. The magnitude of the flows have been calculated by the software when the system was solved.

In some processes, data on emissions etc. from the combustion of a fuel are missing. When the system is solved, estimates for the combustion emissions per kg outflow (inflow) from the process card are calculated through multiplying the fuel demand entered under the heading "Energy carrier" with emission factors for final use in our energy database (see Technical report 7). This calculation is reported through the use of the letters FU under the heading "E Factor". In many cases, the data entered in the process card do not include emissions etc. from the production of fuels and electricity used in the process. These emissions are calculated through multiplying the fuel and electricity demand with the corresponding emission factors for extraction etc. in the energy database (see Technical report 7). This calculation is reported through the use of the letters "Ex" under the heading "Energy carriers".

When the system is solved, the environmental inputs and outputs of the whole system are calculated. For each process, the data estimated through the use of emission factors are added to the data entered under the heading "Emissions, waste and resources". The totals are multiplied by the total outflow (or inflow, when applicable) to obtain the total resource demand, emissions etc. of the process.

Calculation procedures - transport cards:
Data on transport modes and distances are entered in the transport cards. When the system is solved, the distances are multiplied by the output flow from the transport card to obtain the transport volume measured as kg-km per functional unit. For each transport mode, this volume is multiplied by the fuel demand factors in our transport database (see Technical report 7). The emissions and resource demand are calculated through multiplying the fuel demand by the emission factors for fuel production and final use in the energy database.

Process Card: 1. PET-resin

Outflows	**Percent**	**Massflow [kg]**
PET-resin		5.245

Emissions, waste and resources	**[g]**	**Reference**
Particulates	3.800	Air
CO2	2.33e+003	
CO	18.000	
SO2	25.000	
NOx	20.200	
HCl	0.110	
HC	40.000	
Metals	1.00e-002	
Organics	9.400	
COD (aq)	3.300	Water
BOD (aq)	1.000	
Na+ (aq)	1.500	
Acid as H+ (aq)	0.180	
Metals (aq)	0.120	
Cl- (aq)	0.710	
Dissolved organics (aq)	13.000	
Suspended solids (aq)	0.600	
Detergent/oil (aq)	2.00e-002	
HC (aq)	0.400	
Dissolved solids (aq)	0.580	
Phosphate (as P2O5) (aq)	1.00e-002	
Other nitrogen (aq)	1.00e-003	
SO42- (aq)	4.00e-002	
Waste, mineral	30.000	Waste
Waste, ashes	9.600	
Waste, mixed industrial	3.500	
Waste, regulated chemicals	0.130	
Waste, inert chemicals	1.900	
Bauxite (r)	0.310	Resource
NaCl (r)	4.900	
Clay (r)	1.00e-003	
Ferromanganese (r)	1.00e-003	
Iron ore (r)	0.550	
Limestone (r)	0.270	
Manganese (r)	5.00e-002	
Metallurgical coal (r)	0.230	

--- To be continued ---

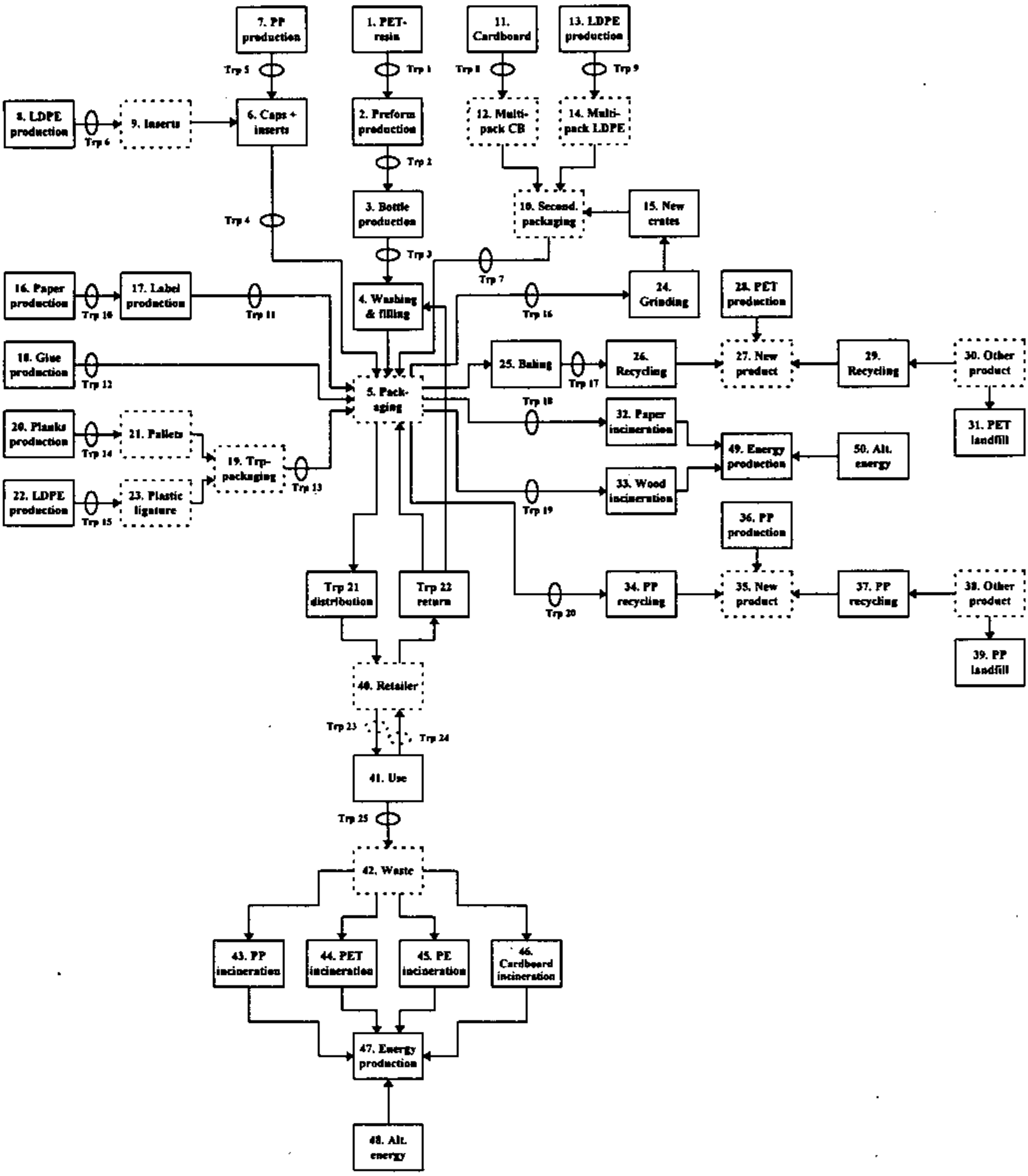


Figure A.1
Process tree for the 50 and 150 cl refillable PET bottle system.

Sand (r)	2.00e-002		
Water (r)	1.75e+004		
Phosphate rock (r)	3.00e-002		
Crude oil (r)	376.100		(2) Fuel resource
Natural gas (r)	307.900		(2) Fuel resource
Coal (r)	138.900		(2) Fuel resource
Crude oil, feedstock (r)	777.500		(2) Feedstock resource
Natural gas, feedstock (r)	233.500		(2) Feedstock resource
Coal, feedstock (r)	0.356		(2) Feedstock resource
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Oil	16.060	None	(3) Fuel
Natural gas	16.660	None	(3) Fuel
Coal	3.890	None	(3) Fuel
Oil, feedstock	33.180	None	(3) Feedstock
Natural gas, feedstock	12.630	None	(3) Feedstock
Coal, feedstock	1.00e-002	None	(3) Feedstock
Electricity, coal marginal	0.727	Ex	(4)

The sum of output flow(s) (5.245 kg) is used to calculate emissions and energies

Notes

Production of 1 kg of bottle grade polyethylene terephthalate (PET) from virgin feedstock (ethylene and para-xylene) (1). The data includes all process steps from extraction of feedstock resources (crude oil and natural gas) to solid state polymerisation.

General comments concerning the APME Eco-profiles report series:
- In the report, the results for the cradle to gate life cycle are aggregated. This means that emissions from combustion of fuels and from the production of electricity are already included in the process emissions and that resources from the production of electricity are included in the energy demand (fuels). The fuel "other" (in the APME-report) mainly consists of oil and gas and has therefore been added to the value for oil.

References and comments:
(1) Boustead, Ian, Eco-profiles of the European plastics industry, Report 8: Polyethylene terephtalate (PET), A report for APME's Technical and Environmental Centre, Brussels, April 1995, table 1, page 6.
(2) The fuels and feedstocks in the Eco-profile report correspond to primary resources (MJ). The MJ-figure has been converted to g by using the higher heat value (6).
(3) The original figure is an internal parameter because the environmental load associated with the production and combustion is included in the emissions and resource consumption above. Therefore it would not be correct to use the emission factors from the database.
(4) The hydro power and nuclear power inputs have been replaced by electricity from coal condensing plants, in accordance with the long-term marginal assumption (see the main report). The efficiencies used for electricity production are 0.80 for hydro power and 0.35 for nuclear power (5).
(5) Boustead, Ian, Eco-balance methodology for commodity plastics, PWMI/APME, Brussels, 1992.
(6) The Eco-profile reports have been carried out by Boustead Consulting (Ian Boustead). The heat values used in these studies were provided by William Dove, Boustead Consulting, UK.
- Oil: 42.7 MJ/kg.
- Natural gas: 54.1 MJ/kg.
- Coal: 28 MJ/kg.

Transport Card: Trp 1

Inflows	**Percent**	**Massflow [kg]**	
PET-resin		5.245	
Outflows			
		5.245	
Modes of conveyance	**[km]**		**Reference**
Truck, heavy (highway, 70%)	300.000		

The sum of output flow(s) (5.245 kg) is used to calculate emissions and energies

Notes

The transport of PET-resin to preform production has been estimated.

Both PET-resin and preforms are assumed to be produced in central Europe. A transport distance of 300 km has been assumed to be representative.

Process Card: 2. Preform production

Inflows	**Percent**	**Massflow [kg]**	
PET-resin		5.245	
Outflows			
Preforms		5.245	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (5.245 kg) is used to calculate emissions and energies

Notes

The production of preforms is included in the production of bottles. There are no information available concerning the share of material scrap lost in the process. Therefore the inflow is identical to the outflow.

Transport Card: Trp 2

--- To be continued ---

Inflows	Percent	Massflow [kg]	
Preforms		5.245	
Outflows			
		5.245	

Modes of conveyance	[km]	Reference
Truck, heavy (highway, 70%)	800.000	

The sum of output flow(s) (5.245 kg) is used to calculate emissions and energies

Notes
The transport of preforms to bottle production has been estimated.

The preforms are assumed to be produced in central Europe and the bottles are assumed to be produced in Denmark. A transport distance of 800 km has been assumed to be representative.

Process Card: 3. Bottle production

Inflows	Percent	Massflow [kg]
Preforms		5.245
Outflows		
Bottles		5.245

Emissions, waste and resources	[g]	Reference
Water (r)	1.75e+004	Resource
Coal (r)	0.485	(2) Fuel resource
Crude oil (r)	5.33e-002	(2) Fuel resource
Natural gas (r)	1.41e-002	(2) Fuel resource
Waste, mineral	92.000	Waste
Waste, slags & ashes	28.100	
Waste, mixed industrial	0.200	
Dust	6.400	Air
CO	0.980	
CO2	1.60e+003	
SO2	17.000	
NOx	5.400	
HCl	0.270	
HF	1.00e-002	
HC	1.300	
COD (aq)	3.00e-003	Water
BOD (aq)	2.00e-003	
Suspended solids (aq)	0.150	

Energy carrier	[MJ]	E Factor	Reference
Hard coal	13.571	None	(3) Fuel
Oil	2.277	None	(3) Fuel
Natural gas	0.763	None	(3) Fuel
Electricity, coal marginal	2.410	FU/Ex	(4)

The sum of output flow(s) (5.245 kg) is used to calculate emissions and energies

Notes
Production of 1 kg of PET bottles from PET-resin (production of polymer not included) (1).

General comments concerning the APME Eco-profiles report series:
- In the report, the results for the cradle to gate life cycle are aggregated. This means that emissions from combustion of fuels and from the production of electricity are already included in the process emissions and that resources from the production of electricity are included in the energy demand (fuels).
- Neither the size of the bottles nor the type of bottles (refillable/disposable) are specified in the report.
- There are no information available concerning the share of material scrap lost in the process. Therefore the inflow is identical to the outflow.

Other references and comments:
(1) Boustead, I., Eco-profiles of the European plastics industry, Report 10: Polymer Conversion, A report for the Technical and Environmental Centre of the Plastics Manufacturers in Europe (APME) in collaboration with EuPC (European Plastics Converters) and supported by EUROMAP (European Commitee of Machinery Manufacturers for the Plastics and Rubber Industries), Brussels, May 1997, table 27, page 22.
(2) The fuels and feedstocks in the Eco-profile report correspond to primary resources (MJ). The MJ-figure has been converted to g by using the higher heat value (6).
(3) The original figure is an internal parameter because the environmental load associated with the production and combustion is included in the emissions and resource consumption above. Therefore it would not be correct to use the emission factors from the database.
(4) The hydro power and nuclear power inputs have been replaced by electricity from coal condensing plants, in accordance with the long-term marginal assumption (see the main report). The efficiencies used for electricity production are 0.80 for hydro power and 0.35 for nuclear power (5).
(5) Boustead, Ian, Eco-balance methodology for commodity plastics, PWMI/APME, Brussels, 1992.
(6) The Eco-profile reports have been carried out by Boustead Consulting (Ian Boustead). The heat values used in these studies were provided by William Dove, Boustead Consulting, UK.
- Oil: 42.7 MJ/kg.
- Natural gas: 54.1 MJ/kg.

--- To be continued ---

- Coal: 28 MJ/kg.

Transport Card: Trp 3

Inflows	**Percent**	**Massflow [kg]**
Bottles		5.245
Outflows		
		5.245

Modes of conveyance	**[km]**	**Reference**
Truck, heavy (highway, 70%)	100.000	

The sum of output flow(s) (5.245 kg) is used to calculate emissions and energies

Notes

The transport of bottles to the soft-drink producer has been estimated.

The bottles are assumed to be produced in Denmark relatively close to the soft-drink producer. A transport distance of 100 km has been assumed to be representative.

Process Card: 4. Washing & filling

Inflows	**Percent**	**Massflow [kg]**
Bottles		5.245
Return (bottles)		104.237
Outflows		
Bottle+beverage		1.11e+003

Emissions, waste and resources	**[g]**	**Reference**
Water (r)	8.11e+003	Resource
NaOH (in)	26.000	Non-elementary inflow

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.679	Ex	
Natural gas (>100 kW)	1.019	FU/Ex	

The sum of input flow(s) (109.482 kg) is used to calculate emissions and energies
Mass change factor 10.115

Notes

Washing and filling of 50 cl refillable PET bottles for soft drinks at the soft-drink producer (1).

The fuel used and the furnace size is unknown. Natural gas and a furnace size larger than 100 kW has been assumed.

Material balance per bottle (2) (3):
- Inflow: bottles (new and reused) + bottles (for recycling) = 53 + [0.035x53] = 54.855 g (3) (4).
- Outflow: bottle + beverage = 54.855+ 500 = 554.855 g (4) (5).
- Mass change factor (out/in) = ... = 10.115.

Data gaps:
Pasteurisation of soft drinks is associated with the beverage. Thus energy use associated with the pasteurisation procedure is not included. The production of sodium hydroxide (NaOH) has not been included and is therefore accounted for as a non-elementary inflow. Cleaning agents (except NaOH) are used in quite small amounts and have not been accounted for. Aquatic emissions of e.g. COD, BOD, N and P are subjects to efficient cleaning procedures in municipal waste water treatment plants and emissions to the environment are assumed to be minimal and thus negligible. Energy use at the waste water treatment plant is estimated to be only a few percent of the total energy use for tapping. The fate of organic cleaning agents in municipal waste water treatment plants as well as their eventual impact in the environment have not been quantified due to lack of data, and potential environmental impacts are unknown.

References and comments:
(1) The soft-drink producer (confidential). Data were collected by Per Nielsen, IPU and entered by Lisa Person, CIT.
(2) The information about the recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.
(3) The information about the bottle weights were provided by PLM, Sweden, Nils Ljungqvist and Constar International, UK, Tom Chilton. The weight used in the previous study was 52 g. The weight used above has been estimated by Vince Matthews, PETCORE, UK, to be an representative average for Europe.
(4) The recycling rates were provided by reference 1. 3.5 % of the bottles goes to material recycling, which means that an additional amount of 3.5 % is taken into to the system.
(5) The amount of beverage is 50 cl, which corresponds to 0.50 kg.

Process Card: 5. Packaging

Inflows	**Percent**	**Massflow [kg]**
Labels	9.30e-002 %	1.201
Caps+inserts	0.340 %	4.392
Bottle+beverage		1.11e+003
Secondary packaging	0.100 %	1.292
Return (other pac.)		174.635
Transport packaging	0.180 %	2.325
Glue	3.10e-002 %	0.400

--- To be continued ---

Outflows		
Crate/tray recyc.	5.70e-002 %	0.736
Bottle recycling	0.287 %	3.707
Paper incineration	9.20e-002 %	1.188
Wood incineration	0.177 %	2.286
Cap/insert recyc.	0.289 %	3.733
Beverage distribu.		1.28e+003

Emissions, waste and resources	[g]	Reference
Glue (out)	0.308	Non-elementary outflow

Energy carrier	[MJ]	E Factor	Reference

The sum of output flow(s) (1.29e+003 kg) is used to calculate emissions and energies

Notes
Packaging of the beverage bottles at the soft-drink producer. The environmental load associated with the packaging equipment etc. has not been inclu

Material balance per bottle (1):
Inflows:
- Bottle+beverage: Distribution of 1 bottle corresponds to 53+500 g. Furthermore, 3.5 % of the bottles goes to material recycling (0.035x53=1.855 g), see the outflow "Bottles to recycling" below. This means that the inflow of "Bottle+beverage" = 53+1.855+500=554.855 g.
- Caps and inserts: 2.2 g.
- Secondary packaging: 0.6463 g (2).
- Labels: 0.6 g.
- Glue (for labels): 0.2 g.
- Transport packaging: Pallets + Plastic ligature = 1.17 g (4) (5).
- Return of other packaging: 0.85 x (Cap+insert) + 0.985 x (Label + Glue) + Crates (distribution flow) + Trays (distribution flow) + Pallets (distribution flow) = ... = 87.46 g (6) (7).
- Total inflow = ... = 647.13 g.

Outflows:
- Crates and trays to recycling (identical to the inflow of crates and trays, see reference 2 and 3) = ... = 0.3713 g.
- Bottles to recycling (3.5 % of the bottles are recycled according to reference 1): 0.035 x 53 = 1.855 g.
- Paper to incineration (0.5 % of the labels disappears in the waste management according to reference 1, which means that 98.5 % is washed away at the soft-drink producer) = 0.985 x 0.6 = 0.591 g.
- Pallets (wood) to incineration (identical to the inflow of pallets, see reference 4 and 5) = ... = 1.146 g.
- Caps and inserts to recycling (85 % of the caps and inserts are recycled according to reference 1) = 0.85 x 2.2 = 1.87 g
- Distribution of beverage: (Bottle+beverage) + (Cap+insert) + Label + Glue + Crates (distribution flow) + Trays (distribution flow) + Multipack(CB) + Multipack(PE) + Pallets (distribution flow) + Plastic ligature = 554.85 + 2.2 + 0.6 + 0.2 + 58.13 + 3.75 + [18/6x0.05] + [15/6x0.05] + 22.92 + 0.021 = 641.09 g.
- Total outflow = ... = 646.93 g.

Mass change factor (out/in) = ... = 0.9997 = 1.000.

The waste water treatment of glue has not been included in the study. Glue has therefore been accounted for as a non-elementary outflow. This explains that the inflow is larger than the outflow (inflow - outflow = 0.199 g). This corresponds to the amount of glue that does not disappear in the waste management (together with the bottles and labels). The amount of glue per kg outflow = 0.199/0.64693 = 0.308 g.

References and comments:
(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriforeningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.
(2) Secondary packaging consists of: Crates + Trays + Multipack (CB) + Multipack (LDPE) = [Weight of crate/Number of bottles x Market share x (1-Recycling rate)] + [Weight of tray/Number of bottles x Market share x (1-Recycling rate)] + [Weight of Multipack (CB)/Number of bottles x Market share] + [Weight of Multipack (LDPE)/Number of bottles x Market share] = [1550/24x0.9x0.006] + [1800/48x0.1x0.006] + [18/6x0.05] + [15/6x0.05] = 0.6463 g (3).
(3) The recycling rates were provided by reference 1. As much as 99.4 % of the crates and trays is recycled, which means that only 0.6 % of new crates and trays is taken into to the system.
(4) Pallets + Plastic ligature = [Weight of pallet/Number of bottles x Market share x (1-Recycling rate)] + [Amount of plastic ligature per pallet/Number of bottles x Market share] = [22000/690x1x0.05] + [20/960x1] = 1.146 + 0.021 = 1.17 g.
(5) The reuse rate were provided by reference 1. As much as 95 % of the pallets is reused, which means that only 5 % of new pallets is taken into to the system.
(6) The recycling rates (provided by reference 1) were used to calculate the return of packaging to the soft-drink producer. 15 % of the caps and inserts and 1.5 % of the labels and glue disappear in the waste management (together with 1.5 % of the bottles).
(7) The distribution flow corresponds to the real material flow in the distribution system. The distribution flows (of crates, trays and pallets) = [Weight/Number of bottles x Market share] ---> [1550/24x0.9] + [1800/48x0.1] + [22000/690x1] = 58.13 + 3.75 + 22.92.

Process Card: 6. Caps+inserts

Inflows	Percent	Massflow [kg]
PP		3.992
Inserts	9.091 %	0.399
Outflows		
Caps+inserts		4.392

Emissions, waste and resources	[g]	Reference
Pigment (in)	8.450	Inflow not followed from the cradle

--- To be continued ---

Waste, PP	41.800		Incinerated
Waste, pigment	9.70e-003		Unspecified, no heavy metals
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	6.180	Ex	

The sum of input flow(s) (4.392 kg) is used to calculate emissions and energies

Notes

Production of 1 kg of PP caps, not including the production of PP.

Data are the same as those used in the study from 1995 (1), according to the producer of PP-caps, Larsen & Becker. The data in reference 1 is given per kg of PP-caps (not per kg caps+inserts) and these figures have been recalculated using the following factor: weight of cap/weight of cap+insert = 2.0/(2.0 + 0.2) = 0.909 kg PP-caps/kg total outflow.

Material balance per bottle (2):
Inflows:
- Caps: 2.0 g.
- Insert: 0.2 g.

Outflow: Caps+inserts: 2.2 g.

Mass change factor (out/in) = ... = 1.000.

References:

(1) Pommer K., Suhr Wesnæs M., Madsen C. (1995): Miljømæssig kortlægning af emballager til øl og læskedrikke. Delrapport 5: Genpåfyldelige PET-flasker. Miljø- og Energiministeriet Miljøstyrelsen, page 38.
(2) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Transport Card: Trp 4

Inflows	**Percent**	**Massflow [kg]**	
Caps+inserts		4.392	
Outflows			
		4.392	
Modes of conveyance	**[km]**		**Reference**
Truck, medium (rural, 40%)	100.000		

The sum of output flow(s) (4.392 kg) is used to calculate emissions and energies

Notes

The transport of caps and inserts to the soft-drink producer has been estimated.

The caps are assumed to be produced in Denmark relatively close to the soft-drink producer. A transport distance of 100 km has been assumed to be representative.

Process Card: 7. PP-production

Outflows	**Percent**	**Massflow [kg]**	
PP		3.992	
Emissions, waste and resources	**[g]**		**Reference**
Particulates	2.000		Air
CO2	1.10e+003		
CO	0.700		
SO2	11.000		
H2S	1.00e-002		
NOx	10.000		
HCl	4.00e-002		
HF	1.00e-003		
HC	13.000		
Metals	5.00e-003		
COD (aq)	0.400		Water
BOD (aq)	6.00e-002		
Acid as H+ (aq)	9.00e-002		
Nitrates (aq)	2.00e-002		
Metals (aq)	0.300		
NH4+ (aq)	1.00e-002		
Cl- (aq)	0.800		
Dissolved organics (aq)	3.00e-002		
Suspended solids (aq)	0.200		
Oil (aq)	4.00e-002		
HC (aq)	0.300		
Dissolved solids (aq)	0.200		
Phosphate (aq)	2.00e-002		
Other nitrogen (aq)	1.00e-002		

--- To be continued ---

Other organics (aq)	0.250		
Waste, industrial	4.000		Waste
Waste, mineral	14.000		
Waste, ashes	5.000		
Waste, toxic chemicals	3.00e-002		
Waste, non toxic chemicals	8.000		
Iron ore (r)	0.300		Resource
Limestone (r)	0.200		
Water (r)	3.10e+003		
Bauxite (r)	0.400		
NaCl (r)	5.000		
Clay (r)	3.00e-002		
Crude oil (r)	139.100		(1) Fuel resource
Natural gas (r)	167.470		(1) Fuel resource
Coal (r)	59.290		(1) Fuel resource
Crude oil, feedstock (r)	1.15e+003		(1) Feedstock resource
Natural gas, feedstock (r)	234.000		(1) Feedstock resource
Coal, feedstock (r)	0.357		(1) Feedstock resource
Hydropower [MJel] (r)	0.810		(2) Electricity resource
Uranium (as pure U) (r)	7.58e-003		(3) Electricity resource
Waste, highly radioactive	2.10e-002		(4) Waste
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Oil	5.940	None	(5) Fuel
Natural gas	9.060	None	(5) Fuel
Coal	1.660	None	(5) Fuel
Oil, feedstock	48.900	None	(5) Feedstock
Natural gas, feedstock	12.660	None	(5) Feedstock
Coal, feedstock	1.00e-002	None	(5) Feedstock
Electricity	2.370	None	(6)
Hydro power [MJel]	1.000	None	(8)
Hydro power [MJel]	0.810	None	(7)

The sum of output flow(s) (3.992 kg) is used to calculate emissions and energies

Notes

Production of 1 kg of polypropene (PP) from virgin feedstock (propylene). The data includes all process steps from extraction of feedstock resources (crude oil and natural gas) to polymerisation.

General comments concerning the APME Eco-profile report series:
- In the APME-reports, the results for the cradle to gate life cycle are aggregated. This means that emissions from combustion of fuels and from the production of electricity are already included in the process emissions and that resources from the production of electricity are included in the energy demand (fuels). The fuel "other" (in the APME-report) mainly consists of oil and gas and has therefore been added to the value for oil.

Main reference: Boustead, Ian, Eco-profiles of the European plastics industry, Report 3: Polyethylene and Polypropylene, A report for The European Centre for Plastics in the Environment (PWMI/APME), Brussels, May 1993, table 26, page 17.

Other references and comments:
(1) The fuels and feedstocks in the Eco-profile report correspond to primary resources (MJ). The MJ-figure has been converted to g by using the higher heat value (9).
(2) Hydro power has been accounted for as a resource in MJ electricity. Since LCAiT does not handle other units than g, the MJel is put in the name
(3) The consumption of uranium has been calculated based on the original figure for nuclear power given as MJ electricity. 1 MJ of electricity from nuclear power corresponds to 0.00758 g of uranium (as pure U) (10).
(4) The generation of radioactive waste has been calculated based on the original figure for nuclear power given as MJ electricity. 1 MJ of electricity from nuclear power corresponds to 0.021 g of highly radioactive waste (10).
(5) The original figure is an internal parameter because the environmental load associated with the production and combustion is included in the emissions and resource consumption above. Therefore it would not be correct to use the emission factors from the database.
(6) The original figure is an internal parameter because the environmental load associated with the production is included in the emissions and resource consumption above. Therefore it would not be correct to use any emission factors for electricity production from the database.
(7) The original figure corresponds to MJ consumed electricity from hydro power. This parameter is internal because the environmental load associated with the production is included in the emissions and resource consumption above.
(8) The original figure corresponds to MJ consumed electricity from nuclear power. This parameter is internal because the environmental load associated with the production is included in the emissions and resource consumption above.
(9) The Eco-profile reports from APME have been carried out by Boustead Consulting (Ian Boustead). The heat values used in these studies were provided by William Dove, Boustead Consulting, UK.
- Oil: 42.7 MJ/kg.
- Natural gas: 54.1 MJ/kg.
- Coal: 28 MJ/kg.
(10) Livscykelanalys av Vattenfalls Elproduktion, Sammanfattande rapport, Stockholm, Sweden, 1996, page 70-71.

Transport Card: Trp 5

Inflows	**Percent**	**Massflow [kg]**
PP		3.992
Outflows		
		3.992

--- To be continued ---

Modes of conveyance	[km]	Reference
Truck, heavy (highway, 70%)	300.000	

The sum of output flow(s) (3.992 kg) is used to calculate emissions and energies

Notes
The transport of PP has been estimated.

The PP is assumed to be produced in Denmark. A transport distance of 300 km has been assumed to be representative.

Process Card: 8. LDPE-production

Outflows	Percent	Massflow [kg]
LDPE		0.399

Emissions, waste and resources	[g]	Reference
Particulates	3.000	Air
CO2	1.25e+003	
CO	0.900	
SO2	9.000	
NOx	12.000	
HCl	7.00e-002	
HF	5.00e-003	
HC	21.000	
Metals	5.00e-003	
COD (aq)	1.500	Water
BOD (aq)	0.200	
Acid as H+ (aq)	6.00e-002	
Nitrates (aq)	5.00e-003	
Metals (aq)	0.250	
NH4+ (aq)	5.00e-003	
Cl- (aq)	0.130	
Dissolved organics (aq)	2.00e-002	
Suspended solids (aq)	0.500	
Oil (aq)	0.200	
HC (aq)	0.100	
Dissolved solids (aq)	0.300	
Phosphate (aq)	5.00e-003	
Other nitrogen (aq)	1.00e-002	
Waste, industrial	3.500	Waste
Waste, mineral	26.000	
Waste, ashes	9.000	
Waste, toxic chemicals	0.100	
Waste, non toxic chemicals	0.800	
Iron ore (r)	0.200	Resource
Limestone (r)	0.150	
Water (r)	2.40e+004	
Bauxite (r)	0.300	
NaCl (r)	8.000	
Clay (r)	2.00e-002	
Ferromanganese (r)	1.00e-003	
Crude oil (r)	88.760	(1) Fuel resource
Natural gas (r)	228.800	(1) Fuel resource
Coal (r)	117.100	(1) Fuel resource
Crude oil, feedstock (r)	793.200	(1) Feedstock resource
Natural gas, feedstock (r)	610.400	(1) Feedstock resource
Coal, feedstock (r)	0.357	(1) Feedstock resource
Hydropower [MJel] (r)	0.540	(2) Electricity resource
Uranium (as pure U) (r)	1.27e-002	(3) Electricity resource
Waste, highly radioactive	3.50e-002	(4) Waste

Energy carrier	[MJ]	E Factor	Reference
Oil	3.790	None	(5) Fuel
Natural gas	12.380	None	(5) Fuel
Coal	3.280	None	(5) Fuel
Oil, feedstock	33.870	None	(5) Feedstock
Natural gas, feedstock	33.020	None	(5) Feedstock
Coal, feedstock	1.00e-002	None	(5) Feedstock
Electricity	3.140	None	(6)
Nuclear power [MJel]	1.670	None	(8)
Hydro power [MJel]	0.540	None	(7)

The sum of output flow(s) (0.399 kg) is used to calculate emissions and energies

Notes
Production of 1 kg of low density polyethylene (LDPE) from virgin feedstock (ethylene). The data includes all process steps from extraction of

--- To be continued ---

feedstock resources (crude oil and natural gas) to polymerisation.

General comments concerning the APME Eco-profile report series:
- In the APME-reports, the results for the cradle to gate life cycle are aggregated. This means that emissions from combustion of fuels and from the production of electricity are already included in the process emissions and that resources from the production of electricity are included in the energy demand (fuels). The fuel "other" (in the APME-report) mainly consists of oil and gas and has therefore been added to the value for oil.

Main reference: Boustead, Ian, Eco-profiles of the European plastics industry, Report 3: Polyethylene and Polypropylene, A report for The European Centre for Plastics in the Environment (PWMI/APME), Brussels, May 1993, table 17, page 11.

Other references and comments:
(1) The fuels and feedstocks in the Eco-profile report correspond to primary resources (MJ). The MJ-figure has been converted to g by using the higher heat value (9).
(2) Hydro power has been accounted for as a resource in MJ electricity. Since LCAiT does not handle other units than g, the MJel is put in the name.
(3) The consumption of uranium has been calculated based on the original figure for nuclear power given as MJ electricity. 1 MJ of electricity from nuclear power corresponds to 0.00758 g of uranium (as pure U) (10).
(4) The generation of radioactive waste has been calculated based on the original figure for nuclear power given as MJ electricity. 1 MJ of electricity from nuclear power corresponds to 0.021 g of highly radioactive waste (10).
(5) The original figure is an internal parameter because the environmental load associated with the production and combustion is included in the emissions and resource consumption above. Therefore it would not be correct to use the emission factors from the database.
(6) The original figure is an internal parameter because the environmental load associated with the production is included in the emissions and resource consumption above. Therefore it would not be correct to use any emission factors for electricity production from the database.
(7) The original figure corresponds to MJ consumed electricity from hydro power. This parameter is internal because the environmental load associated with the production is included in the emissions and resource consumption above.
(8) The original figure corresponds to MJ consumed electricity from nuclear power. This parameter is internal because the environmental load associated with the production is included in the emissions and resource consumption above.
(9) The Eco-profile reports from APME have been carried out by Boustead Consulting (Ian Boustead). The heat values used in these studies were provided by William Dove, Boustead Consulting, UK.
- Oil: 42.7 MJ/kg.
- Natural gas: 54.1 MJ/kg.
- Coal: 28 MJ/kg.
(10) Livscykelanalys av Vattenfalls Elproduktion, Sammanfattande rapport, Stockholm, Sweden, 1996, page 70-71.

Transport Card: Trp 6

Inflows	**Percent**	**Massflow [kg]**	
LDPE		0.399	
Outflows			
		0.399	
Modes of conveyance	**[km]**		**Reference**
Truck, heavy (highway, 70%)	300.000		

The sum of output flow(s) (0.399 kg) is used to calculate emissions and energies

Notes
The transport of LDPE has been estimated.

Process Card: 9. Inserts

Inflows	**Percent**	**Massflow [kg]**	
LDPE		0.399	
Outflows			
Inserts		0.399	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.399 kg) is used to calculate emissions and energies

Notes
Data for the production of inserts are not available. This process is however assumed to be negligible and is therefore not included.

Process Card: 10. Secondary packaging

Inflows	**Percent**	**Massflow [kg]**	
Multipack-Cardboard	23.211 %	0.300	
Multipack-LDPE		0.256	
New crates/trays		0.736	
Outflows			
Secondary packaging		1.292	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.292 kg) is used to calculate emissions and energies

Notes
This process box is just used in order to summarise the different flows of secondary packaging.

--- To be continued ---

Material balance per bottle (1):
Inflows:
- Crates + Trays = [Weight of crate/Number of bottles x Market share x (1-Recycling rate)] + [Weight of tray/Number of bottles x Market share x (1-Recycling rate)] = [1550/24x0.9x0.006] + [1800/48x0.1x0.006] = 0.3488 + 0.0225 g (2).
- Multipack (Cardboard) = [Weight of Multipack (CB)/Number of bottles x Market share] = [18/6x0.05] = 0.15 g.
- Multipack (LDPE) = [Weight of Multipack(LDPE)/Number of bottles x Market share] = [15/6x0.05] = 0.125 g.
- Total inflow = ... = 0.6463 g.

Outflow:
- Secondary packaging = 0.6463 g.

Mass change factor (out/in) = ... = 1.000.

References and comments:
(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.
(2) The recycling rates were provided by reference 1. As much as 99.4 % of the crates and trays is recycled, which means that only 0.6 % of new crates and trays is taken into to the system.

Transport Card: Trp 7

Inflows	**Percent**	**Massflow [kg]**
Secondary packaging		1.292
Outflows		
		1.292

Modes of conveyance	**[km]**	**Reference**
Truck, medium (rural, 40%)	100.000	

The sum of output flow(s) (1.292 kg) is used to calculate emissions and energies

Notes
The transport of secondary packaging to the soft-drink producer has been estimated.

The secondary packaging is assumed to be produced in Denmark relatively close to the soft-drink producer. A transport distance of 100 km has been assumed to be representative.

Process Card: 11. Cardboard

Outflows	**Percent**	**Massflow [kg]**
Cardboard		0.300

Emissions, waste and resources	**[g]**	**Reference**
Land use [m2*years] (r)	18.069	
Particulates	1.959	
CO2 (bio)	1.33e+003	
CO2	456.189	
NOx	3.782	
SO2	1.194	
H2S	0.110	
COD (aq)	16.710	
BOD-5 (aq)	5.900	
Suspended solids (aq)	2.100	
Waste, ashes	5.800	
Waste, inorganic sludges	15.700	
Waste, other rejects	10.800	
Waste, organic sludges	2.600	
NaOH (in)	7.800	
HCl (in)	6.00e-002	
Starch (in)	1.600	
Sizing agents (in)	5.900	
Retention agents (in)	2.000	
Defoamer (in)	1.200	
Biocides (in)	2.00e-002	
Lubricants (in)	0.260	
Na2CO3 (in)	1.700	
CaCO3 (in)	3.100	
CaO (in)	8.200	
Na2SO4 (in)	4.900	
H2SO4 (in)	13.200	
Sulphur (in)	0.200	
Alum (in)	3.700	
Other additives (in)	0.300	
CO	0.722	
NMVOC	0.510	
CH4	0.499	

--- To be continued ---

Dioxin	4.58e-010
NH3	2.65e-004
N2O	9.65e-003
HCl	1.42e-003
HF	9.23e-004
Radioactive emissions [kBq]	3.32e+004
As	2.75e-006
Cd	6.10e-006
Cr	5.16e-006
Hg	6.34e-007
Ni	2.31e-004
Pb	1.99e-005
CN-	1.61e-005
Tot-N (aq)	2.01e-002
Phosphate (aq)	1.54e-004
H2S (aq)	5.07e-007
Oil (aq)	0.114
Organics (aq)	9.15e-002
Radioactive emissions [kBq] (aq)	311.600
Al (aq)	2.01e-003
As (aq)	1.33e-005
Cd (aq)	6.91e-006
Co (aq)	2.18e-003
Cr (aq)	4.87e-005
Cu (aq)	1.60e-005
Ni (aq)	3.98e-005
Pb (aq)	4.99e-005
Sb (aq)	5.54e-008
Sn (aq)	4.34e-003
V (aq)	1.30e-005
Zn (aq)	5.47e-005
F- (aq)	7.47e-004
Cl- (aq)	3.347
SO42- (aq)	0.131
CN- (aq)	1.55e-005
Waste, industrial	51.055
Waste, hazardous	5.326
Waste, highly radioactive	2.86e-002
Crude oil (r)	123.652
Natural gas (r)	19.466
Hard coal (r)	2.619
Brown coal (r)	2.336
Wood (r)	6.31e-002
Uranium (as pure U) (r)	1.77e-004
Hydro power-water (r)	8.34e+008
NMVOC, diesel engines	0.232
Zn	5.65e-005
Se	5.65e-007
Cu	9.82e-005
NMVOC, oil combustion	0.471
Benzene	1.61e-003
Cr3+	2.71e-006
PO43- (aq)	1.63e-004
Cr3+ (aq)	4.88e-005
Waste, radioactive	2.86e-004
Biomass (r)	6.24e-002
Peat (in)	5.236
Bark (in)	48.216

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Oil, heavy fuel	2.040	None	
Oil, light fuel	1.00e-002	None	
Natural gas (>100 kW)	0.690	None	
Diesel, heavy & medium truck (urban)	0.784	None	
Peat	0.110	None	
Bark	0.820	None	
Heat	-0.340	None	
Electricity, coal marginal	2.600	Ex	
Diesel, heavy & medium truck (highway)	0.325	None	
Diesel, ship (4-stroke)	1.377	None	

The sum of output flow(s) (0.300 kg) is used to calculate emissions and energies

Notes

--- To be continued ---

Production of 1 kg of cardboard (1). The data are imported from a database file (card-b.lca).

Production of cardboard has been approximated with data for production of kraftliner. This approximation has been validated through a comparison with confidential actual cardboard data.

The file includes data on wood harvesting, wood transport and production of kraftliner. Data on wood transport and on kraftliner production are adapted from FEFCO (1). Data on wood harvesting are adapted from reference 2.

The data above include emissions etc. from fuel production. These have been calculated by using emission factors from our energy database. The emission factors take into account emissions etc. for production of the electricity that is used for fuel production. However, the data above do not include emissions etc. for production of the electricity that is used in production of kraftliner. When the total emissions profile of the packaging system is calculated, these emissions etc. are included through the use of emission factors for extraction etc. as is denoted above (E Factor: Ex).

References:
(1) European Database for Corrugated Board Life Cycle Studies, FEFCO, Groupement Ondulé, KRAFT Institute, 1996/1.
(2) Örjan Hedenberg, Birgit Backlund Jacobson, Tiina Pajula, Lisa Person, Helena Wessman; Use of agro fibre for paper production from an environmental point of view, NordPap DP2/54, Scan Forskrapport 682, Nordic Industrial Fund, Oslo, 1997.

Transport Card: Trp 8

Inflows	**Percent**	**Massflow [kg]**	
Cardboard		0.300	
Outflows			
		0.300	
Modes of conveyance	**[km]**		**Reference**
Truck, heavy (highway, 70%)	300.000		

The sum of output flow(s) (0.300 kg) is used to calculate emissions and energies

Notes
The transport of cardboard has been estimated.

The cardboard is assumed to be produced in Denmark. A transport distance of 300 km has been assumed to be representative.

Process Card: 12. Multipack-Cardboard

Inflows	**Percent**	**Massflow [kg]**	
Cardboard		0.300	
Outflows			
Multipack-Cardboard		0.300	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.300 kg) is used to calculate emissions and energies

Notes
Data for the production of cardboard multipacks are not available. This process is however assumed to be negligible and is therefore not included.

Process Card: 13. LDPE-production

Outflows	**Percent**	**Massflow [kg]**	
LDPE		0.256	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.256 kg) is used to calculate emissions and energies

Notes
Identical to process 8.

Transport Card: Trp 9

Inflows	**Percent**	**Massflow [kg]**	
LDPE		0.256	
Outflows			
		0.256	
Modes of conveyance	**[km]**		**Reference**
Truck, heavy (highway, 70%)	300.000		

The sum of output flow(s) (0.256 kg) is used to calculate emissions and energies

Notes
The transport of LDPE has been estimated.

Process Card: 14. Multipack-LDPE

Inflows	**Percent**	**Massflow [kg]**
LDPE		0.256

Outflows

--- To be continued ---

Multipack-LDPE		0.256	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.256 kg) is used to calculate emissions and energies

Notes
Data for the production of LDPE multipacks are not available. This process is however assumed to be negligible and is therefore not included.

Process Card: 15. New crate/tray

Inflows	**Percent**	**Massflow [kg]**	
Recycled PE		0.736	
Outflows			
New crates/trays		0.736	
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	2.070	Ex	

The sum of output flow(s) (0.736 kg) is used to calculate emissions and energies

Notes
Production of crates and trays by injection moulding of recycled HDPE (1).

For 50 cl bottles, crates holding 24 bottles are most common (market share: 90 %). Trays holding 48 bottles are used as well (market share: 10 %) (2).

Based on the market shares the average weight of one crate or tray is 1.580 kg and it holds an average of 26.4 bottles.

The electricity consumption for the production of crates and trays is the same per kg product.

References:
(1) Data were provided by John Holm at Schoeller-Plast-Enterprise A/S, Regstrup, Denmark, collected and entered by Lisa Person, CIT.
(2) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriforeningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Process Card: 16. Paper production

Outflows	**Percent**	**Massflow [kg]**	
Paper		2.046	
Emissions, waste and resources	**[g]**		**Reference**
Land use [m2*years] (r)	9.324		
Surface water (r)	6.40e+004		
Dust	3.150		
CO2	361.950		
CO	0.292		
NOx	2.309		
SO2	1.269		
CH4	0.423		
N2O	6.55e-003		
PAH	1.50e-006		
Alkanes	1.80e-003		
Propane	9.00e-005		
Formaldehyde	1.35e-003		
Aromates (C9-C10)	4.51e-004		
Benzo(a)pyrene	9.00e-008		
Toluene	9.00e-005		
HCl	5.63e-003		
HF	1.70e-003		
TRS	0.430		
As	4.16e-005		
Ca	2.40e-004		
Cd	1.04e-004		
Co	9.90e-005		
Cu	1.65e-004		
Cr	4.90e-005		
Fe	5.40e-004		
Hg	1.03e-006		
Mo	4.80e-005		
Na	2.25e-003		
Ni	2.15e-003		
Pb	1.88e-004		
Se	3.61e-005		
Zn	1.30e-004		
V	7.80e-003		
BOD-7 (aq)	7.670		
AOX (aq)	0.155		

--- To be continued ---

Suspended solids (aq)	2.920
Tot-N (aq)	0.312
Tot-P (aq)	3.90e-002
Chlorate (aq)	1.080
Waste, paper production	85.800
Binders (in)	47.800
Corrugated board (in)	18.500
Fillers (in)	216.000
H2SO4 (in)	26.700
NaClO3 (in)	27.600
NaOH (in)	26.400
O2 (in)	24.800
SO2 (in)	19.400
Dry strength additives (in)	20.300
Tall oil (out)	26.000
Steam [MJ] (out)	2.210
Warm water [MJ] (out)	0.150
NMVOC	9.91e-002
Dioxin	3.94e-010
NH3	1.19e-004
H2S	2.01e-005
Particulates	0.171
Radioactive emissions [kBq]	1.07e+005
CN-	2.37e-005
COD (aq)	1.87e-003
BOD-5 (aq)	5.67e-005
Phosphate (aq)	3.00e-005
H2S (aq)	9.86e-008
Oil (aq)	9.17e-002
Organics (aq)	7.12e-002
Radioactive emissions [kBq] (aq)	1.01e+003
Al (aq)	3.93e-004
As (aq)	1.12e-005
Cd (aq)	5.51e-006
Co (aq)	4.78e-005
Cr (aq)	9.47e-006
Cu (aq)	3.11e-006
Ni (aq)	3.35e-005
Pb (aq)	4.09e-005
Sb (aq)	1.08e-008
Sn (aq)	8.45e-004
V (aq)	2.52e-006
Zn (aq)	1.09e-005
F- (aq)	1.01e-003
Cl- (aq)	2.719
SO42- (aq)	0.106
CN- (aq)	3.01e-006
Waste, industrial	10.458
Waste, hazardous	0.122
Waste, highly radioactive	5.23e-003
Crude oil (r)	99.822
Natural gas (r)	4.238
Hard coal (r)	3.886
Brown coal (r)	2.138
Wood (r)	1.23e-002
Uranium (as pure U) (r)	1.66e-004
Hydro power-water (r)	1.23e+009
NMVOC, diesel engines	6.65e-002
NMVOC, oil combustion	0.693
Benzene	2.37e-003
Cr3+	3.99e-006
PO43- (aq)	2.40e-004
Cr3+ (aq)	7.17e-005
Waste, radioactive	4.23e-004
Biomass (r)	9.18e-002
VOC, natural gas combustion	9.40e-014
VOC, coal combustion	1.42e-006
VOC, diesel engines	3.33e-005
NMVOC, power plants	2.54e-005
NMVOC, petrol engines	8.99e-015
HC	1.46e-004
Aldehydes	3.56e-008
Organics	7.09e-008
Metals	2.29e-008

--- To be continued ---

BOD (aq)	1.14e-007
Dissolved organics (aq)	6.29e-015
Dissolved solids (aq)	9.56e-004
NO3-N (aq)	5.91e-009
NH4-N (aq)	7.64e-007
Nitrogen (aq)	3.47e-007
H+ (aq)	6.87e-007
HC (aq)	4.58e-007
Phenol (aq)	1.57e-016
Aromates (C9-C10) (aq)	1.57e-007
Fe (aq)	1.91e-006
Mn (aq)	9.56e-007
Sr (aq)	4.78e-006
Metals (aq)	1.14e-007
Salt (aq)	9.56e-005
Waste, mineral	4.98e-005
Waste, slags & ashes (waste incin.)	7.48e-009
Waste, slags & ashes (energy prod.)	2.80e-003
Waste, bulky	0.518
Waste, sludge	4.02e-013
Waste, rubber	5.85e-007
Waste, chemical	3.85e-006
Crude oil, feedstock (r)	1.62e-007
Softwood (r)	5.01e-004
Fuel, unspecified [MJ] (r)	5.35e-009
NaCl (r)	3.21e-006
Clay (r)	6.87e-007
CaCO3 (r)	3.21e-006
Al (r)	1.83e-006
Fe (r)	1.92e-006
Mn (r)	1.13e-008
Water (r)	344.400
Ground water (r)	4.33e-008
Peat (in)	28.560
Bark (in)	14.112

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	2.725	Ex	
Oil, heavy fuel	3.000	None	
Oil, light fuel	4.00e-002	None	
Diesel, heavy & medium truck (urban)	0.349	None	
Hard coal	2.80e-002	None	
Bark	0.240	None	
Peat	0.600	None	
Diesel, heavy & medium truck (highway)	5.93e-002	None	
Diesel, ship (4-stroke)	2.98e-002	None	
Diesel, heavy & medium truck (rural)	7.34e-003	None	

The sum of output flow(s) (2.046 kg) is used to calculate emissions and energies

Notes

Production of 1 kg of fine paper (1). The data are imported from a database file (paper.lca). The file includes data on wood harvesting, wood transport and production of paper. Data for wood transport and for production of paper are adapted from STFI (1). Data on wood harvesting are adapted from reference 2.

The data above include emissions etc. from fuel production. These have been calculated by using emission factors from our energy database. The emission factors take into account emissions etc. for production of the electricity that is used for fuel production. However, the data above do not include emissions etc. for production of the electricity that is used in production of paper. When the total emissions profile of the packaging system is calculated, these emissions etc. are included through the use of emission factors for extraction etc. as is denoted above (E Factor: Ex).

References:

(1) Data from the STFI database (The Swedish Pulp and Paper Institute).
(2) Örjan Hedenberg, Birgit Backlund Jacobson, Tiina Pajula, Lisa Person, Helena Wessman; Use of agro fibre for paper production from an environmental point of view, NordPap DP2/54, Scan Forskrapport 682, October 1997.

Transport Card: Trp 10

Inflows	**Percent**	**Massflow [kg]**
Paper		2.046
Outflows		
		2.046

Modes of conveyance	**[km]**	**Reference**
Truck, heavy (highway, 70%)	300.000	

The sum of output flow(s) (2.046 kg) is used to calculate emissions and energies

--- To be continued ---

Notes
The transport of paper has been estimated.

Process Card: 17. Label printing

Inflows	**Percent**	**Massflow [kg]**	
Paper		2.046	
Outflows			
Labels		1.201	

Emissions, waste and resources	**[g]**		**Reference**
Ink (in)	23.652		Non-elementary inflow
Lacquer, water (in)	14.191		Non-elementary inflow
Lacquer, various (in)	4.730		Non-elementary inflow
Auxiliary materials (in)	9.697		(2) Non-elementary inflow
VOC	0.946		
Waste, ink	2.365		
Waste, paper	496.689		Incinerated
Waste, other	7.096		
Paper, recycling (out)	83.254		Non-elementary outflow
Paper, fuel (out)	163.200		Non-elementary outflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	2.725	Ex	

The sum of output flow(s) (1.201 kg) is used to calculate emissions and energies
Mass change factor 0.587

Notes
Printing of 1 kg of labels for glass and PET refillable and disposable bottles. The data for the different labels are aggregated into a "standard average" label for beer and carbonated soft drink (1).

The production of labels for beer and carbonated softdrinks corresponds to about 55% of Nova Prints total production (defined as printed paper). Therefore, 55% of all the activities at Nova-Print (i.e. cleaning, maintenance, research and development, laboratory facilities, marketing, administration, facilities for personnel) are allocated to the production of labels for beer and carbonated softdrinks.

The weight of the labels has been calculated based on the inflows and outflows below:
Inflows and outflows per 1000 labels:
Inflows:
- paper = 360 g
- ink & lacquer = 9 g
Outflows:
- waste, ink = 0.5 g
- waste, paper = 105 g
- paper for recycling = 17.6 g
- paper for fuel = 34.5 g
Weight of 1000 labels:
360+9-0.5-105-17.6-34.5 = 211.4 g.

Material balance:
- Inflow: 360 g of paper.

- Outflow: 211.4 g of labels.

- Mass change factor (out/in) = ... = 0.587. The rest of the inflows and outflows are not included in the material balance since they are accounted for as non-elementary inflows and outflows.

References and comments:
(1) Data were supplied by Jørgen Jensen at Nova Print AS Danmark, Odense, Denmark, collected by Anna Ryberg, CIT and entered by Johan Widheden, CIT.
(2) The many small individual flows of auxiliary materials have been aggregated into one value.
The auxiliary materials are: IPA spirit, Mineral cleaning agent, Vegetable cleaning agent, Spray powder, Cloths, Various oils, Various chemicals, Wat

Transport Card: Trp 11

Inflows	**Percent**	**Massflow [kg]**	
Labels		1.201	
Outflows			
		1.201	
Modes of conveyance	**[km]**		**Reference**
Truck, medium (rural, 40%)	100.000		

The sum of output flow(s) (1.201 kg) is used to calculate emissions and energies

Notes
The transport of labels to the soft-drink producer has been estimated.

--- To be continued ---

The labels are assumed to be produced in Denmark relatively close to the soft-drink producer. A transport distance of 100 km has been assumed to be representative.

Process Card: 18. Glue production

Outflows	**Percent**	**Massflow [kg]**	
Glue		0.400	
Emissions, waste and resources	**[g]**		**Reference**
Uranium (as pure U) (r)	7.07e-006		
Hydro power-water (r)	6.60e+004		
Crude oil (r)	6.061		
Natural gas (r)	0.250		
Hard coal (r)	0.117		
Brown coal (r)	9.71e-002		
Wood (r)	5.96e-003		
Water (r)	559.881		
Particulates	1.76e-002		
CO2	19.752		
CO	3.46e-002		
NOx	0.188		
SO2	2.20e-002		
NMVOC	4.81e-002		
NMVOC, diesel engines	1.91e-002		
CH4	2.48e-002		
Dioxin	2.07e-011		
NH3	5.85e-005		
N2O	6.09e-004		
HCl	5.82e-005		
H2S	1.15e-006		
HF	6.24e-006		
Radioactive emissions [kBq]	624.264		
As	1.08e-007		
Cd	2.66e-007		
Cr	4.91e-007		
Cu	9.42e-006		
Hg	2.59e-008		
Ni	1.03e-005		
Pb	8.67e-007		
Se	5.42e-008		
Zn	5.42e-006		
CN-	1.67e-009		
COD (aq)	9.07e-004		
BOD-5 (aq)	2.76e-005		
Tot-N (aq)	1.33e-003		
Phosphate (aq)	1.46e-005		
H2S (aq)	4.78e-008		
Oil (aq)	5.61e-003		
Organics (aq)	4.69e-003		
Radioactive emissions [kBq] (aq)	5.866		
Al (aq)	1.90e-004		
As (aq)	6.20e-007		
Cd (aq)	3.44e-007		
Co (aq)	3.72e-007		
Cr (aq)	4.59e-006		
Cu (aq)	1.51e-006		
Ni (aq)	1.86e-006		
Pb (aq)	2.40e-006		
Sb (aq)	5.23e-009		
Sn (aq)	4.10e-004		
V (aq)	1.22e-006		
Zn (aq)	5.16e-006		
F- (aq)	6.93e-006		
Cl- (aq)	0.164		
SO42- (aq)	6.48e-003		
CN- (aq)	1.46e-006		
Waste, industrial	0.705		
Waste, hazardous	7.18e-003		
Waste, highly radioactive	2.06e-002		
Other additives (in)	433.168		Non-elementary inflows
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.810	Ex	
Diesel, heavy & medium truck (highway)	0.236	None	

--- To be continued ---

The sum of output flow(s) (0.400 kg) is used to calculate emissions and energies

Notes

Production of 1 kg of glue for labels (1). The data are imported from a database file (glue.lca).

The file includes glue production. No data were available for the production of raw materials (Casein, Urea, Starch etc.) and therefore these have been accounted for as non-elementary inflows (Other additives). Transportation data (distances with truck) for raw materials were provided by the supplier and are included.

The data above include emissions etc. from fuel production. These have been calculated by using emission factors from our energy database. The emission factors take into account emissions etc. for production of the electricity that is used for fuel production. However, the data above do not include emissions etc. for production of the electricity that is used in production of glue. When the total emissions profile of the packaging system is calculated, these emissions etc. are included through the use of emission factors for extraction etc. as is denoted above (E Factor: Ex).

References:

(1) The glue is produced by Casco Products, Fredensborg, Denmark, and the data were recieved from Jean Paul Schwartz (Casco, Denmark), via Birgit Nilsson (Casco, Stockholm, Sweden). They were collected and entered by Lisa Person, CIT.

Transport Card: Trp 12

Inflows	**Percent**	**Massflow [kg]**	
Glue		0.400	
Outflows			
		0.400	
Modes of conveyance	**[km]**		**Reference**
Truck, heavy (highway, 70%)	300.000		

The sum of output flow(s) (0.400 kg) is used to calculate emissions and energies

Notes

The transport of glue has been estimated.

The glue is assumed to be produced in Denmark. A transport distance of 300 km has been assumed to be representative.

Process Card: 19. Transport packaging

Inflows	**Percent**	**Massflow [kg]**	
Plastic ligature	1.778 %	4.13e-002	
Pallets		2.284	
Outflows			
Transport packaging		2.325	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (2.325 kg) is used to calculate emissions and energies

Notes

This process box is just used in order to summarise the different flows of transport packaging.

Material balance per bottle (1):

Inflows:

- Pallets = [Weight of pallet/Number of bottles x Market share x (1-Recycling rate)]= [22000/960x1.0x0.05] = 1.146 g (2).
- Plastic ligature = [Weight of plastic ligature/Number of bottles x Market share] = [20/960x1.0] = 0.0208 g.
- Total inflow = ... = 1.17 g.

Outflow:

- Transport packaging = 1.17 g.

Mass change factor (out/in) = ... = 1.000.

References and comments:

(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

(2) The recycling rates were provided by reference 1. As much as 95 % of the pallets is reused, which means that only 5 % of new pallets is taken into to the system.

Transport Card: Trp 13

Inflows	**Percent**	**Massflow [kg]**	
Transport packaging		2.325	
Outflows			
		2.325	
Modes of conveyance	**[km]**		**Reference**
Truck, medium (rural, 40%)	100.000		

The sum of output flow(s) (2.325 kg) is used to calculate emissions and energies

Notes

--- To be continued ---

The transport of transport packaging to the soft-drink producer has been estimated.

The transport packaging is assumed to be produced in Denmark relatively close to the soft-drink producer. A transport distance of 100 km has been assumed to be representative.

Process Card: 20. Planks for pallets

Outflows	**Percent**	**Massflow [kg]**	
Planks		2.284	
Emissions, waste and resources	**[g]**		**Reference**
Land use [m2*years] (r)	18.770		
HC	0.571		
CO2	103.005		
CO	1.324		
NOx	1.050		
SO2	0.140		
NMVOC	0.250		
CH4	0.131		
Dioxin	1.08e-010		
NH3	1.88e-004		
N2O	2.28e-003		
HCl	3.03e-004		
H2S	5.98e-006		
HF	3.33e-005		
Particulates	0.273		
Radioactive emissions [kBq]	7.04e+005		
As	5.62e-007		
Cd	1.32e-006		
Cr	2.24e-006		
Hg	2.67e-007		
Ni	5.33e-005		
Pb	4.51e-006		
CN-	8.70e-009		
COD (aq)	4.72e-003		
BOD-5 (aq)	1.43e-004		
Tot-N (aq)	6.90e-003		
Phosphate (aq)	7.58e-005		
H2S (aq)	2.49e-007		
Oil (aq)	2.92e-002		
Organics (aq)	2.44e-002		
Radioactive emissions [kBq] (aq)	6.61e+003		
Al (aq)	9.89e-004		
As (aq)	3.22e-006		
Cd (aq)	1.79e-006		
Co (aq)	9.57e-005		
Cr (aq)	2.39e-005		
Cu (aq)	7.85e-006		
Ni (aq)	9.68e-006		
Pb (aq)	1.25e-005		
Sb (aq)	2.72e-008		
Sn (aq)	2.13e-003		
V (aq)	6.37e-006		
Zn (aq)	2.69e-005		
F- (aq)	3.60e-005		
Cl- (aq)	0.854		
SO42- (aq)	3.37e-002		
CN- (aq)	7.59e-006		
Waste, industrial	3.666		
Waste, hazardous	3.74e-002		
Waste, highly radioactive	1.04e-002		
Crude oil (r)	31.529		
Natural gas (r)	1.306		
Hard coal (r)	0.606		
Brown coal (r)	0.505		
Wood (r)	3.10e-002		
Uranium (as pure U) (r)	3.67e-005		
Hydro power-water (r)	7.42e+007		
NMVOC, diesel engines	0.146		
Zn	2.22e-005		
Se	2.21e-007		
Cu	3.85e-005		
Ethane	2.11e-005		
Propane	3.17e-005		

--- To be continued ---

Alkanes	2.64e-004
Ethene	5.28e-005
Acetylene	1.06e-005
Propene	2.11e-005
Alkenes	2.11e-005
PAH	1.21e-007
Benzene	2.11e-005
Toluene	1.06e-005
Aromates (C9-C10)	2.11e-005
Formaldehyde	6.34e-006
TOC (aq)	6.60e-005
Bark (in)	94.080
Waste, slags & ashes	5.760

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.525	Ex	
Oil, light fuel	0.264	None	
Diesel, heavy & medium truck (urban)	0.783	None	
Bark	1.600	None	
Diesel, heavy & medium truck (highway)	0.118	None	
Diesel, ship (4-stroke)	5.94e-002	None	

The sum of output flow(s) (2.284 kg) is used to calculate emissions and energies

Notes

Production of 1 kg of planks. The data are imported from a database file (planks.lca).

The file includes data on production (planting, forestry and harvesting) of pine pulpwood (softwood) in Sweden, using mechanised and manual wood harvesting (1). The softwood is both naturally rejuvenated and planted. The sawmill includes barking, sawing and drying of wood (2). The transport between harvesting and saw mill is included as well (3).

The data above include emissions etc. from fuel production and combustion. These have been calculated by using emission factors from our energy database. The emission factors take into account emissions etc. for production of the electricity that is used for fuel production. However, the data above do not include emissions etc. for production of the electricity that is used in the saw mill. When the total emissions profile of the packaging system is calculated, these emissions etc. are included through the use of emission factors for extraction etc. as is denoted above (E Factor: Ex).

References:

(1) Örjan Hedenberg, Birgit Backlund Jacobson, Tiina Pajula, Lisa Person, Helena Wessman; Use of agro fibre for paper production from an environmental point of view, NordPap DP2/54, Scan Forskrapport 682, Nordic Industrial Fund, Oslo, 1997.
(2) Tillman et al., Packaging and the Environment, Chalmers Industriteknik, Gothenburg, Sweden, 1992.
(3) Data from the STFI database (The Swedish Pulp and Paper Institute).

Transport Card: Trp 14

Inflows	**Percent**	**Massflow [kg]**
Planks		2.284
Outflows		
		2.284

Modes of conveyance	**[km]**	**Reference**
Truck, medium (rural, 40%)	100.000	

The sum of output flow(s) (2.284 kg) is used to calculate emissions and energies

Notes

The transport of planks to pallet production has been estimated.

The planks are assumed to be produced in Denmark relatively close to the soft-drink producer. A transport distance of 100 km has been assumed to be representative.

Process Card: 21. Pallets

Inflows	**Percent**	**Massflow [kg]**
Planks		2.284
Outflows		
Pallets		2.284

Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (2.284 kg) is used to calculate emissions and energies

Notes

Data for the production of pallets are not available. This process is however assumed to be negligible and is therefore not included.

Process Card: 22. LDPE-production

Outflows	**Percent**	**Massflow [kg]**

--- To be continued ---

LDPE		4.13e-002	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (4.13e-002 kg) is used to calculate emissions and energies

Notes
Identical to process 8.

Transport Card: Trp 15

Inflows	**Percent**	**Massflow [kg]**	
LDPE		4.13e-002	
Outflows			
		4.13e-002	
Modes of conveyance	**[km]**		**Reference**
Truck, heavy (highway, 70%)	300.000		

The sum of output flow(s) (4.13e-002 kg) is used to calculate emissions and energies

Notes
The transport of LDPE has been estimated.

Process Card: 23. Plastic ligature

Inflows	**Percent**	**Massflow [kg]**	
LDPE		4.13e-002	
Outflows			
Plastic ligature		4.13e-002	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (4.13e-002 kg) is used to calculate emissions and energies

Notes
Data for the production of plastic ligature are not available. This process is however assumed to be negligible and is therefore not included.

Transport Card: Trp 16

Inflows	**Percent**	**Massflow [kg]**	
Crate/tray recyc.		0.736	
Outflows			
		0.736	
Modes of conveyance	**[km]**		**Reference**
Truck, heavy (highway, 70%)	130.000		

The sum of output flow(s) (0.736 kg) is used to calculate emissions and energies

Notes
Transport of crates and trays to material recycling (1).

References:
(1) The information about transport distances were provided by Bryggeriføreningen via Logisys (Jan Jacobsen).

Process Card: 24. Grinding

Inflows	**Percent**	**Massflow [kg]**	
Crate/tray recyc.		0.736	
Outflows			
Recycled PE		0.736	
Emissions, waste and resources	**[g]**		**Reference**
Waste, PE-dust	20.000		Waste, incinerated
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.162	Ex	

The sum of output flow(s) (0.736 kg) is used to calculate emissions and energies

Notes
Grinding of crates and trays into polyethylene granulates (1). A mobile grinding unit at the soft-drink producer grinds the crates and trays into granulates, which are transported to the factory for production of new crates.

References:
(1) Data were supplied by John Holm at Schoeller-Plast-Enterprise A/S, Regstrup, Denmark, collected and entered by Lisa Person, CIT.

Transport Card: Trp 17

Inflows	**Percent**	**Massflow [kg]**
Bottle bales		3.707

--- To be continued ---

Outflows

		3.707	
Modes of conveyance	**[km]**		**Reference**
Truck, heavy (highway, 70%)	700.000		

The sum of output flow(s) (3.707 kg) is used to calculate emissions and energies

Notes

The transport of bottle bales to material recycling has been estimated. (The potential transport of bottles to baling has been neglected.)

The bottles bales are transported to the Netherlands (1). A transport distance of 700 km has been assumed to be representative.

References:
(1) The information about the location of the recycling plant were provided by John Holm at Schoeller-Plast-Enterprise A/S, Regstrup, Denmark.

Process Card: 25. Baling

Inflows	**Percent**	**Massflow [kg]**	
Bottle recycling		3.707	
Outflows			
Bottle bales		3.707	
Emissions, waste and resources	**[g]**		**Reference**
Steel strappings (in)	3.000		Non-elementary inflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	6.48e-002	Ex	

The sum of output flow(s) (3.707 kg) is used to calculate emissions and energies

Notes

Baling of PET bottles (1). A mobile bale press unit produces bales of 250 kg, which are transported to the Netherlands, where they are grinned into flakes, washed and dried. The production of steel strappings has been assumed to be negligible and therefore this has been accounted for as a non-elementary inflow.

References:
(1) Data were supplied by John Holm at Schoeller-Plast-Enterprise A/S, Regstrup, Denmark, collected and entered by Lisa Person, CIT.

Process Card: 26. Recycling

Inflows	**Percent**	**Massflow [kg]**	
Bottle bales		3.707	
Outflows			
PET-resin (rec-1)		3.707	
Emissions, waste and resources	**[g]**		**Reference**
Nitrogen (in)	1.85e-002		(2) Non-elementary inflow
Polymer filter screens (in)	1.500		Non-elementary inflow
Acetaldehyde	2.30e-002		Air
Water (r)	4.00e+004		
Water (aq)	3.50e+004		
Waste, industrial	1.500		(3) Waste
Waste, polymer	15.000		
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.403	Ex	
Natural gas (>100 kW)	1.125	FU/Ex	(4) Fuel

The sum of output flow(s) (3.707 kg) is used to calculate emissions and energies

Notes

Production of PET-resin for bottle production (1). The data is valid for production of PET-resin from 75 % of virgin PET and 25 % of clean PET-flakes from recycled PET bottles. In this case the raw material is only recycled PET bottles, but these data is assumed to be a good approximation. Furthermore there is a data gap for the production of PET-flakes from baled PET bottles.

The output from the process is solid state PET-resin ready for use in PET bottles. The production of nitrogen and polymer filter screens has not been included and therefore these are accounted for as non-elementary inflows. There are no information available concerning the share of material scrap lost in the process. Therefore the inflow is identical to the outflow.

References and comments:
(1) Data were supplied by Steve Nichols, Wellman, USA, from Wellman PET Resins Europe, situated in Emmen, The Netherlands, collected by Lisa Person, CIT and entered by Johan Widheden, CIT. Data refers to EcoClear PET-resin.
(2) Data from Hoekloos, Rotterdam, The Netherlands. Density used: 1.23 kg/m3.
(3) Filter screens.
(4) Density: 0.8 m3. Heat value used: 48.5 MJ/kg.

Process Card: 27. New product

Inflows	**Percent**	**Massflow [kg]**

--- To be continued ---

Virgin PET		1.854	
PET-resin (rec-2)	25.000 %	1.854	
PET-resin (rec-1)	50.000 %	3.707	

Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (7.414 kg) is used to calculate emissions and energies

Notes

The PET-resin produced from recycled bottles from the packaging system is assumed to replace in part (50%) virgin PET-resin and in part (50%) PET-resin based on recycled bottles from other systems in Europe.

Process Card: 28. PET-production (avoided)

Outflows	**Percent**	**Massflow [kg]**	
Virgin PET		1.854	

Emissions, waste and resources	**[g]**		**Reference**
Particulates	-3.800		Air
CO2	-2.33e+003		
CO	-18.000		
SO2	-25.000		
NOx	-20.200		
HCl	-0.110		
HC	-40.000		
Metals	-1.00e-002		
Organics	-9.400		
COD (aq)	-3.300		Water
BOD (aq)	-1.000		
Na+ (aq)	-1.500		
Acid as H+ (aq)	-0.180		
Metals (aq)	-0.120		
Cl- (aq)	-0.710		
Dissolved organics (aq)	-13.000		
Suspended solids (aq)	-0.600		
Detergent/oil (aq)	-2.00e-002		
HC (aq)	-0.400		
Dissolved solids (aq)	-0.580		
Phosphate (as P2O5) (aq)	-1.00e-002		
Other nitrogen (aq)	-1.00e-003		
SO42- (aq)	-4.00e-002		
Waste, mineral	-30.000		Waste
Waste, ashes	-9.600		
Waste, mixed industrial	-3.500		
Waste, regulated chemicals	-0.130		
Waste, inert chemicals	-1.900		
Bauxite (r)	-0.310		Resource
NaCl (r)	-4.900		
Clay (r)	-1.00e-003		
Ferromanganese (r)	-1.00e-003		
Iron ore (r)	-0.550		
Limestone (r)	-0.270		
Manganese (r)	-5.00e-002		
Metallurgical coal (r)	-0.230		
Sand (r)	-2.00e-002		
Water (r)	-1.75e+004		
Phosphate rock (r)	-3.00e-002		
Crude oil (r)	-376.100		(1) Fuel resource
Natural gas (r)	-307.900		(1) Fuel resource
Coal (r)	-138.900		(1) Fuel resource
Crude oil, feedstock (r)	-777.500		(1) Feedstock resource
Natural gas, feedstock (r)	-233.500		(1) Feedstock resource
Coal, feedstock (r)	-0.356		(1) Feedstock resource
Hydro power [MJel] (r)	-0.550		(2) Electricity resource
Uranium (as pure U) (r)	-6.20e-003		(3) Electricity resource
Waste, highly radioactive	-1.70e-002		(4) Waste

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Oil	-16.060	None	(5) Fuel
Natural gas	-16.660	None	(5) Fuel
Coal	-3.890	None	(5) Fuel
Oil, feedstock	-33.180	None	(5) Feedstock
Natural gas, feedstock	-12.630	None	(5) Feedstock
Coal, feedstock	-1.00e-002	None	(5) Feedstock
Electricity	-2.710	None	(6)
Hydro power [MJel]	-0.550	None	(7)

--- To be continued ---

Nuclear power [MJel]	-0.820	None	(8)

The sum of output flow(s) (1.854 kg) is used to calculate emissions and energies

Notes
The reduced production of virgin PET caused by the outflow of discarded PET bottles from the packaging system.

Production of 1 kg of bottle grade polyethylene terephthalate (PET) from virgin feedstock (ethylene and para-xylene) (1). The data includes all process steps from extraction of feedstock resources (crude oil and natural gas) to solid state polymerisation.

General comments concerning the APME Eco-profiles report series:
- In the report, the results for the cradle to gate life cycle are aggregated. This means that emissions from combustion of fuels and from the production of electricity are already included in the process emissions and that resources from the production of electricity are included in the energy demand (fuels). The fuel "other" (in the APME-report) mainly consists of oil and gas and has therefore been added to the value for oil.

Main reference: Boustead, Ian, Eco-profiles of the European plastics industry, Report 8: Polyethylene terephtalate (PET), A report for APME's Technical and Environmental Centre, Brussels, April 1995, table 1, page 6.

Other references and comments:
(1) The fuels and feedstocks in the Eco-profile report correspond to primary resources (MJ). The MJ-figure has been converted to g by using the higher heat value (9).
(2) Hydro power has been accounted for as a resource in MJ electricity. Since LCAiT does not handle other units than g, the MJel is put in the name.
(3) The consumption of uranium has been calculated based on the original figure for nuclear power given as MJ electricity. 1 MJ of electricity from nuclear power corresponds to 0.00758 g of uranium (as pure U) (10).
(4) The generation of radioactive waste has been calculated based on the original figure for nuclear power given as MJ electricity. 1 MJ of electricity from nuclear power corresponds to 0.021 g of highly radioactive waste (10).
(5) The original figure is an internal parameter because the environmental load associated with the production and combustion is included in the emissions and resource consumption above. Therefore it would not be correct to use the emission factors from the database.
(6) The original figure is an internal parameter because the environmental load associated with the production is included in the emissions and resource consumption above. Therefore it would not be correct to use any emission factors for electricity production from the database.
(7) The original figure corresponds to MJ consumed electricity from hydro power. This parameter is internal because the environmental load associated with the production is included in the emissions and resource consumption above.
(8) The original figure corresponds to MJ consumed electricity from nuclear power. This parameter is internal because the environmental load associated with the production is included in the emissions and resource consumption above.
(9) The Eco-profile reports from PWMI have been carried out by Boustead Consulting (Ian Boustead). The heat values used in these studies were provided by William Dove, Boustead Consulting, UK.
- Oil: 42.7 MJ/kg.
- Natural gas: 54.1 MJ/kg.
- Coal: 28 MJ/kg.
(10) Livscykelanalys av Vattenfalls Elproduktion, Sammanfattande rapport, Stockholm, Sweden, 1996, page 70-71.

Process Card: 29. Recycling (avoided)

Inflows	**Percent**	**Massflow [kg]**	
Other PET-product		1.854	
Outflows			
PET-resin (rec-2)		1.854	
Emissions, waste and resources	**[g]**		**Reference**
Nitrogen (in)	-1.85e-002		(2) Non-elementary inflow
Polymer filter screens (in)	-1.500		Non-elementary inflow
Acetaldehyde	-2.30e-002		Air
Water (r)	-4.00e+004		
Water (aq)	-3.50e+004		
Waste, industrial	-1.500		(3) Waste
Waste, polymer	-15.000		
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	-0.403	Ex	
Natural gas (>100 kW)	-1.125	FU/Ex	(4) Fuel

The sum of output flow(s) (1.854 kg) is used to calculate emissions and energies

Notes
This is the production of recycled PET-resin based on used PET bottles from other systems which is reduced through the use of recycled bottles from the packaging system. The reason for the negative figures is that they refer to a reduction in the production.

For further details, see process 26.

Process Card: 30. Other product

Outflows	**Percent**	**Massflow [kg]**	
PET-landfilling	50.000 %	1.854	
Other PET-product		1.854	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (3.707 kg) is used to calculate emissions and energies

--- To be continued ---

Notes
When production of PET-resin based on PET bottles from other systems (in Europe) is reduced, these bottles end up at waste management. The marginal waste management is assumed to be landfilling (see Main report).

Process Card: 31. PET-landfill

Inflows	**Percent**	**Massflow [kg]**	
PET-landfilling		1.854	

Emissions, waste and resources	**[g]**		**Reference**
CH4	8.000		(1) Air
CO2	23.000		(1)
COD (aq)	0.240		(1) Water
Elementary waste, solid	980.000		Elementary waste

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	7.00e-004	Ex	(2)
Diesel, heavy & medium truck (urban)	3.50e-002	FU/Ex	(2)

The sum of output flow(s) (1.854 kg) is used to calculate emissions and energies

Notes
Landfilling of polyethyleneterephtalate (PET) during a short-term perspective (1) (2). During the surveyable time-period 2 % of the polymer is assumed to be decomposed. "Solid waste" gives the weight of the waste in the landfill remaining after the surveyable time-period.

References:
(1) Sundqvist J-O et al, Life Cycle Assessment and Solid Waste, AFR, Stockholm, 1994.
(2) Tillman et al., Packaging and the Environment, Chalmers Industriteknik, Gothenburg, Sweden, 1992.

Transport Card: Trp 18

Inflows	**Percent**	**Massflow [kg]**	
Paper incineration		1.188	
Outflows			
		1.188	

Modes of conveyance	**[km]**		**Reference**
Truck, medium (rural, 40%)	20.000		

The sum of output flow(s) (1.188 kg) is used to calculate emissions and energies

Notes
Trp 18
Transport of paper to waste incineration (1).

References:
(1) The information about transport distances were provided by Bryggeriføreningen via Logisys (Jan Jacobsen).

Process Card: 32. Paper incineration

Inflows	**Percent**	**Massflow [kg]**	
Paper incineration		1.188	
Outflows			
Energy (paper)		14.105	

Emissions, waste and resources	**[g]**		**Reference**
Ca(OH)2 (in)	17.600		(1)(2) Non-elementary inflow
Water (r)	243.000		(1)(2)
CO2 (bio)	1.59e+003		(1) Air
CO	5.000		(1)
NOx	1.200		(1)
Dioxin	1.00e-008		(1)
H2O	544.000		(1)
Water to WWTP	243.000		(1) Water
Waste, slags & ashes	20.000		(1) Waste

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.180	Ex	(1)

The sum of input flow(s) (1.188 kg) is used to calculate emissions and energies
Mass change factor 11.870

Notes
Incineration of paper used in labels.
Data used for paper were found in the EDIP unit process database (1), and calculated as cellulose, except data for the amount of heat and electricity produced in the process. These were calculated based on energy production in Danish waste incineration plants in 1992 (3). The incineration plants' own energy consumption was subtracted from the production, to yield the energy exported from the plant. The (lower) heat value used for paper was 15 MJ/kg (3). For further details, see Technical report 7.

--- To be continued ---

Energy production:
The heat produced in waste incineration is 11.3 MJ/kg waste and the electricity produced is 0.57 MJ/kg waste (3).

The outflow of energy from this process is not a mass flow, despite what is indicated above. Instead it is an energy flow, measured in MJ.

"Mass change factor":
The mass change factor in the LCAiT software is generally defined as the total outflow [kg]/total inflow [kg]. Since the outflow from this process is energy, the "mass change factor" is in this case the energy outflow[MJ]/the waste inflow [kg] = 11.87 MJ produced energy/kg waste.

References and comments:
(1) Frees N and Pedersen M A (1996): EDIP unit database.
(2) Used for fluegas cleaning.
(3) SK energi (1994): Opgørelse af affaldsressourcer i Danmark. Elsam/Elkraft. Styregruppe 4 for biomasse.

Transport Card: Trp 19

Inflows	**Percent**	**Massflow [kg]**
Wood incineration		2.286
Outflows		
		2.286

Modes of conveyance	**[km]**	**Reference**
Truck, medium (rural, 40%)	20.000	

The sum of output flow(s) (2.286 kg) is used to calculate emissions and energies

Notes
Transport of wood to waste incineration (1).

References:
(1) The information about transport distances were provided by Bryggeriføreningen via Logisys (Jan Jacobsen).

Process Card: 33. Wood incineration

Inflows	**Percent**	**Massflow [kg]**
Wood incineration		2.286
Outflows		
Energy (wood)		32.853

Emissions, waste and resources	**[g]**	**Reference**
Ca(OH)2 (in)	17.600	(1)(2) Non-elementary inflow
Water (r)	243.000	(1)(2)
CO2 (bio)	1.78e+003	(1)(5) Air
CO	6.000	(1)(5)
NOx	1.200	(1)(5)
Dioxin	1.00e-008	(1)(5)
H2O	522.000	(1)(5)
Water to WWTP	243.000	(1) Water
Waste, slags & ashes	30.000	(1) Waste

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.180	Ex	(1)

The sum of input flow(s) (2.286 kg) is used to calculate emissions and energies
Mass change factor 14.370

Notes
Incineration of wood used in pallets.
Data used for wood were found in the EDIP unit process database (1), except data for the amount of heat and electricity produced in the process. These were calculated based on energy production in Danish waste incineration plants in 1992 (3). The incineration plants' own energy consumption was subtracted from the production, to yield the energy exported from the plant. The (lower) heat value used for wood was 18.3 MJ/kg (5). For further details, see Technical report 7.

Energy production:
The heat produced in waste incineration is 13.8 MJ/kg waste and the electricity produced is 0.57 MJ/kg waste (3).

The outflow of energy from this process is not a mass flow, despite what is indicated above. Instead it is an energy flow, measured in MJ.

"Mass change factor":
The mass change factor in the LCAiT software is generally defined as the total outflow [kg]/total inflow [kg]. Since the outflow from this process is energy, the "mass change factor" is in this case the energy outflow[MJ]/the waste inflow [kg] = 14.37 MJ produced energy/kg waste.

References and comments:
(1) Frees N and Pedersen M A (1996): EDIP unit database.
(2) Used for fluegas cleaning.
(3) SK energi (1994): Opgørelse af affaldsressourcer i Danmark. Elsam/Elkraft. Styregruppe 4 for biomasse.
(4) The air emissions are calculated based on an assumption that during incineration, 1 % of the wood becomes ashes, and also that the ashes

--- To be continued ---

consist of 50 wt% C, 44 wt% O and 6 wt% H (6).
(5) Arbeidsrapport nr. 29 (1995): Miljøøkonomi for papir- og papkredsløb. Delrapport 2: Bølgepap. Miljø- og Energiministeriet Miljøstyrelsen.

Transport Card: Trp 20

Inflows	**Percent**	**Massflow [kg]**
Cap/insert recyc.		3.733
Outflows		
		3.733

Modes of conveyance	**[km]**	**Reference**

The sum of output flow(s) (3.733 kg) is used to calculate emissions and energies

Notes
Transport of caps and inserts to material recycling (1).

References:
(1) The information about transport distances were provided by Bryggeriføreningen via Logisys (Jan Jacobsen).

Process Card: 34. PP-recycling

Inflows	**Percent**	**Massflow [kg]**
Cap/insert recyc.		3.733
Outflows		
PP (rec-1)		3.733

Emissions, waste and resources	**[g]**		**Reference**
Waste, PP-dust	20.000		(1) (2) Waste, incinerated

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.162	Ex	(1) (2)
Electricity, coal marginal	2.070	Ex	(1) (3)

The sum of output flow(s) (3.733 kg) is used to calculate emissions and energies

Notes
Recycling of caps and inserts. Caps and inserts consist of 91 % polypropylene (PP) and 9 % of low density polyethylene (LDPE).

There are no data available for recycling of PP. The recycling process has been approximated with the recycling of HDPE into crates (1). These data involves grinding and injection moulding (process 24 and 15). There are no information available concerning the share of material scrap lost in the process. Therefore the inflow is identical to the outflow.

References:
(1) Data were provided by John Holm at Schoeller-Plast-Enterprise A/S, Regstrup, Denmark. The data were entered by Lisa Person, CIT.
(2) Grinding.
(3) Injection moulding.

Process Card: 35. New product

Inflows	**Percent**	**Massflow [kg]**
Virgin PP		1.866
PP (rec-2)	25.000 %	1.866
PP (rec-1)	50.000 %	3.733

Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (7.466 kg) is used to calculate emissions and energies

Notes
The PP produced from recycled caps from the packaging system is assumed to replace in part (50%) virgin PP and in part (50%) PP recycled from other systems in Europe.

Process Card: 36. PP-production (avoided)

Outflows	**Percent**	**Massflow [kg]**
Virgin PP		1.866

Emissions, waste and resources	**[g]**		**Reference**
Particulates	-2.000		Air
CO2	-1.10e+003		
CO	-0.700		
SO2	-11.000		
H2S	-1.00e-002		
NOx	-10.000		
HCl	-4.00e-002		
HF	-1.00e-003		
HC	-13.000		
Metals	-5.00e-003		
COD (aq)	-0.400		Water

--- To be continued ---

BOD (aq)	-6.00e-002		
Acid as H+ (aq)	-9.00e-002		
Nitrates (aq)	-2.00e-002		
Metals (aq)	-0.300		
NH4+ (aq)	-1.00e-002		
Cl- (aq)	-0.800		
Dissolved organics (aq)	-3.00e-002		
Suspended solids (aq)	-0.200		
Oil (aq)	-4.00e-002		
HC (aq)	-0.300		
Dissolved solids (aq)	-0.200		
Phosphate (aq)	-2.00e-002		
Other nitrogen (aq)	-1.00e-002		
Other organics (aq)	-0.250		
Waste, industrial	-4.000		Waste
Waste, mineral	-14.000		
Waste, ashes	-5.000		
Waste, toxic chemicals	-3.00e-002		
Waste, non toxic chemicals	-8.000		
Iron ore (r)	-0.300		Resource
Limestone (r)	-0.200		
Water (r)	-3.10e+003		
Bauxite (r)	-0.400		
NaCl (r)	-5.000		
Clay (r)	-3.00e-002		
Crude oil (r)	-139.100		(1) Fuel resource
Natural gas (r)	-167.470		(1) Fuel resource
Coal (r)	-59.290		(1) Fuel resource
Crude oil, feedstock (r)	-1.15e+003		(1) Feedstock resource
Natural gas, feedstock (r)	-234.000		(1) Feedstock resource
Coal, feedstock (r)	-0.357		(1) Feedstock resource
Hydropower [MJel] (r)	-0.810		(2) Electricity resource
Uranium (as pure U) (r)	-7.58e-003		(3) Electricity resource
Waste, highly radioactive	-2.10e-002		(4) Waste
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Oil	-5.940	None	(5) Fuel
Natural gas	-9.060	None	(5) Fuel
Coal	-1.660	None	(5) Fuel
Oil, feedstock	-48.900	None	(5) Feedstock
Natural gas, feedstock	-12.660	None	(5) Feedstock
Coal, feedstock	-1.00e-002	None	(5) Feedstock
Electricity	-2.370	None	(6)
Hydro power [MJel]	-1.000	None	(8)
Hydro power [MJel]	-0.810	None	(7)

The sum of output flow(s) (1.866 kg) is used to calculate emissions and energies

Notes
The reduced production of virgin PP caused by the outflow of PP-caps from the packaging system.

For further details, see process 7.

Process Card: 37. PP-recycling (avoided)

Inflows	**Percent**	**Massflow [kg]**	
Other PP-product		1.866	
Outflows			
PP (rec-2)		1.866	
Emissions, waste and resources	**[g]**		**Reference**
Waste, PP-dust	-20.000		(1) (2) Waste, incinerated
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	-0.162	Ex	(1) (2)
Electricity, coal marginal	-2.070	Ex	(1) (3)

The sum of output flow(s) (1.866 kg) is used to calculate emissions and energies

Notes
This is the recycling of used PP from other systems which is reduced through the use of recycled caps from the packaging system. The reason for the negative figures is that they refer to a reduction in the production.

For further details, see process 34.

Process Card: 38. Other products

Outflows	**Percent**	**Massflow [kg]**

--- To be continued ---

PP-landfilling	50.000 %	1.866	
Other PP-product		1.866	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (3.733 kg) is used to calculate emissions and energies

Notes
When production of PP based on caps from other systems (in Europe) is reduced, these caps end up at waste management. The marginal waste management is assumed to be landfilling (see Main report).

Process Card: 39. PP-landfill

Inflows	**Percent**	**Massflow [kg]**	
PP-landfilling		1.866	
Emissions, waste and resources	**[g]**		**Reference**
CH4	26.000		(1) Air
CO2	24.000		(1)
COD (aq)	0.770		(1) Water
Elementary waste, solid	970.000		Elementary waste
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	7.00e-004	Ex	(2)
Diesel, heavy & medium truck (urban)	3.50e-002	FU/Ex	(2)

The sum of output flow(s) (1.866 kg) is used to calculate emissions and energies

Notes
Landfilling of polypropylene (PP) during a short-term perspective (1) (2). During the surveyable time-period 3 % of the polymer is assumed to be decomposed. "Elementary solid waste" gives the weight of the waste in the landfill remaining after the surveyable time-period.

References:
(1) Sundqvist J-O et al, Life Cycle Assessment and Solid Waste, AFR, Stockholm, 1994.
(2) Tillman et al., Packaging and the Environment, Chalmers Industriteknik, Gothenburg, Sweden, 1992.

Transport Card: Trp 21 (Distribution of beverage)

Inflows	**Percent**	**Massflow [kg]**	
Beverage distribu.		1.28e+003	
Outflows			
		1.28e+003	
Modes of conveyance	**[km]**		**Reference**
Distr, heavy (highway, 50%)(Scan)	56.700		
Distr, heavy (rural, 50%)(Scan)	45.360		
Distr, heavy (urban, 50%)(Scan)	11.340		
Distr, medium (highway, 50%)	14.400		
Distr, medium (rural, 50%)	14.400		
Distr, medium (urban, 50%)	19.200		
Distr, medium (highway, 40%)	0.800		
Distr, medium (rural, 40%)	2.400		
Distr, medium (urban, 40%)	4.800		

Calculated for a reference flow of 1.28e+003 [kg] which corresponds to 1000 l of beverage
The sum of output flow(s) (1.28e+003 kg) is used to calculate emissions and energies

Notes
Distribution of PET bottles by truck, including beverage, pallet and all packaging.
During the distribution from the soft-drink producer to the retailer, the bottles are transported various distances on different types of roads, and by different kinds of trucks.

The distance on each type of road, for each of these trucks, have been supplied by LOGISYS (1). The load rate, fuel consumption and the emissions are calculated and described in Technical report 7 (2).

Reference flow: Distribution of 1000 litres of beverage corresponds to 1282 kg (3).

References:
(1) Supplied by Jan Jacobsen, LOGISYS, collected by Per Nielsen, IPU and entered by Johan Widheden, CIT.
(2) Technical report 7: Energy and transport scenarios.
(3) Distribution of one bottle corresponds to 0.6411 kg (see the "Packaging" process above).

Process Card: 40. Retailers

Inflows	**Percent**	**Massflow [kg]**
Beverage distribu.	92.115 %	1.28e+003
Bottles, caps etc		109.567
Outflows		
Return	20.069 %	278.872

--- To be continued ---

Bever. to consumer 1.11e+003

Emissions, waste and resources	[g]		Reference
Plastic ligature (out)	2.10e-002		Non-elementary outflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.39e+003 kg) is used to calculate emissions and energies

Notes
The choice of packaging is assumed to have negligible effect on the environmental impacts of the retailer.

Material balance per bottle (1):
Inflows:
- Distribution of beverage = ...= 641.09 g.
- From consumer: (0.985 x Bottles) + (0.85 x Cap+insert) + 0.985 x (Label + Glue) = ...= 55.88 g.

Outflows:
- To consumer: (Bottle+beverage) + (Cap+insert) + Label + Glue + Multipack (CB) + Multipack (LDPE) + (0.30 x Plastic ligature) = ... = 556.28 g.
- Return: The inflow from consumer + Crates (distribution flow) + Trays (distribution flow) + Pallets (distribution flow) = ... = 139.67 g.

The mass change factor (out/in) = ...= 0.9999 = 1.000.

70 % of the plastic ligature goes to material recycling (1). This corresponds to less than 1 % of the primary packaging and therefore this has been assumed to be negligible and the plastic ligature has been accounted for as a non-elementary outflow.

References:
(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Process Card: Trp 22 (Return)

Inflows	Percent	Massflow [kg]	
Return		278.872	
Outflows			
Return (other pac.)		174.635	
Return (bottles)	37.378 %	104.237	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (278.872 kg) is used to calculate emissions and energies

Notes
The return transport to the soft-drink producer is included in the distribution of beverage (Trp 21) (1).

Material balance per bottle:
Inflow: From retailer = ... = 139.67 g.

Outflow:
- Bottles to washing and filling: 0.985 x Bottles = ... = 52.21 g.
(Labels, glue, cap and insert are included in the return-to-packaging flow below. This is not logical, but it makes it easier when carrying out the LC-c
- To packaging =... = 87.46 g (See the process "Packaging" above).

Mass change factor (out/in) = ... = 1.000.

References:
(1) This information were provided by Bryggeriføreningen via Logisys (Jan Jacobsen).

Transport Card: Trp 23

Inflows	Percent	Massflow [kg]	
Bever. to consumer		1.11e+003	
Outflows			
		1.11e+003	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (1.11e+003 kg) is used to calculate emissions and energies

Notes
Transport of PET bottles (1) from retailer to consumer. The choice of beverage packaging is assumed not to affect the transport mode, the transport distance or the number of transports from retailer to home. Under this assumption, preliminary calculations show that the choice of packaging has negligible effect on the environmental impact of this transport.

Comments:
(1) Includes: (Bottle+beverage) + (Cap+insert) + Label + Glue + Multipack (CB) + Multipack (LDPE) + (0.30 x Plastic ligature).

Process Card: 41. Use (refrigeration)

--- To be continued ---

Inflows	Percent	Massflow [kg]	
Bever. to consumer		1.11e+003	
Outflows			
Bottles, caps etc		109.567	
Waste		2.613	

Emissions, waste and resources	[g]		Reference
Multipac-CB (out)	0.533		Non-elementary outflow

Energy carrier	[MJ]	E Factor	Reference
Electricity, coal marginal	1.87e-006	Ex	

The sum of output flow(s) (112.180 kg) is used to calculate emissions and energies
Mass change factor 0.101

Notes
The same data as those used in the study from 1995 have been used (1). The PET-bottle is cooled from 20 to 5 degrees Celsius, which correspond to an electricity consumption of 0.000396 MJ/kg PET-bottle. This figure has been recalculated into per kg total outflow using the factor 4.71 e-03 (see the material balance below) ---> 1.87 e-06 MJ/kg total outflow.

This figure has been recalculated into per kg total outflow using the factor: Weight of bottle/Total outflow (see the material balance below) = ... = 1.87 e-06 MJ/kg total outflow.

Material balance per bottle (2):
Inflow: From retailer = ... = 556.28 g.

Outflow:
- To retailer = (0.985 x Bottles) + (0.85 x Cap+insert) + 0.985 x (Label + Glue) = ...= 55.88 g.
- Waste: (0.015 x bottle) + (0.15 x Cap+insert) + 0.015 x (Label+Glue) + (0.8 x Multipack (CB)) + Multipack (LDPE) + (0.3 x Plastic ligature) = ... = 1.376 g.
- Total outflow = ... = 56.25 g.

Mass change factor (out/in) = ... = 0.1011.

Factor for recalculating the original electricity consumption: Weight of bottle/Total outflow = (0.005x53)/(56.25) = ...= 4.71 e-03 kg PET-bottle/kg total outflow.

20 % of the cardboard in the Multipacks goes to material recycling (2). This corresponds to less than 1 % of the primary packaging and therefore this has been assumed to be negligible and the cardboard has been accounted for as a non-elementary outflow.

References:
(1) Pommer K., Suhr Wesnæs M., Madsen C. (1995): Miljømæssig kortlægning af emballager til øl og læskedrikke. Delrapport 5: Genpåfyldelige PET-flasker. Miljø- og Energiministeriet Miljøstyrelsen. page 60.
(2) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Transport Card: Trp 24

Inflows	Percent	Massflow [kg]	
Bottles, caps etc		109.567	
Outflows			
		109.567	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (109.567 kg) is used to calculate emissions and energies

Notes
Transport of PET bottles (1) from consumer to retailer. The choice of beverage packaging is assumed not to affect the transport mode, the transport distance or the number of transports from home to retailer. Under this assumption, preliminary calculations show that the choice of packaging has negligible effect on the environmental impact of this transport.

Comments:
(1) Includes: (0.985 x Bottles) + (0.85 x Cap+insert) + 0.985 x (Label + Glue).

Transport Card: Trp 25

Inflows	Percent	Massflow [kg]	
Waste		2.613	
Outflows			
		2.613	
Modes of conveyance	**[km]**		**Reference**
Truck, medium (rural, 40%)	20.000		

The sum of output flow(s) (2.613 kg) is used to calculate emissions and energies

Notes

--- To be continued ---

Transport of waste to incineration (1).

References:
(1) The information about transport distances were provided by Bryggeriføreningen via Logisys (Jan Jacobsen).

Process Card: 42. Waste management

Inflows	**Percent**	**Massflow [kg]**	
Waste		2.613	
Outflows			
Cardboard waste	8.719 %	0.228	
PE-waste	11.717 %	0.306	
PET-waste	57.766 %	1.509	
PP-waste		0.570	
Emissions, waste and resources	**[g]**		**Reference**
Paper (out)	2.200		Non-elementary outflow
Glue (out)	0.700		Non-elementary outflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (2.613 kg) is used to calculate emissions and energies

Notes
This process is only used in order to distribute the different waste flows.

Two waste flows are not followed to the grave; paper and glue used in bottle labels. These flows have therefore been accounted for as non-elementary outflows.

Material balance per bottle (1):
Inflow: Waste = ... = 1.376 g.

Outflows:
- PP: (0.15 x Cap) = ... = 0.300 g.
- PET: (0.015 x bottle) = ... = 0.795 g.
- PE: Multipack (LDPE) + (0.3 x Plastic ligature) + 0.15xInsert = ... = 0.161 g.
- Cardboard: 0.8 x Multipack (CB) = ... = 0.120 g.
- Total outflow = ... = 0.8462 g.
Mass change factor (out/in) = ... = 1.000.

References:
(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Process Card: 43. PP-incineration

Inflows	**Percent**	**Massflow [kg]**	
PP-waste		0.570	
Outflows			
Energy (PP)		19.387	
Emissions, waste and resources	**[g]**		**Reference**
Ca(OH)2 (in)	17.600		(1)(2) Non-elementary inflow
Water (r)	243.000		(1)(2)
CO2	3.07e+003		(1) Air
CO	10.000		(1)
NOx	1.200		(1)
Dioxin	1.00e-008		(1)
H2O	1.26e+003		(1)
Water to WWTP	243.000		(1) Water
Waste, slags & ashes	20.000		(1) Waste
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.180	Ex	(1)

The sum of input flow(s) (0.570 kg) is used to calculate emissions and energies
Mass change factor 34.040

Notes
Incineration of PP used in PET bottle caps.
Data used for PP were found in the EDIP unit process database (1), except data for the amount of heat and electricity produced in the process. These were calculated based on energy production in Danish waste incineration plants in 1992 (3). The incineration plants' own energy consumption is subtracted from the production, to yield the energy exported from the plant. The (lower) heat value used for PP was 43 MJ/kg (3). For further details, see Technical report 7.

Energy production:
The heat produced in waste incineration is 32.4 MJ/kg waste and the electricity produced is 1.64 MJ/kg waste (3).

--- To be continued ---

The outflow of energy from this process is not a mass flow, despite what is indicated above. Instead it is an energy flow, measured in MJ.

"Mass change factor":
The mass change factor in the LCAiT software is generally defined as the total outflow [kg]/total inflow [kg]. Since the outflow from this process is energy, the "mass change factor" is in this case the energy outflow[MJ]/the waste inflow [kg] = 34.04 MJ produced energy/kg waste.

References and comments:
(1) Frees N and Pedersen M A (1996): EDIP unit database.
(2) Used for fluegas cleaning.
(3) SK energi (1994): Opgørelse af affaldsressourcer i Danmark. Elsam/Elkraft. Styregruppe 4 for biomasse.

Process Card: 45. PE-incineration

Inflows	**Percent**	**Massflow [kg]**	
PE-waste		0.306	
Outflows			
Energy (PE)		10.485	

Emissions, waste and resources	**[g]**		**Reference**
Ca(OH)2 (in)	17.600		(1)(2) Non-elementary inflow
Water (r)	243.000		(1)(2)
CO2	3.07e+003		(1) Air
CO	10.000		(1)
NOx	1.200		(1)
Dioxin	1.00e-008		(1)
H2O	1.26e+003		(1)
Water to WWTP	243.000		(1) Water
Waste, slags & ashes	20.000		(1) Waste
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.180	Ex	(1)

The sum of input flow(s) (0.306 kg) is used to calculate emissions and energies
Mass change factor 34.250

Notes
Incineration of PE used in crates (HDPE), in caps (inserts to prevent leakage; LDPE) and in shrink film (LDPE).
PE includes both HDPE and LDPE since the processes for these plastics during incineration are the same. Data used for PE were found in the EDIP unit process database (1), except data for the amount of heat and electricity produced in the process. These were calculated based on energy production in Danish waste incineration plants in 1992 (3). The incineration plants' own energy consumption was subtracted from the production, to yield the energy exported from the plant. The (lower) heat value used for PE was 43.3 MJ/kg (3). For further details, see Technical report 7.

Energy production:
The heat produced in waste incineration is 32.6 MJ/kg waste and the electricity produced is 1.65 MJ/kg waste (3)

The outflow of energy from this process is not a mass flow, despite what is indicated above. Instead it is an energy flow, measured in MJ.

"Mass change factor":
The mass change factor in the LCAiT software is generally defined as the total outflow [kg]/total inflow [kg]. Since the outflow from this process is energy, the "mass change factor" is in this case the energy outflow[MJ]/the waste inflow [kg] = 34.25 MJ produced energy/kg waste.

References and comments:
(1) Frees N and Pedersen M A (1996): EDIP unit database.
(2) Used for fluegas cleaning.
(3) SK energi (1994): Opgørelse af affaldsressourcer i Danmark. Elsam/Elkraft. Styregruppe 4 for biomasse.

Process Card: 46. Cardboard incineration

Inflows	**Percent**	**Massflow [kg]**	
Cardboard waste		0.228	
Outflows			
Energy (CB)		2.704	

Emissions, waste and resources	**[g]**		**Reference**
Ca(OH)2 (in)	17.600		(1)(2) Non-elementary inflow
Water (r)	243.000		(1)(2)
CO2 (bio)	1.59e+003		(1) Air
CO	5.000		(1)
NOx	1.200		(1)
Dioxin	1.00e-008		(1)
H2O	544.000		(1)
Water to WWTP	243.000		(1) Water
Waste, slags & ashes	20.000		(1) Waste
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.180	Ex	(1)

--- To be continued ---

The sum of input flow(s) (0.228 kg) is used to calculate emissions and energies
Mass change factor 11.870

Notes
Incineration of cardboard used in secondary packaging.
Data used for cardboard and corrugated board were found in the EDIP unit process database (1), and calculated as cellulose, except data for the amount of heat and electricity produced in the process. These were calculated based on energy production in Danish waste incineration plants in 1992 (3). The incineration plants' own energy consumption was subtracted from the production, to yield the energy exported from the plant. The (lower) heat value used for cardboard and corrugated board was 15 MJ/kg (3). For further details, see Technical report 7.

Energy production:
The heat produced in waste incineration is 11.3 MJ/kg waste and the electricity produced is 0.57 MJ/kg waste (3).

The outflow of energy from this process is not a mass flow, despite what is indicated above. Instead it is an energy flow, measured in MJ.

"Mass change factor":
The mass change factor in the LCAiT software is generally defined as the total outflow [kg]/total inflow [kg]. Since the outflow from this process is energy, the "mass change factor" is in this case the energy outflow[MJ]/the waste inflow [kg] = 11.87 MJ produced energy/kg waste.

References and comments:
(1) Frees N and Pedersen M A (1996): EDIP unit database.
(2) Used for fluegas cleaning.
(3) SK energi (1994): Opgørelse af affaldsressourcer i Danmark. Elsam/Elkraft. Styregruppe 4 for biomasse.

Process Card: 47. Energy use

Inflows	**Percent**	**Massflow [kg]**	
Energy (PET)		37.431	
Energy (PE)		10.485	
Energy (CB)		2.704	
Alt.energy	50.000 %	70.008	
Energy (PP)		19.387	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (140.016 kg) is used to calculate emissions and energies

Notes
Heat and electricity produced in waste incineration is assumed to replace the same amount of heat and electricity from alternative energy production. The outflows/inflows of energy to/from this process are not mass flows, despite what is indicated above. Instead they are energy flows, measured in MJ (see remarks in the incineration processes).

Process Card: 48. Alt. energy production

Outflows	**Percent**	**Massflow [kg]**	
Alt.energy 1		70.008	
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Natural gas (>100 kW)	-0.447	FU/Ex	(1) (2)
Oil, light fuel	-0.671	FU/Ex	(1) (2)
Electricity, coal marginal	-5.00e-002	Ex	(1)

The sum of output flow(s) (70.008 kg) is used to calculate emissions and energies

Notes
Alternative production of heat and electricity per MJ total energy produced:

- Heat: 0.95 MJ (2). The efficiency for production of heat from oil and natural gas is assumed to be 85 %. The total amount of primary fuels = 0.95/0.85 = 1.118 MJ/MJ of total energy produced. The heat produced in waste incineration is assumed to replace district heat produced from other fuels, which (as an average for Denmark) is a mix of 60 % light fuel oil and 40 % natural gas (1). This corresponds to 0.671 MJ of light fuel oil and 0.447 MJ of natural gas.

- Electricity: 0.05 MJ (2). The electricity produced in waste incineration is assumed to replace electricity from the grid.

The outflow of energy from this process is not a mass flow, despite what is indicated above. Instead it is an energy flow, measured in MJ (see remarks in the incineration processes).

References:
(1) Eurostat. (1997a). Energy Balance Sheets 1994-1995. Luxembourg: Statistical Office of the European Communities.
(2) Frees N and Pedersen M A (1996): EDIP unit database.

Process Card: 49. Energy use

Inflows	**Percent**	**Massflow [kg]**	
Alt.energy 2	50.000 %	46.958	
Energy (wood)		32.853	
Energy (paper)		14.105	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

--- To be continued ---

The sum of output flow(s) (93.917 kg) is used to calculate emissions and energies

Notes
Identical to process 47.

Process Card:	50. Alt. energy production		
Outflows	**Percent**	**Massflow [kg]**	
Alt.energy 2		46.958	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (46.958 kg) is used to calculate emissions and energies

Notes
Identical to process 48.

Process Card:	44. PET-incineration		
Inflows	**Percent**	**Massflow [kg]**	
PET-waste		1.509	
Outflows			
Energy (PE)		37.431	
Emissions, waste and resources	**[g]**		**Reference**
Ca(OH)2 (in)	17.600		(1)(2) Non-elementary inflow
Water (r)	243.000		(1)(2)
CO2	2.41e+003		(1) Air
CO	8.000		(1)
NOx	1.200		(1)
Dioxin	1.00e-008		(1)
H2O	496.000		(1)
Water to WWTP	243.000		(1) Water
Waste, slags & ashes	20.000		(1) Waste
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	0.180	Ex	(1)

The sum of input flow(s) (1.509 kg) is used to calculate emissions and energies
Mass change factor 24.800

Notes
Incineration of PET used in bottles.
Data used for PET were found in the EDIP unit process database (1), except data for the amount of heat and electricity produced in the process. These were calculated based on energy production in Danish waste incineration plants in 1992 (3). The incineration plants' own energy consumption is subtracted from the production, to yield the energy exported from the plant. The (lower) heat value used for PET was 31.4 MJ/kg (3). For further details, see Technical report 7.

Energy production:
The heat produced in waste incineration is 23.6 MJ/kg waste and the electricity produced is 1.20 MJ/kg waste (3).

The outflow of energy from this process is not a mass flow, despite what is indicated above. Instead it is an energy flow, measured in MJ.

"Mass change factor":
The mass change factor in the LCAiT software is generally defined as the total outflow [kg]/total inflow [kg]. Since the outflow from this process is energy, the "mass change factor" is in this case the energy outflow[MJ]/the waste inflow [kg] = 24.8 MJ produced energy/kg waste.

References and comments:
(1) Frees N and Pedersen M A (1996): EDIP unit database.
(2) Used for fluegas cleaning.
(3) SK energi (1994): Opgørelse af affaldsressourcer i Danmark. Elsam/Elkraft. Styregruppe 4 for biomasse.

150 cl refillable PET bottles

File: 150CL-RE.LCA **Printed:** Fri 98-05-29 10:18
For general comments, see Annex A.

Process Card: 1. PET-resin

Outflows	**Percent**	**Massflow [kg]**	
PET-resin		3.486	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (3.486 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 1

Inflows	**Percent**	**Massflow [kg]**	
PET-resin		3.486	
Outflows			
		3.486	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (3.486 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 2. Preform production

Inflows	**Percent**	**Massflow [kg]**	
PET-resin		3.486	
Outflows			
Preforms		3.486	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (3.486 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 2

Inflows	**Percent**	**Massflow [kg]**	
Preforms		3.486	
Outflows			
		3.486	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (3.486 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 3. Bottle production

Inflows	**Percent**	**Massflow [kg]**	
Preforms		3.486	
Outflows			
Bottles		3.486	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (3.486 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 3

Inflows	**Percent**	**Massflow [kg]**	
Bottles		3.486	
Outflows			
		3.486	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (3.486 kg) is used to calculate emissions and energies

Notes

--- To be continued ---

150 cl refillable PET bottles

File: 150CL-RE.LCA **Printed:** Fri 98-05-29 10:18

Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 4. Washing & filling

Inflows	**Percent**	**Massflow [kg]**	
Bottles		3.486	
Return (bottles)		69.060	
Outflows			
Bottle+beverage		1.07e+003	
Emissions, waste and resources	**[g]**		**Reference**
Water (r)	1.01e+004		Resource
NaOH (in)	13.000		Non-elementary inflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	1.286	Ex	
Natural gas (>100 kW)	1.336	FU/Ex	

The sum of input flow(s) (72.546 kg) is used to calculate emissions and energies
Mass change factor 14.803

Notes
Washing and filling of 150 cl refillable PET bottles for soft drinks at the soft-drink producer (1).

The fuel used and the furnace size is unknown. Natural gas and a furnace size larger than 100 kW has been assumed.

Material balance per bottle (2) (3):
- Inflow: bottles (new and reused) + bottles (for recycling) = 105 + [0.035x105] = 108.675 g (3) (4).
- Outflow: bottle + beverage = 108.675 + 1500 = 1608.675 g (4) (5).
- Mass change factor (out/in) = ... = 14.803.

Data gaps:
Pasteurisation of soft drinks is associated with the beverage. Thus energy use associated with the pasteurisation procedure is not included. The production of sodium hydroxide (NaOH) has not been included and is therefore accounted for as a non-elementary inflow. Cleaning agents (except NaOH) are used in quite small amounts and have not been accounted for. Aquatic emissions of e.g. COD, BOD, N and P are subjects to efficient cleaning procedures in municipal waste water treatment plants and emissions to the environment are assumed to be minimal and thus negligible. Energy use at the waste water treatment plant is estimated to be only a few percent of the total energy use for tapping. The fate of organic cleaning agents in municipal waste water treatment plants as well as their eventual impact in the environment have not been quantified due to lack of data, and potential environmental impacts are unknown.

References and comments:
(1) The soft-drink producer (confidential). Data were collected by Per Nielsen, IPU and entered by Lisa Person, CIT.
(2) The information about the recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.
(3) The information about the bottle weights were provided by PLM, Sweden, Nils Ljungqvist and Constar International, UK, Tom Chilton. The weight used in the previous study was 52 g. The weight used above has been estimated by Vince Matthews, PETCORE, UK, to be an representative average for Europe.
(4) The recycling rates were provided by reference 1. 3.5 % of the bottles goes to material recycling, which means that an additional amount of 3.5 % is taken into to the system.
(5) The amount of beverage is 150 cl, which corresponds to 1.50 kg.

Process Card: 5. Packaging

Inflows	**Percent**	**Massflow [kg]**	
Labels	4.20e-002 %	0.528	
Caps+inserts	0.117 %	1.472	
Bottle+beverage		1.07e+003	
Secondary packaging	8.40e-002 %	1.057	
Return (other pac.)		177.698	
Transport packaging	0.248 %	3.120	
Glue	1.60e-002 %	0.201	
Outflows			
Crate/tray recyc.	5.50e-002 %	0.692	
Bottle recycling	0.195 %	2.453	
Paper incineration	4.20e-002 %	0.528	
Wood incineration	0.243 %	3.057	
Cap/insert recyc.	9.90e-002 %	1.245	
Beverage distribu.		1.25e+003	
Emissions, waste and resources	**[g]**		**Reference**
Glue (out)	0.158		Non-elementary outflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.26e+003 kg) is used to calculate emissions and energies

Notes
Packaging of the beverage bottles at the soft-drink producer. The environmental load associated with the packaging equipment etc. has not been incluc

--- To be continued ---

Material balance per bottle (1):
Inflows:
- Bottle+beverage: Distribution of 1 bottle corresponds to 105+1500 g. Furthermore, 3.5 % of the bottles goes to material recycling (0.035x105=3.675 g), see the outflow "Bottles to recycling" below. This means that the inflow of "Bottle+beverage" = 105+3.675 +1500=1608.68 g.
- Caps and inserts: 2.2 g.
- Secondary packaging:1.579 g (2).
- Labels: 0.8 g.
- Glue (for labels): 0.3 g.
- Transport packaging: Pallets + Plastic ligature = 4.67 g (4) (5).
- Return of other packaging: 0.85 x (Cap+insert) + 0.985 x (Label + Glue) + Crates (distribution flow) + Trays (distribution flow) + Pallets (distribution flow) = ... = 266.12 g (6) (7).
- Total inflow = ... = 1884.3 g.

Outflows:
- Crates and trays to recycling (identical to the inflow of crates and trays, see reference 2 and 3) = ... = 1.029 g.
- Bottles to recycling (3.5 % of the bottles are recycled according to reference 1): 0.035 x 105 = 3.675 g.
- Paper to incineration (0.5 % of the labels disappears in the waste management according to reference 1, which means that 98.5 % is washed away at the soft-drink producer) = 0.985 x 0.8 = 0.788 g.
- Pallets (wood) to incineration (identical to the inflow of pallets, see reference 4 and 5) = ... = 4.583 g.
- Caps and inserts to recycling (85 % of the caps and inserts are recycled according to reference 1) = 0.85 x 2.2 = 1.87 g.
- Distribution of beverage: (Bottle+beverage) + (Cap+insert) + Label + Glue + Crates (distribution flow) + Trays (distribution flow) + Multipack(CB) + Multipack(PE) + Pallets (distribution flow) + Plastic ligature = 1608.68 + 2.2 + 0.8 + 0.3 + 165.03 + 6.458 + [18/3x0.05] + [15/3x0.05] + 91.67 + 0.0833 = 1872.09 g.
- Total outflow = ... = 1884.0 g.

Mass change factor (out/in) = ... = 0.9998 = 1.000.

The waste water treatment of glue has not been included in the study. Glue has therefore been accounted for as a non-elementary outflow. This explains that the inflow is larger than the outflow (inflow - outflow = 0.299 g). This corresponds to the amount of glue that does not disappear in the waste management (together with the bottles and labels). The amount of glue per kg outflow = 0.299/1.884 = 0.158 g.

References and comments:
(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriforeningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.
(2) Secondary packaging consists of: Crates + Trays + Multipack (CB) + Multipack (LDPE) = [Weight of crate/Number of bottles x Market share x (1-Recycling rate)] + [Weight of tray/Number of bottles x Market share x (1-Recycling rate)] + [Weight of Multipack (CB)/Number of bottles x Market share] + [Weight of Multipack (LDPE)/Number of bottles x Market share] = [2017/11x0.9x0.006] + [1550/24x0.1x0.006] + [18/3x0.05] + [15/3x0.05] = 1.579 g (3).
(3) The recycling rates were provided by reference 1. As much as 99.4 % of the crates and trays is recycled, which means that only 0.6 % of new crates and trays is taken into to the system.
(4) Pallets + Plastic ligature = [Weight of pallet/Number of bottles x Market share x (1-Recycling rate)] + [Amount of plastic ligature per pallet/Number of bottles x Market share] = [22000/240x1x0.05] + [20/240x1] = 4.583 + 0.083 = 4.67 g.
(5) The reuse rate were provided by reference 1. As much as 95 % of the pallets is reused, which means that only 5 % of new pallets is taken into to the system.
(6) The recycling rates (provided by reference 1) were used to calculate the return of packaging to the soft-drink producer. 15 % of the caps and inserts and 1.5 % of the labels and glue disappear in the waste management (together with 1.5 % of the bottles).
(7) The distribution flow corresponds to the real material flow in the distribution system. The distribution flows (of crates, trays and pallets) = [Weight/Number of bottles x Market share] ---> [2017/11x0.9] + [1550/24x0.1] + [22000/240x1] = 165.03 + 6.458 + 91.67.

Process Card: 6. Caps+inserts

Inflows	**Percent**	**Massflow [kg]**	
PP		1.338	
Inserts	9.091 %	0.134	
Outflows			
Caps+inserts		1.472	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.472 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 4

Inflows	**Percent**	**Massflow [kg]**	
Caps+inserts		1.472	
Outflows			
		1.472	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (1.472 kg) is used to calculate emissions and energies

Notes

--- To be continued ---

Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 7. PP-production

Outflows	Percent	Massflow [kg]	
PP		1.338	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.338 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 5

Inflows	Percent	Massflow [kg]	
PP		1.338	
Outflows			
		1.338	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (1.338 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 8. LDPE-production

Outflows	Percent	Massflow [kg]	
LDPE		0.134	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.134 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 6

Inflows	Percent	Massflow [kg]	
LDPE		0.134	
Outflows			
		0.134	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (0.134 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 9. Inserts

Inflows	Percent	Massflow [kg]	
LDPE		0.134	
Outflows			
Inserts		0.134	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.134 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 10. Secondary packaging

Inflows	Percent	Massflow [kg]	
Multipack-Cardboard	19.000 %	0.201	
Multipack-LDPE		0.164	
New crates/trays		0.692	
Outflows			
Secondary packaging		1.057	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.057 kg) is used to calculate emissions and energies

Notes

--- To be continued ---

This process box is just used in order to summarise the different flows of secondary packaging.

Material balance per bottle (1):
Inflows:
- Crates + Trays = [Weight of crate (3)/Number of bottles x Market share x (1-Recycling rate)] + [Weight of tray/Number of bottles x Market share x (1-Recycling rate)] = [2017/11x0.9x0.006] + [1550/24x0.1x0.006] = 0.9902 + 0.0388 g (2).
- Multipack (Cardboard) = [Weight of Multipack (CB)/Number of bottles x Market share] = [18/3x0.05] = 0.30 g.
- Multipack (LDPE) = [Weight of Multipack(LDPE)/Number of bottles x Market share] = [15/3x0.05] = 0.25 g.
- Total inflow = ... = 1.579 g.

Outflow:
- Secondary packaging = 1.579 g.

Mass change factor (out/in) = ... = 1.000.

References and comments:
(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.
(2) The recycling rates were provided by reference 1. As much as 99.4 % of the crates and trays is recycled, which means that only 0.6 % of new crates and trays is taken into to the system.
(3) There are two types of crates on the market: The first with a market share of 45 %, holding 12 bottles and with a weight of 2200 g. The second with a market share of 45 %, holding 10 bottles and the weight is unknown. An average of these two crates has been made (using the same weight "per bottle" for the 10-bottle crate) ---> a market share of 90 %, 11 bottles and a weight of 2017 in average.

Transport Card: Trp 7

Inflows	**Percent**	**Massflow [kg]**	
Secondary packaging		1.057	
Outflows			
		1.057	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (1.057 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 11. Cardboard

Outflows	**Percent**	**Massflow [kg]**	
Cardboard		0.201	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.201 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 8

Inflows	**Percent**	**Massflow [kg]**	
Cardboard		0.201	
Outflows			
		0.201	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (0.201 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 12. Multipack-Cardboard

Inflows	**Percent**	**Massflow [kg]**	
Cardboard		0.201	
Outflows			
Multipack-Cardboard		0.201	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.201 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 13. LDPE-production

Outflows	**Percent**	**Massflow [kg]**

--- To be continued ---

LDPE		0.164	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.164 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 9

Inflows	**Percent**	**Massflow [kg]**
LDPE		0.164

Outflows

		0.164

Modes of conveyance	**[km]**	**Reference**

The sum of output flow(s) (0.164 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 14. Multipack-LDPE

Inflows	**Percent**	**Massflow [kg]**
LDPE		0.164

Outflows

Multipack-LDPE		0.164

Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.164 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 15. New crate/tray

Inflows	**Percent**	**Massflow [kg]**
Recycled PE		0.692

Outflows

New crates/trays		0.692

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	2.070	Ex	

The sum of output flow(s) (0.692 kg) is used to calculate emissions and energies

Notes
Production of crates and trays by injection moulding of recycled HDPE (1).

For 150 cl bottles, crates holding 11 bottles (2) are most common (market share: 90 %). Trays holding 24 bottles are used as well (market share: 10 %) (3).

Based on the market shares the average weight of one crate or tray is 1.970 kg and it holds an average of 12.3 bottles.

The electricity consumption for the production of crates and trays is the same per kg product.

References:
(1) Data were provided by John Holm at Schoeller-Plast-Enterprise A/S, Regstrup, Denmark, collected and entered by Lisa Person, CIT.
(2) There are two types of crates on the market: The first with a market share of 45 %, holding 12 bottles and with a weight of 2200 g. The second with a market share of 45 %, holding 10 bottles and the weight is unknown. An average of these two crates has been made (using the same weight "per bottle" for the 10-bottle crate) ---> a market share of 90 %, 11 bottles and a weight of 2017 in average.
(3) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Process Card: 16. Paper production

Outflows	**Percent**	**Massflow [kg]**
Paper		0.900

Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.900 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 10

Inflows	**Percent**	**Massflow [kg]**

--- To be continued ---

Paper		0.900	
Outflows			
		0.900	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (0.900 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 17. Label printing

Inflows	**Percent**	**Massflow [kg]**	
Paper		0.900	
Outflows			
Labels		0.528	

Emissions, waste and resources	**[g]**	**Reference**
Ink (in)	23.652	Non-elementary inflow
Lacquer, water (in)	14.191	Non-elementary inflow
Lacquer, various (in)	4.730	Non-elementary inflow
Auxiliary materials (in)	9.697	(2) Non-elementary inflow
VOC	0.946	
Waste, ink	2.365	
Waste, paper	496.689	Incinerated
Waste, other	7.096	
Paper, recycling (out)	83.254	Non-elementary outflow
Paper, fuel (out)	163.200	Non-elementary outflow

Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity, coal marginal	2.725	Ex	

The sum of output flow(s) (0.528 kg) is used to calculate emissions and energies
Mass change factor 0.587

Notes
Printing of 1 kg of labels for glass and PET refillable and disposable bottles. The data for the different labels are aggregated into a "standard average" label for beer and carbonated soft drink (1).

The production of labels for beer and carbonated softdrinks corresponds to about 55% of Nova Prints total production (defined as printed paper). Therefore, 55% of all the activities at Nova-Print (i.e. cleaning, maintenance, research and development, laboratory facilities, marketing, administration, facilities for personnel) are allocated to the production of labels for beer and carbonated softdrinks.

The same mass change factor (out/in) = (kg Labels/kg Paper) = 0.587 as for labels for 50 cl refillable bottles is used. The only difference between the two systems is the weight of the label (0.6 g for 50 cl bottles and 0.8 g for 150 cl bottles). The rest of the inflows and outflows are not included in the material balance since they are accounted for as non-elementary inflows and outflows.

References and comments:
(1) Data were supplied by Jørgen Jensen at Nova Print AS Danmark, Odense, Denmark, collected by Anna Ryberg, CIT and entered by Johan Widheden, CIT.
(2) The many small individual flows of auxiliary materials have been aggregated into one value.
The auxiliary materials are: IPA spirit, Mineral cleaning agent, Vegetable cleaning agent, Spray powder, Cloths, Various oils, Various chemicals,

Transport Card: Trp 11

Inflows	**Percent**	**Massflow [kg]**	
Labels		0.528	
Outflows			
		0.528	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (0.528 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 18. Glue production

Outflows	**Percent**	**Massflow [kg]**	
Glue		0.201	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.201 kg) is used to calculate emissions and energies

Notes

--- To be continued ---

150 cl refillable PET bottles

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Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 12

Inflows	**Percent**	**Massflow [kg]**
Glue		0.201
Outflows		
		0.201

Modes of conveyance **[km]** **Reference**

The sum of output flow(s) (0.201 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 19. Transport packaging

Inflows	**Percent**	**Massflow [kg]**
Plastic ligature	1.784 %	5.57e-002
Pallets		3.064
Outflows		
Transport packaging		3.120

Energy carrier **[MJ]** **E Factor** **Reference**

The sum of output flow(s) (3.120 kg) is used to calculate emissions and energies

Notes
This process box is just used in order to summarise the different flows of transport packaging.

Material balance per bottle (1):
Inflows:
- Pallets = [Weight of pallet/Number of bottles x Market share x (1-Recycling rate)]= [22000/240x1.0x0.05] = 4.583 g (2).
- Plastic ligature = [Weight of plastic ligature/Number of bottles x Market share] = [20/240x1.0] = 0.0833 g.
- Total inflow = ... = 4.67 g.

Outflow:
- Transport packaging = 4. 7 g.

Mass change factor (out/in) = ... = 1.000.

References and comments:
(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.
(2) The recycling rates were provided by reference 1. As much as 95 % of the pallets is reused, which means that only 5 % of new pallets is taken into to the system.

Transport Card: Trp 13

Inflows	**Percent**	**Massflow [kg]**
Transport packaging		3.120
Outflows		
		3.120

Modes of conveyance **[km]** **Reference**

The sum of output flow(s) (3.120 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 20. Planks for pallets

Outflows	**Percent**	**Massflow [kg]**
Planks		3.064

Energy carrier **[MJ]** **E Factor** **Reference**

The sum of output flow(s) (3.064 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 14

Inflows	**Percent**	**Massflow [kg]**
Planks		3.064
Outflows		
		3.064

--- To be continued ---

Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (3.064 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 21. Pallets

Inflows	**Percent**	**Massflow [kg]**	
Planks		3.064	
Outflows			
Pallets		3.064	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (3.064 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 22. LDPE-production

Outflows	**Percent**	**Massflow [kg]**	
LDPE		5.57e-002	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (5.57e-002 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 15

Inflows	**Percent**	**Massflow [kg]**	
LDPE		5.57e-002	
Outflows			
		5.57e-002	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (5.57e-002 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 23. Plastic ligature

Inflows	**Percent**	**Massflow [kg]**	
LDPE		5.57e-002	
Outflows			
Plastic ligature		5.57e-002	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (5.57e-002 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 16

Inflows	**Percent**	**Massflow [kg]**	
Crate/tray recyc.		0.692	
Outflows			
		0.692	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (0.692 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 24. Grinding

Inflows	**Percent**	**Massflow [kg]**	
Crate/tray recyc.		0.692	
Outflows			
Recycled PE		0.692	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

--- To be continued ---

The sum of output flow(s) (0.692 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 17

Inflows	Percent	Massflow [kg]	
Bottle bales		2.453	
Outflows			
		2.453	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (2.453 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 25. Baling

Inflows	Percent	Massflow [kg]	
Bottle recycling		2.453	
Outflows			
Bottle bales		2.453	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (2.453 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 26. Recycling

Inflows	Percent	Massflow [kg]	
Bottle bales		2.453	
Outflows			
PET-resin (rec-1)		2.453	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (2.453 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 27. New product

Inflows	Percent	Massflow [kg]	
Virgin PET		1.227	
PET-resin (rec-2)	25.000 %	1.227	
PET-resin (rec-1)	50.000 %	2.453	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (4.906 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 28. PET-production (avoided)

Outflows	Percent	Massflow [kg]	
Virgin PET		1.227	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.227 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 29. Recycling (avoided)

Inflows	Percent	Massflow [kg]	
Other PET-product		1.227	
Outflows			
PET-resin (rec-2)		1.227	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

--- To be continued ---

The sum of output flow(s) (1.227 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 30. Other product

Outflows	Percent	Massflow [kg]	
PET-landfilling	50.000 %	1.227	
Other PET-product		1.227	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (2.453 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 31. PET-landfill

Inflows	Percent	Massflow [kg]	
PET-landfilling		1.227	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.227 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 18

Inflows	Percent	Massflow [kg]	
Paper incineration		0.528	
Outflows			
		0.528	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (0.528 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 32. Paper incineration

Inflows	Percent	Massflow [kg]	
Paper incineration		0.528	
Outflows			
Energy (paper)		0.528	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.528 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 19

Inflows	Percent	Massflow [kg]	
Wood incineration		3.057	
Outflows			
		3.057	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (3.057 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 33. Wood incineration

Inflows	Percent	Massflow [kg]	
Wood incineration		3.057	
Outflows			
Energy (wood)		3.057	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (3.057 kg) is used to calculate emissions and energies

Notes

--- To be continued ---

Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 20

Inflows	**Percent**	**Massflow [kg]**	
Cap/insert recyc.		1.245	
Outflows			
		1.245	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (1.245 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 34. PP-recycling

Inflows	**Percent**	**Massflow [kg]**	
Cap/insert recyc.		1.245	
Outflows			
PP (rec-1)		1.245	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.245 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 35. New product

Inflows	**Percent**	**Massflow [kg]**	
Virgin PP		0.623	
PP (rec-2)	25.000 %	0.623	
PP (rec-1)	50.000 %	1.245	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (2.491 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 36. PP-production (avoided)

Outflows	**Percent**	**Massflow [kg]**	
Virgin PP		0.623	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.623 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 37. PP-recycling (avoided)

Inflows	**Percent**	**Massflow [kg]**	
Other PP-product		0.623	
Outflows			
PP (rec-2)		0.623	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.623 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 38. Other products

Outflows	**Percent**	**Massflow [kg]**	
PP-landfilling	50.000 %	0.623	
Other PP-product		0.623	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.245 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

--- To be continued ---

Process Card: 39. PP-landfill

Inflows	Percent	Massflow [kg]	
PP-landfilling		0.623	

Energy carrier	[MJ]	E Factor	Reference

The sum of output flow(s) (0.623 kg) is used to calculate emissions and energies

Notes

Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 21 (Distribution of beverage)

Inflows	Percent	Massflow [kg]
Beverage distribu.		1.25e+003
Outflows		
		1.25e+003

Modes of conveyance	[km]	Reference
Distr, heavy (highway, 50%)(Scan)	56.700	
Distr, heavy (rural, 50%)(Scan)	45.360	
Distr, heavy (urban, 50%)(Scan)	11.340	
Distr, medium (highway, 50%)	14.400	
Distr, medium (rural, 50%)	14.400	
Distr, medium (urban, 50%)	19.200	
Distr, medium (highway, 40%)	0.800	
Distr, medium (rural, 40%)	2.400	
Distr, medium (urban, 40%)	4.800	

Calculated for a reference flow of 1.25e+003 [kg] which corresponds to 1000 l of beverage
The sum of output flow(s) (1.25e+003 kg) is used to calculate emissions and energies

Notes

Distribution of PET bottles by truck, including beverage, pallet and all packaging.
During the distribution from the soft-drink producer to the retailer, the bottles are transported various distances on different types of roads, and by different kinds of trucks.

The distance on each type of road, for each of these trucks, have been supplied by LOGISYS (1). The load rate, fuel consumption and the emissions are calculated and described in Technical report 7 (2).

Reference flow: Distribution of 1000 litres of beverage corresponds to 1248 kg (3).

References:
(1) Supplied by Jan Jacobsen, LOGISYS, collected by Per Nielsen, IPU and entered by Johan Widheden, CIT.
(2) Technical report 7: Energy and transport scenarios.
(3) Distribution of one bottle corresponds to 1.872 kg (see the "Packaging" process above).

Process Card: 40. Retailers

Inflows	Percent	Massflow [kg]	
Beverage distribu.	94.622 %	1.25e+003	
Bottles, caps etc		71.046	
Outflows			
Return	18.679 %	246.758	
Bever. to consumer		1.07e+003	
Emissions, waste and resources	**[g]**		**Reference**
Plastic ligature (out)	2.95e-002		Non-elementary outflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.32e+003 kg) is used to calculate emissions and energies

Notes

The choice of packaging is assumed to have negligible effect on the environmental impacts of the retailer.

Material balance per bottle (1):
Inflows:
- Distribution of beverage = ...= 1872.09 g.
- From consumer: (0.985 x Bottles) + (0.85 x Cap+insert) + 0.985 x (Label + Glue) = ...= 106.40 g.

Outflows:
- To consumer: (Bottle+beverage) + (Cap+insert) + Label + Glue + Multipack (CB) + Multipack (LDPE) + (0.30 x Plastic ligature) = ... = 1608.88 g.
- Return: The inflow from consumer + Crates (distribution flow) + Trays (distribution flow) + Pallets (distribution flow) = ... = 369.55 g.

The mass change factor (out/in) = ...= 0.9999 = 1.000.

--- To be continued ---

70 % of the plastic ligature goes to material recycling (1). This corresponds to less than 1 % of the primary packaging and therefore this has been assumed to be negligible and the plastic ligature has been accounted for as a non-elementary outflow.

References:
(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriforeningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Process Card: Trp 22 (Return)

Inflows	**Percent**	**Massflow [kg]**	
Return		246.758	
Outflows			
Return (other pac.)		177.698	
Return (bottles)	27.987 %	69.060	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (246.758 kg) is used to calculate emissions and energies

Notes
The return transport to the soft-drink producer is included in the distribution of beverage (Trp 21) (1).

Material balance per bottle:
Inflow: From retailer = ... = 369.55 g.

Outflow:
- Bottles to washing and filling: 0.985 x Bottles = ... = 103.42 g.
(Labels, glue, cap and insert are included in the return-to-packaging flow below. This is not logical, but it makes it easier when carrying out the LC-ca
- To packaging =... = 266.12 g (See the process "Packaging" above).

Mass change factor (out/in) = ... = 1.000.

References:
(1) This information were provided by Bryggeriforeningen via Logisys (Jan Jacobsen).

Transport Card: Trp 23

Inflows	**Percent**	**Massflow [kg]**	
Bever. to consumer		1.07e+003	
Outflows			
		1.07e+003	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (1.07e+003 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 41. Use (refrigeration)

Inflows	**Percent**	**Massflow [kg]**	
Bever. to consumer		1.07e+003	
Outflows			
Bottles, caps etc		71.046	
Waste		1.576	
Emissions, waste and resources	**[g]**		**Reference**
Multipac-CB (out)	0.551		Non-elementary outflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**
Electricity; coal marginal	1.91e-006	Ex	

The sum of output flow(s) (72.622 kg) is used to calculate emissions and energies
Mass change factor 6.76e-002

Notes
The same data as those used in the study from 1995 have been used (1). The PET bottle is cooled from 20 to 5 degrees Celsius, which correspond to an electricity consumption of 0.000396 MJ/kg PET bottle. This figure has been recalculated into per kg total outflow using the factor 4.82 e-03 (see the material balance below) ---> 1.87 e-06 MJ/kg total outflow.

Material balance per bottle (2):
Inflow: From retailer = ... = 1608.88 g.

Outflow:
- To retailer = (0.985 x Bottles) + (0.85 x Cap+insert) + 0.985 x (Label + Glue) = ...= 106.40 g.
- Waste: (0.015 x bottle) + (0.15 x Cap+insert) + 0.005 x (Label+Glue) + (0.8 x Multipack (CB)) + Multipack (LDPE) + (0.3 x Plastic ligature) = ... = 2.420 g.
- Total outflow = ... = 108.82 g.

--- To be continued ---

Mass change factor (out/in) = … = 0.0676.

Factor for recalculating the original electricity consumption: Weight of bottle/Total outflow = (0.005x105)/(108.82) = …= 4.82 e-03 kg PET bottle/kg total outflow.

20 % of the cardboard in the Multipacks goes to material recycling (2). This corresponds to less than 1 % of the primary packaging and therefore this has been assumed to be negligible and the cardboard has been accounted for as a non-elementary outflow.

References:

(1) Pommer K., Suhr Wesnæs M., Madsen C. (1995): Miljømæssig kortlægning af emballager til øl og læskedrikke. Delrapport 5: Genpåfyldelige PET-flasker. Miljø- og Energiministeriet Miljøstyrelsen. page 35.
(2) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriforeningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Transport Card: Trp 24

Inflows	**Percent**	**Massflow [kg]**	
Bottles, caps etc		71.046	
Outflows			
		71.046	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (71.046 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Transport Card: Trp 25

Inflows	**Percent**	**Massflow [kg]**	
Waste		1.576	
Outflows			
		1.576	
Modes of conveyance	**[km]**		**Reference**

The sum of output flow(s) (1.576 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 42. Waste management

Inflows	**Percent**	**Massflow [kg]**	
Waste		1.576	
Outflows			
Cardboard waste	9.917 %	0.156	
PE-waste	12.603 %	0.199	
PET-waste	65.083 %	1.026	
PP-waste		0.195	
Emissions, waste and resources	**[g]**		**Reference**
Paper (out)	1.700		Non-elementary outflow
Glue (out)	0.600		Non-elementary outflow
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.576 kg) is used to calculate emissions and energies

Notes
This process is only used in order to distribute the different waste flows.

Two waste flows are not followed to the grave; paper and glue used in bottle labels. These flows have therefore been accounted for as non-elementary outflows.

Material balance per bottle (1):
Inflow: Waste = … = 2.420 g.

Outflows:
- PP: (0.15 x Cap) = … = 0.300 g.
- PET: (0.015 x bottle) = … = 1.575 g.
- PE: Multipack (LDPE) + (0.3 x Plastic ligature) + 0.15xInsert = … = 0.3050 g.
- Cardboard: 0.8 x Multipack (CB) = … = 0.240 g.
- Total outflow = … = 1.370 g.
Mass change factor (out/in) = … = 1.000.

References:

--- To be continued ---

(1) The information about the weights, recycling rates, market shares etc. for the different packagings were collected by Per Nielsen, IPU, provided by Bryggeriføreningen via Logisys (Jan Jacobsen) and entered by Lisa Person, CIT.

Process Card: 43. PP-incineration

Inflows	Percent	Massflow [kg]	
PP-waste		0.195	
Outflows			
Energy (PP)		0.195	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.195 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 44. PET-incineration

Inflows	Percent	Massflow [kg]	
PET-waste		1.026	
Outflows			
Energy (PET)		1.026	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.026 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 45. PE-incineration

Inflows	Percent	Massflow [kg]	
PE-waste		0.199	
Outflows			
Energy (PE)		0.199	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.199 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 46. Cardboard incineration

Inflows	Percent	Massflow [kg]	
Cardboard waste		0.156	
Outflows			
Energy (CB)		0.156	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (0.156 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 47. Energy use

Inflows	Percent	Massflow [kg]	
Energy (PET)		1.026	
Energy (PE)		0.199	
Energy (CB)		0.156	
Alt.energy	50.000 %	1.576	
Energy (PP)		0.195	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (3.152 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 48. Alt. energy production

Outflows	Percent	Massflow [kg]	
Alt.energy 1		1.576	
Energy carrier	**[MJ]**	**E Factor**	**Reference**

The sum of output flow(s) (1.576 kg) is used to calculate emissions and energies

--- To be continued ---

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 49. Energy use

Inflows	Percent	Massflow [kg]
Alt.energy 2	50.000 %	3.585
Energy (wood)		3.057
Energy (paper)		0.528

Energy carrier	[MJ]	E Factor	Reference

The sum of output flow(s) (7.170 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

Process Card: 50. Alt. energy production

Outflows	Percent	Massflow [kg]
Alt.energy 2		3.585

Energy carrier	[MJ]	E Factor	Reference

The sum of output flow(s) (3.585 kg) is used to calculate emissions and energies

Notes
Identical to the 50 cl PET bottle system, see Annex A.

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	1. PET-resin	Trp 1	2. Preform production	Trp 2	3. Bottle production	Trp 3	4. Washing & filling
Electricity [MJ]							
Electricity, coal marginal [MJ]	3,81E+00				1,26E+01		7,43E+01
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**3,81E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**1,26E+01**	**0,00E+00**	**7,43E+01**
Coal [MJ]	2,04E+01						
Coal, feedstock [MJ]	5,24E-02						
Diesel, heavy & medium truck (highway) [MJ]		1,05E+00		2,81E+00		3,51E-01	
Diesel, heavy & medium truck (rural) [MJ]							
Diesel, heavy & medium truck (urban) [MJ]							
Diesel, ship (4-stroke) [MJ]							
Fuel, unspecified [MJ]	7,36E-06				2,44E-05		1,43E-04
Hard coal [MJ]					7,12E+01		
Natural gas (>100 kW) [MJ]							1,12E+02
Natural gas [MJ]	8,74E+01				4,00E+00		
Natural gas, feedstock [MJ]	6,62E+01						
Oil [MJ]	8,42E+01				1,19E+01		
Oil, feedstock [MJ]	1,74E+02						
Oil, heavy fuel [MJ]							
Oil, light fuel [MJ]							
Peat [MJ]							
Fossil fuel, total [MJ at final use]	**4,32E+02**	**1,05E+00**	**0,00E+00**	**2,81E+00**	**8,71E+01**	**3,51E-01**	**1,12E+02**
Bark [MJ]							
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]							
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	5. Packaging	6. Caps+inserts	Trp 4	7. PP-production	Trp 5	8. LDPE-production	Trp 6	9. Inserts
Electricity [MJ]				9,46E+00		1,25E+00		
Electricity, coal marginal [MJ]		2,71E+01						
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	3,23E+00	0,00E+00	2,16E-01	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**2,71E+01**	**0,00E+00**	**1,27E+01**	**0,00E+00**	**1,47E+00**	**0,00E+00**	**0,00E+00**
Coal [MJ]				6,63E+00		1,31E+00		
Coal, feedstock [MJ]				3,99E-02		3,99E-03		
Diesel, heavy & medium truck (highway) [MJ]					8,02E-01		8,02E-02	
Diesel, heavy & medium truck (rural) [MJ]			0,931					
Diesel, heavy & medium truck (urban) [MJ]								
Diesel, ship (4-stroke) [MJ]								
Fuel, unspecified [MJ]		5,24E-05						
Hard coal [MJ]								
Natural gas (>100 kW) [MJ]								
Natural gas [MJ]				3,62E+01		4,94E+00		
Natural gas, feedstock [MJ]				5,05E+01		1,32E+01		
Oil [MJ]				2,37E+01		1,51E+00		
Oil, feedstock [MJ]				1,95E+02		1,35E+01		
Oil, heavy fuel [MJ]								
Oil, light fuel [MJ]								
Peat [MJ]								
Fossil fuel, total [MJ at final use]	**0,00E+00**	**5,24E-05**	**9,31E-01**	**3,12E+02**	**8,02E-01**	**3,45E+01**	**8,02E-02**	**0,00E+00**
Bark [MJ]								
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]								
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	10. Secondary packaging	Trp 7	11. Cardboard	Trp 8	12. Multipack-Cardboard	13. LDPE-production
Electricity [MJ]						8,03E-01
Electricity, coal marginal [MJ]			7,79E-01			
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,38E-01
Electricity, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**7,79E-01**	**0,00E+00**	**0,00E+00**	**9,41E-01**
Coal [MJ]						8,38E-01
Coal, feedstock [MJ]						2,56E-03
Diesel, heavy & medium truck (highway) [MJ]			9,74E-02	6,03E-02		
Diesel, heavy & medium truck (rural) [MJ]		0,274				
Diesel, heavy & medium truck (urban) [MJ]			2,35E-01			
Diesel, ship (4-stroke) [MJ]			4,13E-01			
Fuel, unspecified [MJ]			1,50E-06			
Hard coal [MJ]						
Natural gas (>100 kW) [MJ]			2,07E-01			
Natural gas [MJ]						3,16E+00
Natural gas, feedstock [MJ]						8,44E+00
Oil [MJ]						9,69E-01
Oil, feedstock [MJ]						8,66E+00
Oil, heavy fuel [MJ]			6,12E-01			
Oil, light fuel [MJ]			3,00E-03			
Peat [MJ]			3,30E-02			
Fossil fuel, total [MJ at final use]	**0,00E+00**	**2,74E-01**	**1,60E+00**	**6,03E-02**	**0,00E+00**	**2,21E+01**
Bark [MJ]			2,46E-01			
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**2,46E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]			-1,02E-01			
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**-1,02E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	Trp 9	14. Multipack-LDPE	15. New crate/tray	16. Paper production	Trp 10	17. Label printing	Trp 11
Electricity [MJ]							
Electricity, coal marginal [MJ]			1,52E+00	5,58E+00		3,27E+00	
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**1,52E+00**	**5,58E+00**	**0,00E+00**	**3,27E+00**	**0,00E+00**
Coal [MJ]							
Coal, feedstock [MJ]							
Diesel, heavy & medium truck (highway) [MJ]	5,14E-02			1,21E-01	4,11E-01		
Diesel, heavy & medium truck (rural) [MJ]				0,015			0,255
Diesel, heavy & medium truck (urban) [MJ]				7,14E-01			
Diesel, ship (4-stroke) [MJ]				6,10E-02			
Fuel, unspecified [MJ]			2,94E-06	1,08E-05		6,32E-06	
Hard coal [MJ]				5,73E-02			
Natural gas (>100 kW) [MJ]							
Natural gas [MJ]							
Natural gas, feedstock [MJ]							
Oil [MJ]							
Oil, feedstock [MJ]							
Oil, heavy fuel [MJ]				6,14E+00			
Oil, light fuel [MJ]				8,19E-02			
Peat [MJ]				1,23E+00			
Fossil fuel, total [MJ at final use]	**5,14E-02**	**0,00E+00**	**2,94E-06**	**8,42E+00**	**4,11E-01**	**6,32E-06**	**2,55E-01**
Bark [MJ]				4,91E-01			
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**4,91E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]							
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	-4,52E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	-3,07E-01	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	18. Glue production	Trp 12	19. Transport packaging	Trp 13	20. Planks for pallets	Trp 14	21. Pallets
Electricity [MJ]							
Electricity, coal marginal [MJ]	3,24E-01				1,20E+00		
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**3,24E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**1,20E+00**	**0,00E+00**	**0,00E+00**
Coal [MJ]							
Coal, feedstock [MJ]							
Diesel, heavy & medium truck (highway) [MJ]	9,45E-02	8,05E-02			2,69E-01		
Diesel, heavy & medium truck (rural) [MJ]				0,493		0,484	
Diesel, heavy & medium truck (urban) [MJ]					1,79E+00		
Diesel, ship (4-stroke) [MJ]					1,36E-01		
Fuel, unspecified [MJ]	6,26E-07				2,31E-06		
Hard coal [MJ]							
Natural gas (>100 kW) [MJ]							
Natural gas [MJ]							
Natural gas, feedstock [MJ]							
Oil [MJ]							
Oil, feedstock [MJ]							
Oil, heavy fuel [MJ]							
Oil, light fuel [MJ]					6,03E-01		
Peat [MJ]							
Fossil fuel, total [MJ at final use]	**9,45E-02**	**8,05E-02**	**0,00E+00**	**4,93E-01**	**2,80E+00**	**4,84E-01**	**0,00E+00**
Bark [MJ]					3,65E+00		
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**3,65E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]							
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	22. LDPE-production	Trp 15	23. Plastic ligature	Trp 16	24. Grinding	Trp 17	25. Baling	26. Recycling
Electricity [MJ]	1,30E-01							
Electricity, coal marginal [MJ]					1,19E-01		2,40E-01	1,49E+00
Hydro power [MJelectricity]	2,23E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**1,52E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**1,19E-01**	**0,00E+00**	**2,40E-01**	**1,49E+00**
Coal [MJ]	1,36E-01							
Coal, feedstock [MJ]	4,13E-04							
Diesel, heavy & medium truck (highway) [MJ]		8,31E-03		6,41E-02		1,74E+00		
Diesel, heavy & medium truck (rural) [MJ]								
Diesel, heavy & medium truck (urban) [MJ]								
Diesel, ship (4-stroke) [MJ]								
Fuel, unspecified [MJ]					2,30E-07		4,64E-07	2,88E-06
Hard coal [MJ]								
Natural gas (>100 kW) [MJ]								4,17E+00
Natural gas [MJ]	5,12E-01							
Natural gas, feedstock [MJ]	1,37E+00							
Oil [MJ]	1,57E-01							
Oil, feedstock [MJ]	1,40E+00							
Oil, heavy fuel [MJ]								
Oil, light fuel [MJ]								
Peat [MJ]								
Fossil fuel, total [MJ at final use]	**3,57E+00**	**8,31E-03**	**0,00E+00**	**6,41E-02**	**2,30E-07**	**1,74E+00**	**4,64E-07**	**4,17E+00**
Bark [MJ]								
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]								
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	27. New product	28. PET-production (avoided)	29. Recycling (avoided)	30. Other product	31. PET-landfill
Electricity [MJ]		-5,02E+00			
Electricity, coal marginal [MJ]			-7,47E-01		1,30E-03
Hydro power [MJelectricity]	0,00E+00	-1,02E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**-6,04E+00**	**-7,47E-01**	**0,00E+00**	**1,30E-03**
Coal [MJ]		-7,21E+00			
Coal, feedstock [MJ]		-1,85E-02			
Diesel, heavy & medium truck (highway) [MJ]					
Diesel, heavy & medium truck (rural) [MJ]					
Diesel, heavy & medium truck (urban) [MJ]					6,49E-02
Diesel, ship (4-stroke) [MJ]					
Fuel, unspecified [MJ]			-1,44E-06		2,50E-09
Hard coal [MJ]					
Natural gas (>100 kW) [MJ]			-2,09E+00		
Natural gas [MJ]		-3,09E+01			
Natural gas, feedstock [MJ]		-2,34E+01			
Oil [MJ]		-2,98E+01			
Oil, feedstock [MJ]		-6,15E+01			
Oil, heavy fuel [MJ]					
Oil, light fuel [MJ]					
Peat [MJ]					
Fossil fuel, total [MJ at final use]	**0,00E+00**	**-1,53E+02**	**-2,09E+00**	**0,00E+00**	**6,49E-02**
Bark [MJ]					
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]					
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	Trp 18	32. Paper incineration	Trp 19	33. Wood incineration	Trp 20	34. PP-recycling	35. New product
Electricity [MJ]							
Electricity, coal marginal [MJ]		2,14E-01		4,12E-01		8,33E+00	
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**2,14E-01**	**0,00E+00**	**4,12E-01**	**0,00E+00**	**8,33E+00**	**0,00E+00**
Coal [MJ]							
Coal, feedstock [MJ]							
Diesel, heavy & medium truck (highway) [MJ]							
Diesel, heavy & medium truck (rural) [MJ]	0,0504		0,0969				
Diesel, heavy & medium truck (urban) [MJ]							
Diesel, ship (4-stroke) [MJ]							
Fuel, unspecified [MJ]		4,13E-07		7,94E-07		1,61E-05	
Hard coal [MJ]							
Natural gas (>100 kW) [MJ]							
Natural gas [MJ]							
Natural gas, feedstock [MJ]							
Oil [MJ]							
Oil, feedstock [MJ]							
Oil, heavy fuel [MJ]							
Oil, light fuel [MJ]							
Peat [MJ]							
Fossil fuel, total [MJ at final use]	**5,04E-02**	**4,13E-07**	**9,69E-02**	**7,94E-07**	**0,00E+00**	**1,61E-05**	**0,00E+00**
Bark [MJ]							
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]							
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	36. PP-production (avoided)	37. PP-recycling (avoided)	38. Other products	39. PP-landfill
Electricity [MJ]	-4,42E+00			
Electricity, coal marginal [MJ]		-4,17E+00		1,31E-03
Hydro power [MJelectricity]	-1,51E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**-5,94E+00**	**-4,17E+00**	**0,00E+00**	**1,31E-03**
Coal [MJ]	-3,10E+00			
Coal, feedstock [MJ]	-1,87E-02			
Diesel, heavy & medium truck (highway) [MJ]				
Diesel, heavy & medium truck (rural) [MJ]				
Diesel, heavy & medium truck (urban) [MJ]				6,53E-02
Diesel, ship (4-stroke) [MJ]				
Fuel, unspecified [MJ]		-8,04E-06		2,52E-09
Hard coal [MJ]				
Natural gas (>100 kW) [MJ]				
Natural gas [MJ]	-1,69E+01			
Natural gas, feedstock [MJ]	-2,36E+01			
Oil [MJ]	-1,11E+01			
Oil, feedstock [MJ]	-9,13E+01			
Oil, heavy fuel [MJ]				
Oil, light fuel [MJ]				
Peat [MJ]				
Fossil fuel, total [MJ at final use]	**-1,46E+02**	**-8,04E-06**	**0,00E+00**	**6,53E-02**
Bark [MJ]				
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]				
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	Trp 21 (Distribution of beverage)	40. Retailers	Trp 22 (Return)	Trp 23	41. Use (refrigeration)
Electricity [MJ]					
Electricity, coal marginal [MJ]					2,10E-04
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**2,10E-04**
Coal [MJ]					
Coal, feedstock [MJ]					
Diesel, heavy & medium truck (highway) [MJ]	9,11E+01				
Diesel, heavy & medium truck (rural) [MJ]	92,765				
Diesel, heavy & medium truck (urban) [MJ]	7,77E+01				
Diesel, ship (4-stroke) [MJ]					
Fuel, unspecified [MJ]					4,05E-10
Hard coal [MJ]					
Natural gas (>100 kW) [MJ]					
Natural gas [MJ]					
Natural gas, feedstock [MJ]					
Oil [MJ]					
Oil, feedstock [MJ]					
Oil, heavy fuel [MJ]					
Oil, light fuel [MJ]					
Peat [MJ]					
Fossil fuel, total [MJ at final use]	**2,62E+02**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**4,05E-10**
Bark [MJ]					
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]					
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	Trp 24	Trp 25	42. Waste management	43. PP-incineration	44. PET-incineration	45. PE-incineration
Electricity [MJ]						
Electricity, coal marginal [MJ]				1,03E-01	2,72E-01	5,51E-02
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**1,03E-01**	**2,72E-01**	**5,51E-02**
Coal [MJ]						
Coal, feedstock [MJ]						
Diesel, heavy & medium truck (highway) [MJ]						
Diesel, heavy & medium truck (rural) [MJ]		0,111				
Diesel, heavy & medium truck (urban) [MJ]						
Diesel, ship (4-stroke) [MJ]						
Fuel, unspecified [MJ]				1,98E-07	5,24E-07	1,06E-07
Hard coal [MJ]						
Natural gas (>100 kW) [MJ]						
Natural gas [MJ]						
Natural gas, feedstock [MJ]						
Oil [MJ]						
Oil, feedstock [MJ]						
Oil, heavy fuel [MJ]						
Oil, light fuel [MJ]						
Peat [MJ]						
Fossil fuel, total [MJ at final use]	**0,00E+00**	**1,11E-01**	**0,00E+00**	**1,98E-07**	**5,24E-07**	**1,06E-07**
Bark [MJ]						
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]						
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

	46. Cardboard incineration	47. Energy use	48. Alt. energy production	49. Energy use	50. Alt. energy production
Electricity [MJ]					
Electricity, coal marginal [MJ]	4,10E-02		-3,50E+00		-2,35E+00
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**4,10E-02**	**0,00E+00**	**-3,50E+00**	**0,00E+00**	**-2,35E+00**
Coal [MJ]					
Coal, feedstock [MJ]					
Diesel, heavy & medium truck (highway) [MJ]					
Diesel, heavy & medium truck (rural) [MJ]					
Diesel, heavy & medium truck (urban) [MJ]					
Diesel, ship (4-stroke) [MJ]					
Fuel, unspecified [MJ]	7,91E-08		-6,76E-06		-4,53E-06
Hard coal [MJ]					
Natural gas (>100 kW) [MJ]			-3,13E+01		-2,10E+01
Natural gas [MJ]					
Natural gas, feedstock [MJ]					
Oil [MJ]					
Oil, feedstock [MJ]					
Oil, heavy fuel [MJ]					
Oil, light fuel [MJ]			-4,70E+01		-3,15E+01
Peat [MJ]					
Fossil fuel, total [MJ at final use]	**7,91E-08**	**0,00E+00**	**-7,83E+01**	**0,00E+00**	**-5,25E+01**
Bark [MJ]					
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]					
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.1 Energy demand [per 1000 litres of beverage]: 50 cl refillable PET bottles

		Packaging system	Effects on other life cycles	Total
Electricity [MJ]		1,16E+01	-9,45E+00	2,20E+00
Electricity, coal marginal [MJ]		1,31E+02	-2,21E-01	1,31E+02
Hydro power [MJelectricity]		3,61E+00	-2,53E+00	1,08E+00
Electricity, total [MJ at final use]		**1,47E+02**	**-1,22E+01**	**1,34E+02**
Coal [MJ]		2,93E+01	-1,03E+01	1,90E+01
Coal, feedstock [MJ]		9,93E-02	-3,72E-02	6,21E-02
Diesel, heavy & medium truck (highway) [MJ]		9,75E+01	1,74E+00	9,92E+01
Diesel, heavy & medium truck (rural) [MJ]		9,55E+01	0,00E+00	9,55E+01
Diesel, heavy & medium truck (urban) [MJ]		8,05E+01	1,30E-01	8,06E+01
Diesel, ship (4-stroke) [MJ]		6,10E-01	0,00E+00	6,10E-01
Fuel, unspecified [MJ]		2,53E-04	-4,14E-07	2,53E-04
Hard coal [MJ]		7,12E+01	0,00E+00	7,12E+01
Natural gas (>100 kW) [MJ]		1,12E+02	-5,02E+01	6,16E+01
Natural gas [MJ]		1,36E+02	-4,78E+01	8,84E+01
Natural gas, feedstock [MJ]		1,40E+02	-4,70E+01	9,27E+01
Oil [MJ]		1,23E+02	-4,09E+01	8,17E+01
Oil, feedstock [MJ]		3,93E+02	-1,53E+02	2,40E+02
Oil, heavy fuel [MJ]		6,75E+00	0,00E+00	6,75E+00
Oil, light fuel [MJ]		6,88E-01	-7,85E+01	-7,78E+01
Peat [MJ]		1,26E+00	0,00E+00	1,26E+00
Fossil fuel, total [MJ at final use]		**1,29E+03**	**-4,26E+02**	**8,61E+02**
Bark [MJ]		4,39E+00	0,00E+00	4,39E+00
Renewable fuel, total [MJ at final use]		**4,39E+00**	**0,00E+00**	**4,39E+00**
Heat [MJ]		-1,02E-01	0,00E+00	-1,02E-01
Steam [MJ]		-4,52E+00	0,00E+00	-4,52E+00
Warm water [MJ]		-3,07E-01	0,00E+00	-3,07E-01
Heat etc., total [MJ at final use]		**-1,02E-01**	**0,00E+00**	**-1,02E-01**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	1. PET-resin	Trp 1	2. Preform production	Trp 2	3. Bottle production	Trp 3	4. Washing & filling
Electricity [MJ]							
Electricity, coal marginal [MJ]	2,53E+00				8,40E+00		9,33E+01
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**2,53E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**8,40E+00**	**0,00E+00**	**9,33E+01**
Coal [MJ]	1,36E+01						
Coal, feedstock [MJ]	3,49E-02						
Diesel, heavy & medium truck (highway) [MJ]		7,01E-01		1,87E+00		2,34E-01	
Diesel, heavy & medium truck (rural) [MJ]							
Diesel, heavy & medium truck (urban) [MJ]							
Diesel, ship (4-stroke) [MJ]							
Fuel, unspecified [MJ]	4,89E-06				1,62E-05		1,80E-04
Hard coal [MJ]					4,73E+01		
Natural gas (>100 kW) [MJ]							9,69E+01
Natural gas [MJ]	5,81E+01				2,66E+00		
Natural gas, feedstock [MJ]	4,40E+01						
Oil [MJ]	5,60E+01				7,94E+00		
Oil, feedstock [MJ]	1,16E+02						
Oil, heavy fuel [MJ]							
Oil, light fuel [MJ]							
Peat [MJ]							
Fossil fuel, total [MJ at final use]	**2,87E+02**	**7,01E-01**	**0,00E+00**	**1,87E+00**	**5,79E+01**	**2,34E-01**	**9,69E+01**
Bark [MJ]							
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]							
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	5. Packaging	6. Caps+inserts	Trp 4	7. PP-production	Trp 5	8. LDPE-production	Trp 6	9. Inserts
Electricity [MJ]				3,17E+00		4,20E-01		
Electricity, coal marginal [MJ]		9,10E+00						
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	1,08E+00	0,00E+00	7,23E-02	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**9,10E+00**	**0,00E+00**	**4,26E+00**	**0,00E+00**	**4,92E-01**	**0,00E+00**	**0,00E+00**
Coal [MJ]				2,22E+00		4,39E-01		
Coal, feedstock [MJ]				1,34E-02		1,34E-03		
Diesel, heavy & medium truck (highway) [MJ]					2,69E-01		2,69E-02	
Diesel, heavy & medium truck (rural) [MJ]			3,12E-01					
Diesel, heavy & medium truck (urban) [MJ]								
Diesel, ship (4-stroke) [MJ]								
Fuel, unspecified [MJ]		1,76E-05						
Hard coal [MJ]								
Natural gas (>100 kW) [MJ]								
Natural gas [MJ]				1,21E+01		1,66E+00		
Natural gas, feedstock [MJ]				1,69E+01		4,42E+00		
Oil [MJ]				7,95E+00		5,07E-01		
Oil, feedstock [MJ]				6,54E+01		4,53E+00		
Oil, heavy fuel [MJ]								
Oil, light fuel [MJ]								
Peat [MJ]								
Fossil fuel, total [MJ at final use]	**0,00E+00**	**1,76E-05**	**3,12E-01**	**1,05E+02**	**2,69E-01**	**1,16E+01**	**2,69E-02**	**0,00E+00**
Bark [MJ]								
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]								
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	10. Secondary packaging	Trp 7	11. Cardboard	Trp 8	12. Multipack-Cardboard	13. LDPE-production
Electricity [MJ]						5,15E-01
Electricity, coal marginal [MJ]			5,22E-01			
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,86E-02
Electricity, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**5,22E-01**	**0,00E+00**	**0,00E+00**	**6,04E-01**
Coal [MJ]						5,38E-01
Coal, feedstock [MJ]						1,64E-03
Diesel, heavy & medium truck (highway) [MJ]			6,53E-02	4,04E-02		
Diesel, heavy & medium truck (rural) [MJ]		2,24E-01				
Diesel, heavy & medium truck (urban) [MJ]			1,57E-01			
Diesel, ship (4-stroke) [MJ]			2,76E-01			
Fuel, unspecified [MJ]			1,01E-06			
Hard coal [MJ]						
Natural gas (>100 kW) [MJ]			1,39E-01			
Natural gas [MJ]						2,03E+00
Natural gas, feedstock [MJ]						5,42E+00
Oil [MJ]						6,22E-01
Oil, feedstock [MJ]						5,56E+00
Oil, heavy fuel [MJ]			4,10E-01			
Oil, light fuel [MJ]			2,01E-03			
Peat [MJ]			2,21E-02			
Fossil fuel, total [MJ at final use]	**0,00E+00**	**2,24E-01**	**1,07E+00**	**4,04E-02**	**0,00E+00**	**1,42E+01**
Bark [MJ]			1,65E-01			
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**1,65E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]			-6,83E-02			
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**-6,83E-02**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	Trp 9	14. Multipack-LDPE	15. New crate/tray	16. Paper production	Trp 10	17. Label printing	Trp 11
Electricity [MJ]							
Electricity, coal marginal [MJ]			1,43E+00	2,45E+00		1,44E+00	
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**1,43E+00**	**2,45E+00**	**0,00E+00**	**1,44E+00**	**0,00E+00**
Coal [MJ]							
Coal, feedstock [MJ]							
Diesel, heavy & medium truck (highway) [MJ]	3,30E-02			5,34E-02	1,81E-01		
Diesel, heavy & medium truck (rural) [MJ]				6,61E-03			1,12E-01
Diesel, heavy & medium truck (urban) [MJ]				3,14E-01			
Diesel, ship (4-stroke) [MJ]				2,68E-02			
Fuel, unspecified [MJ]			2,76E-06	4,74E-06		2,78E-06	
Hard coal [MJ]				2,52E-02			
Natural gas (>100 kW) [MJ]							
Natural gas [MJ]							
Natural gas, feedstock [MJ]							
Oil [MJ]							
Oil, feedstock [MJ]							
Oil, heavy fuel [MJ]				2,70E+00			
Oil, light fuel [MJ]				3,60E-02			
Peat [MJ]				5,40E-01			
Fossil fuel, total [MJ at final use]	**3,30E-02**	**0,00E+00**	**2,76E-06**	**3,70E+00**	**1,81E-01**	**2,78E-06**	**1,12E-01**
Bark [MJ]				2,16E-01			
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**2,16E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]							
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	-1,99E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	-1,35E-01	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	18. Glue production	Trp 12	19. Transport packaging	Trp 13	20. Planks for pallets	Trp 14	21. Pallets
Electricity [MJ]							
Electricity, coal marginal [MJ]	1,63E-01				1,61E+00		
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**1,63E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**1,61E+00**	**0,00E+00**	**0,00E+00**
Coal [MJ]							
Coal, feedstock [MJ]							
Diesel, heavy & medium truck (highway) [MJ]	4,75E-02	4,05E-02			3,62E-01		
Diesel, heavy & medium truck (rural) [MJ]				6,61E-01		6,50E-01	
Diesel, heavy & medium truck (urban) [MJ]					2,40E+00		
Diesel, ship (4-stroke) [MJ]					1,82E-01		
Fuel, unspecified [MJ]	3,15E-07				3,10E-06		
Hard coal [MJ]							
Natural gas (>100 kW) [MJ]							
Natural gas [MJ]							
Natural gas, feedstock [MJ]							
Oil [MJ]							
Oil, feedstock [MJ]							
Oil, heavy fuel [MJ]							
Oil, light fuel [MJ]					8,09E-01		
Peat [MJ]							
Fossil fuel, total [MJ at final use]	**4,75E-02**	**4,05E-02**	**0,00E+00**	**6,61E-01**	**3,75E+00**	**6,50E-01**	**0,00E+00**
Bark [MJ]					4,90E+00		
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**4,90E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]							
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	22. LDPE-production	Trp 15	23. Plastic ligature	Trp 16	24. Grinding	Trp 17	25. Baling	26. Recycling
Electricity [MJ]	1,75E-01							
Electricity, coal marginal [MJ]					1,12E-01		1,59E-01	9,89E-01
Hydro power [MJelectricity]	3,01E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**2,05E-01**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**1,12E-01**	**0,00E+00**	**1,59E-01**	**9,89E-01**
Coal [MJ]	1,83E-01							
Coal, feedstock [MJ]	5,57E-04							
Diesel, heavy & medium truck (highway) [MJ]		1,12E-02		6,03E-02		1,15E+00		
Diesel, heavy & medium truck (rural) [MJ]								
Diesel, heavy & medium truck (urban) [MJ]								
Diesel, ship (4-stroke) [MJ]								
Fuel, unspecified [MJ]					2,16E-07		3,07E-07	1,91E-06
Hard coal [MJ]								
Natural gas (>100 kW) [MJ]								2,76E+00
Natural gas [MJ]	6,89E-01							
Natural gas, feedstock [MJ]	1,84E+00							
Oil [MJ]	2,11E-01							
Oil, feedstock [MJ]	1,89E+00							
Oil, heavy fuel [MJ]								
Oil, light fuel [MJ]								
Peat [MJ]								
Fossil fuel, total [MJ at final use]	**4,81E+00**	**1,12E-02**	**0,00E+00**	**6,03E-02**	**2,16E-07**	**1,15E+00**	**3,07E-07**	**2,76E+00**
Bark [MJ]								
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]								
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	27. New product	28. PET-production (avoided)	29. Recycling (avoided)	30. Other product	31. PET-landfill
Electricity [MJ]		-3,32E+00			
Electricity, coal marginal [MJ]			-4,94E-01		8,59E-04
Hydro power [MJelectricity]	0,00E+00	-6,75E-01	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**-4,00E+00**	**-4,94E-01**	**0,00E+00**	**8,59E-04**
Coal [MJ]		-4,77E+00			
Coal, feedstock [MJ]		-1,23E-02			
Diesel, heavy & medium truck (highway) [MJ]					
Diesel, heavy & medium truck (rural) [MJ]					
Diesel, heavy & medium truck (urban) [MJ]					4,29E-02
Diesel, ship (4-stroke) [MJ]					
Fuel, unspecified [MJ]			-9,54E-07		1,66E-09
Hard coal [MJ]					
Natural gas (>100 kW) [MJ]			-1,38E+00		
Natural gas [MJ]		-2,04E+01			
Natural gas, feedstock [MJ]		-1,55E+01			
Oil [MJ]		-1,97E+01			
Oil, feedstock [MJ]		-4,07E+01			
Oil, heavy fuel [MJ]					
Oil, light fuel [MJ]					
Peat [MJ]					
Fossil fuel, total [MJ at final use]	**0,00E+00**	**-1,01E+02**	**-1,38E+00**	**0,00E+00**	**4,29E-02**
Bark [MJ]					
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]					
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	Trp 18	32. Paper incineration	Trp 19	33. Wood incineration	Trp 20	34. PP-recycling	35. New product
Electricity [MJ]							
Electricity, coal marginal [MJ]		9,51E-02		5,50E-01		2,78E+00	
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**9,51E-02**	**0,00E+00**	**5,50E-01**	**0,00E+00**	**2,78E+00**	**0,00E+00**
Coal [MJ]							
Coal, feedstock [MJ]							
Diesel, heavy & medium truck (highway) [MJ]							
Diesel, heavy & medium truck (rural) [MJ]	2,24E-02		1,30E-01				
Diesel, heavy & medium truck (urban) [MJ]							
Diesel, ship (4-stroke) [MJ]							
Fuel, unspecified [MJ]		1,84E-07		1,06E-06		5,36E-06	
Hard coal [MJ]							
Natural gas (>100 kW) [MJ]							
Natural gas [MJ]							
Natural gas, feedstock [MJ]							
Oil [MJ]							
Oil, feedstock [MJ]							
Oil, heavy fuel [MJ]							
Oil, light fuel [MJ]							
Peat [MJ]							
Fossil fuel, total [MJ at final use]	**2,24E-02**	**1,84E-07**	**1,30E-01**	**1,06E-06**	**0,00E+00**	**5,36E-06**	**0,00E+00**
Bark [MJ]							
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]							
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	36. PP-production (avoided)	37. PP-recycling (avoided)	38. Other products	39. PP-landfill
Electricity [MJ]	-1,48E+00			
Electricity, coal marginal [MJ]		-1,39E+00		4,36E-04
Hydro power [MJelectricity]	-5,04E-01	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**-1,98E+00**	**-1,39E+00**	**0,00E+00**	**4,36E-04**
Coal [MJ]	-1,03E+00			
Coal, feedstock [MJ]	-6,23E-03			
Diesel, heavy & medium truck (highway) [MJ]				
Diesel, heavy & medium truck (rural) [MJ]				
Diesel, heavy & medium truck (urban) [MJ]				2,18E-02
Diesel, ship (4-stroke) [MJ]				
Fuel, unspecified [MJ]		-2,68E-06		8,41E-10
Hard coal [MJ]				
Natural gas (>100 kW) [MJ]				
Natural gas [MJ]	-5,64E+00			
Natural gas, feedstock [MJ]	-7,88E+00			
Oil [MJ]	-3,70E+00			
Oil, feedstock [MJ]	-3,05E+01			
Oil, heavy fuel [MJ]				
Oil, light fuel [MJ]				
Peat [MJ]				
Fossil fuel, total [MJ at final use]	**-4,87E+01**	**-2,68E-06**	**0,00E+00**	**2,18E-02**
Bark [MJ]				
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]				
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	Trp 21 (Distribution of beverage)	40. Retailers	Trp 22 (Return)	Trp 23	41. Use (refrigeration)
Electricity [MJ]					
Electricity, coal marginal [MJ]					1,39E-04
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**1,39E-04**
Coal [MJ]					
Coal, feedstock [MJ]					
Diesel, heavy & medium truck (highway) [MJ]	8,90E+01				
Diesel, heavy & medium truck (rural) [MJ]	9,06E+01				
Diesel, heavy & medium truck (urban) [MJ]	7,59E+01				
Diesel, ship (4-stroke) [MJ]					
Fuel, unspecified [MJ]					2,68E-10
Hard coal [MJ]					
Natural gas (>100 kW) [MJ]					
Natural gas [MJ]					
Natural gas, feedstock [MJ]					
Oil [MJ]					
Oil, feedstock [MJ]					
Oil, heavy fuel [MJ]					
Oil, light fuel [MJ]					
Peat [MJ]					
Fossil fuel, total [MJ at final use]	**2,56E+02**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**2,68E-10**
Bark [MJ]					
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]					
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	Trp 24	Trp 25	42. Waste management	43. PP-incineration	44. PET-incineration	45. PE-incineration
Electricity [MJ]						
Electricity, coal marginal [MJ]				3,52E-02	1,85E-01	3,58E-02
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**3,52E-02**	**1,85E-01**	**3,58E-02**
Coal [MJ]						
Coal, feedstock [MJ]						
Diesel, heavy & medium truck (highway) [MJ]						
Diesel, heavy & medium truck (rural) [MJ]		6,68E-02				
Diesel, heavy & medium truck (urban) [MJ]						
Diesel, ship (4-stroke) [MJ]						
Fuel, unspecified [MJ]				6,79E-08	3,56E-07	6,90E-08
Hard coal [MJ]						
Natural gas (>100 kW) [MJ]						
Natural gas [MJ]						
Natural gas, feedstock [MJ]						
Oil [MJ]						
Oil, feedstock [MJ]						
Oil, heavy fuel [MJ]						
Oil, light fuel [MJ]						
Peat [MJ]						
Fossil fuel, total [MJ at final use]	**0,00E+00**	**6,68E-02**	**0,00E+00**	**6,79E-08**	**3,56E-07**	**6,90E-08**
Bark [MJ]						
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]						
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

	46. Cardboard incineration	47. Energy use	48. Alt. energy production	49. Energy use	50. Alt. energy production
Electricity [MJ]					
Electricity, coal marginal [MJ]	2,81E-02		-2,04E+00		-2,51E+00
Hydro power [MJelectricity]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Electricity, total [MJ at final use]	**2,81E-02**	**0,00E+00**	**-2,04E+00**	**0,00E+00**	**-2,51E+00**
Coal [MJ]					
Coal, feedstock [MJ]					
Diesel, heavy & medium truck (highway) [MJ]					
Diesel, heavy & medium truck (rural) [MJ]					
Diesel, heavy & medium truck (urban) [MJ]					
Diesel, ship (4-stroke) [MJ]					
Fuel, unspecified [MJ]	5,43E-08		-3,93E-06		-4,84E-06
Hard coal [MJ]					
Natural gas (>100 kW) [MJ]			-1,82E+01		-2,24E+01
Natural gas [MJ]					
Natural gas, feedstock [MJ]					
Oil [MJ]					
Oil, feedstock [MJ]					
Oil, heavy fuel [MJ]					
Oil, light fuel [MJ]			-2,73E+01		-3,37E+01
Peat [MJ]					
Fossil fuel, total [MJ at final use]	**5,43E-08**	**0,00E+00**	**-4,56E+01**	**0,00E+00**	**-5,61E+01**
Bark [MJ]					
Renewable fuel, total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**
Heat [MJ]					
Steam [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Warm water [MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Heat etc., total [MJ at final use]	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

C.2 Energy demand [per 1000 litres of beverage]: 150 cl refillable PET bottles

		Packaging system	Effects on other life cycles	Total
Electricity [MJ]		4,28E+00	-4,80E+00	-5,19E-01
Electricity, coal marginal [MJ]		1,22E+02	-2,22E+00	1,19E+02
Hydro power [MJelectricity]		1,28E+00	-1,18E+00	9,60E-02
Electricity, total [MJ at final use]		**1,27E+02**	**-8,20E+00**	**1,19E+02**
Coal [MJ]		1,69E+01	-5,81E+00	1,11E+01
Coal, feedstock [MJ]		5,18E-02	-1,85E-02	3,33E-02
Diesel, heavy & medium truck (highway) [MJ]		9,30E+01	1,15E+00	9,41E+01
Diesel, heavy & medium truck (rural) [MJ]		9,28E+01	0,00E+00	9,28E+01
Diesel, heavy & medium truck (urban) [MJ]		7,88E+01	6,47E-02	7,89E+01
Diesel, ship (4-stroke) [MJ]		4,85E-01	0,00E+00	4,85E-01
Fuel, unspecified [MJ]		2,35E-04	-4,28E-06	2,31E-04
Hard coal [MJ]		4,73E+01	0,00E+00	4,73E+01
Natural gas (>100 kW) [MJ]		9,71E+01	-3,93E+01	5,78E+01
Natural gas [MJ]		7,72E+01	-2,61E+01	5,12E+01
Natural gas, feedstock [MJ]		7,26E+01	-2,34E+01	4,93E+01
Oil [MJ]		7,32E+01	-2,34E+01	4,98E+01
Oil, feedstock [MJ]		1,93E+02	-7,11E+01	1,22E+02
Oil, heavy fuel [MJ]		3,11E+00	0,00E+00	3,11E+00
Oil, light fuel [MJ]		8,47E-01	-6,10E+01	-6,02E+01
Peat [MJ]		5,62E-01	0,00E+00	5,62E-01
Fossil fuel, total [MJ at final use]		**8,47E+02**	**-2,49E+02**	**5,98E+02**
Bark [MJ]		5,28E+00	0,00E+00	5,28E+00
Renewable fuel, total [MJ at final use]		**5,28E+00**	**0,00E+00**	**5,28E+00**
Heat [MJ]		-6,83E-02	0,00E+00	-6,83E-02
Steam [MJ]		-1,99E+00	0,00E+00	-1,99E+00
Warm water [MJ]		-1,35E-01	0,00E+00	-1,35E-01
Heat etc., total [MJ at final use]		**-6,83E-02**	**0,00E+00**	**-6,83E-02**

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	1. PET-resin	Trp 1	2. Preform production	Trp 2	3. Bottle production	Trp 3	4. Washing & filling	5. Packaging
CO2	1,31E+04	8,83E+01		2,36E+02	1,13E+04	2,94E+01	2,41E+04	
CO2 relative	16,95%	0,11%	0,00%	0,30%	14,62%	0,04%	31,18%	0,00%
SO2	1,33E+02	9,87E-02		2,63E-01	9,40E+01	3,29E-02	2,87E+01	
SO2 relative	48,13%	0,04%	0,00%	0,10%	34,13%	0,01%	10,42%	0,00%
NOx	1,08E+02	8,41E-01		2,24E+00	3,61E+01	2,80E-01	5,25E+01	
NOx relative	24,83%	0,19%	0,00%	0,51%	8,28%	0,06%	12,05%	0,00%
NMVOC:s								
NMVOC		2,15E-01		5,73E-01		7,17E-02	1,90E-01	
NMVOC, diesel engines	2,69E-02	8,54E-02		2,28E-01	8,92E-02	2,85E-02	5,25E-01	
NMVOC, el-coal	1,77E-02				5,86E-02		3,45E-01	
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines	3,44E-12				1,14E-11		6,70E-11	
NMVOC, power plants	8,54E-03				2,83E-02		1,67E-01	
Total NMVOC	5,31E-02	3,00E-01	0,00E+00	8,01E-01	1,76E-01	1,00E-01	1,23E+00	0,00E+00
Total NMVOC relative	0,07%	0,41%	0,00%	1,09%	0,24%	0,14%	1,67%	0,00%
VOC:s								
HC	2,10E+02				6,99E+00		1,03E+00	
VOC								
VOC, coal combustion	4,61E-04				1,53E-03		8,99E-03	
VOC, diesel engines	1,27E-02				4,22E-02		2,48E-01	
VOC, natural gas combustion	3,60E-11				1,19E-10		7,01E-10	
Total VOC	2,10E+02	0,00E+00	0,00E+00	0,00E+00	7,04E+00	0,00E+00	1,28E+00	0,00E+00
Total VOC relative	110,78%	0,00%	0,00%	0,00%	3,71%	0,00%	0,68%	0,00%
"Other specified hydrocarbons"								
Acetaldehyde							1,12E-04	
Acetylene								
Aldehydes	1,15E-05				3,82E-05		2,25E-04	
Alkanes								
Alkenes								
Aromates (C9-C10)	1,69E-04				5,59E-04		3,29E-03	
Butane							7,81E-02	
CH4	4,58E+00	1,11E-01		2,96E-01	1,52E+01	3,70E-02	8,97E+01	
Ethane								
Ethene								
Formaldehyde							1,12E-02	
PAH	2,31E-08				7,65E-08		1,12E-03	
Pentane							1,34E-01	
Propane							2,23E-02	
Propene								
Xylene								
Total "other"	4,58E+00	1,11E-01	0,00E+00	2,96E-01	1,52E+01	3,70E-02	8,99E+01	0,00E+00
Total "other" relative	1,88%	0,05%	0,00%	0,12%	6,24%	0,02%	36,97%	0,00%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	6. Caps+inserts	Trp 4	7. PP-production	Trp 5	8. LDPE-production	Trp 6	9. Inserts	10. Secondary packaging
CO2	6,27E+03	7,81E+01	4,39E+03	6,73E+01	4,99E+02	6,73E+00		
CO2 relative	8,11%	0,10%	5,68%	0,09%	0,65%	0,01%	0,00%	0,00%
SO2	1,04E+01	8,71E-02	4,39E+01	7,51E-02	3,59E+00	7,51E-03		
SO2 relative	3,79%	0,03%	15,94%	0,03%	1,30%	0,00%	0,00%	0,00%
NOx	1,67E+01	7,42E-01	3,99E+01	6,40E-01	4,79E+00	6,40E-02		
NOx relative	3,82%	0,17%	9,16%	0,15%	1,10%	0,01%	0,00%	0,00%
NMVOC:s								
NMVOC		1,90E-01		1,64E-01		1,64E-02		
NMVOC, diesel engines	1,92E-01	7,54E-02		6,50E-02		6,50E-03		
NMVOC, el-coal	1,26E-01							
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines	2,45E-11							
NMVOC, power plants	6,08E-02							
Total NMVOC	3,79E-01	2,65E-01	0,00E+00	2,29E-01	0,00E+00	2,29E-02	0,00E+00	0,00E+00
Total NMVOC relative	0,52%	0,36%	0,00%	0,31%	0,00%	0,03%	0,00%	0,00%
VOC:s								
HC	3,75E-01		5,19E+01		8,38E+00			
VOC								
VOC, coal combustion	3,28E-03							
VOC, diesel engines	9,06E-02							
VOC, natural gas combustion	2,56E-10							
Total VOC	4,69E-01	0,00E+00	5,19E+01	0,00E+00	8,38E+00	0,00E+00	0,00E+00	0,00E+00
Total VOC relative	0,25%	0,00%	27,40%	0,00%	4,43%	0,00%	0,00%	0,00%
"Other specified hydrocarbons"								
Acetaldehyde								
Acetylene								
Aldehydes	8,20E-05							
Alkanes								
Alkenes								
Aromates (C9-C10)	1,20E-03							
Butane								
CH4	3,26E+01	9,81E-02		8,46E-02		8,46E-03		
Ethane								
Ethene								
Formaldehyde								
PAH	1,64E-07							
Pentane								
Propane								
Propene								
Xylene								
Total "other"	3,26E+01	9,81E-02	0,00E+00	8,46E-02	0,00E+00	8,46E-03	0,00E+00	0,00E+00
Total "other" relative	13,39%	0,04%	0,00%	0,03%	0,00%	0,00%	0,00%	0,00%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	Trp 7	11. Cardboard	Trp 8	12. Multipack-Cardboard	13. LDPE-production	Trp 9	14. Multipack-LDPE
CO2	2,30E+01	3,17E+02	5,05E+00		3,20E+02	4,31E+00	
CO2 relative	0,03%	0,41%	0,01%	0,00%	0,41%	0,01%	0,00%
SO2	2,56E-02	6,58E-01	5,64E-03		2,30E+00	4,81E-03	
SO2 relative	0,01%	0,24%	0,00%	0,00%	0,83%	0,00%	0,00%
NOx	2,18E-01	1,61E+00	4,81E-02		3,07E+00	4,10E-02	
NOx relative	0,05%	0,37%	0,01%	0,00%	0,70%	0,01%	0,00%
NMVOC:s							
NMVOC	5,59E-02	1,53E-01	1,23E-02			1,05E-02	
NMVOC, diesel engines	2,22E-02	7,51E-02	4,88E-03			4,16E-03	
NMVOC, el-coal		3,62E-03					
NMVOC, natural gas combustion							
NMVOC, oil combustion		1,41E-01					
NMVOC, petrol engines		7,02E-13					
NMVOC, power plants		1,75E-03					
Total NMVOC	7,81E-02	3,74E-01	1,72E-02	0,00E+00	0,00E+00	1,47E-02	0,00E+00
Total NMVOC relative	0,11%	0,51%	0,02%	0,00%	0,00%	0,02%	0,00%
VOC:s							
HC		1,08E-02			5,37E+00		
VOC							
VOC, coal combustion		9,43E-05					
VOC, diesel engines		2,60E-03					
VOC, natural gas combustion		7,35E-12					
Total VOC	0,00E+00	1,35E-02	0,00E+00	0,00E+00	5,37E+00	0,00E+00	0,00E+00
Total VOC relative	0,00%	0,01%	0,00%	0,00%	2,83%	0,00%	0,00%
"Other specified hydrocarbons"							
Acetaldehyde							
Acetylene							
Aldehydes		2,35E-06					
Alkanes							
Alkenes							
Aromates (C9-C10)		3,45E-05					
Butane							
CH4	2,89E-02	1,09E+00	6,35E-03			5,42E-03	
Ethane							
Ethene							
Formaldehyde							
PAH		4,72E-09					
Pentane							
Propane							
Propene							
Xylene							
Total "other"	2,89E-02	1,09E+00	6,35E-03	0,00E+00	0,00E+00	5,42E-03	0,00E+00
Total "other" relative	0,01%	0,45%	0,00%	0,00%	0,00%	0,00%	0,00%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	15. New crate/tray	16. Paper production	Trp 10	17. Label printing	Trp 11	18. Glue production	Trp 12
CO2	3,52E+02	2,03E+03	3,45E+01	7,56E+02	2,14E+01	8,28E+01	6,75E+00
CO2 relative	0,46%	2,63%	0,04%	0,98%	0,03%	0,11%	0,01%
SO2	5,87E-01	4,74E+00	3,85E-02	1,26E+00	2,38E-02	1,34E-01	7,53E-03
SO2 relative	0,21%	1,72%	0,01%	0,46%	0,01%	0,05%	0,00%
NOx	9,36E-01	8,15E+00	3,28E-01	2,01E+00	2,03E-01	2,74E-01	6,42E-02
NOx relative	0,21%	1,87%	0,08%	0,46%	0,05%	0,06%	0,01%
NMVOC:s							
NMVOC		2,03E-01	8,39E-02		5,20E-02	1,93E-02	1,64E-02
NMVOC, diesel engines	1,08E-02	1,75E-01	3,33E-02	2,31E-02	2,06E-02	9,94E-03	6,52E-03
NMVOC, el-coal	7,07E-03	2,59E-02		1,52E-02		1,50E-03	
NMVOC, natural gas combustion							
NMVOC, oil combustion		1,42E+00					
NMVOC, petrol engines	1,37E-12	5,04E-12		2,95E-12		2,92E-13	
NMVOC, power plants	3,41E-03	1,25E-02		7,33E-03		7,27E-04	
Total NMVOC	2,13E-02	1,83E+00	1,17E-01	4,56E-02	7,26E-02	3,15E-02	2,29E-02
Total NMVOC relative	0,03%	2,50%	0,16%	0,06%	0,10%	0,04%	0,03%
VOC:s							
HC	2,10E-02	7,73E-02		4,52E-02		4,48E-03	
VOC				1,14E+00			
VOC, coal combustion	1,84E-04	6,78E-04		3,96E-04		3,92E-05	
VOC, diesel engines	5,09E-03	1,87E-02		1,09E-02		1,08E-03	
VOC, natural gas combustion	1,44E-11	5,28E-11		3,09E-11		3,06E-12	
Total VOC	2,63E-02	9,67E-02	0,00E+00	1,19E+00	0,00E+00	5,60E-03	0,00E+00
Total VOC relative	0,01%	0,05%	0,00%	0,63%	0,00%	0,00%	0,00%
"Other specified hydrocarbons"							
Acetaldehyde							
Acetylene							
Aldehydes	4,60E-06	1,69E-05		9,89E-06		9,79E-07	
Alkanes		3,68E-03					
Alkenes							
Aromates (C9-C10)	6,74E-05	1,17E-03		1,45E-04		1,43E-05	
Butane							
CH4	1,83E+00	7,56E+00	4,34E-02	3,93E+00	2,68E-02	3,99E-01	8,48E-03
Ethane							
Ethene							
Formaldehyde		2,76E-03					
PAH	9,22E-09	3,10E-06		1,98E-08		1,96E-09	
Pentane							
Propane		1,84E-04					
Propene							
Xylene							
Total "other"	1,83E+00	7,56E+00	4,34E-02	3,93E+00	2,68E-02	3,99E-01	8,48E-03
Total "other" relative	0,75%	3,11%	0,02%	1,62%	0,01%	0,16%	0,00%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	19. Transport packaging	Trp 13	20. Planks for pallets	Trp 14	21. Pallets	22. LDPE-production	Trp 15	23. Plastic ligature
CO2		4,13E+01	5,12E+02	4,06E+01		5,17E+01	6,96E-01	
CO2 relative	0,00%	0,05%	0,66%	0,05%	0,00%	0,07%	0,00%	0,00%
SO2		4,61E-02	7,81E-01	4,53E-02		3,72E-01	7,78E-04	
SO2 relative	0,00%	0,02%	0,28%	0,02%	0,00%	0,14%	0,00%	0,00%
NOx		3,93E-01	3,13E+00	3,86E-01		4,96E-01	6,63E-03	
NOx relative	0,00%	0,09%	0,72%	0,09%	0,00%	0,11%	0,00%	0,00%
NMVOC:s								
NMVOC		1,01E-01	5,71E-01	9,88E-02			1,70E-03	
NMVOC, diesel engines		3,99E-02	3,42E-01	3,92E-02			6,73E-04	
NMVOC, el-coal			5,56E-03					
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines			1,08E-12					
NMVOC, power plants			2,69E-03					
Total NMVOC	0,00E+00	1,41E-01	9,21E-01	1,38E-01	0,00E+00	0,00E+00	2,37E-03	0,00E+00
Total NMVOC relative	0,00%	0,19%	1,26%	0,19%	0,00%	0,00%	0,00%	0,00%
VOC:s								
HC			1,32E+00			8,68E-01		
VOC								
VOC, coal combustion			1,45E-04					
VOC, diesel engines			4,00E-03					
VOC, natural gas combustion			1,13E-11					
Total VOC	0,00E+00	0,00E+00	1,32E+00	0,00E+00	0,00E+00	8,68E-01	0,00E+00	0,00E+00
Total VOC relative	0,00%	0,00%	0,70%	0,00%	0,00%	0,46%	0,00%	0,00%
"Other specified hydrocarbons"								
Acetaldehyde								
Acetylene			2,42E-05					
Aldehydes			3,62E-06					
Alkanes			6,03E-04					
Alkenes			4,82E-05					
Aromates (C9-C10)			1,01E-04					
Butane								
CH4		5,20E-02	1,74E+00	5,10E-02			8,76E-04	
Ethane			4,82E-05					
Ethene			1,21E-04					
Formaldehyde			1,45E-05					
PAH			2,84E-07					
Pentane								
Propane			7,24E-05					
Propene			4,82E-05					
Xylene								
Total "other"	0,00E+00	5,20E-02	1,74E+00	5,10E-02	0,00E+00	0,00E+00	8,76E-04	0,00E+00
Total "other" relative	0,00%	0,02%	0,72%	0,02%	0,00%	0,00%	0,00%	0,00%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	Trp 16	24. Grinding	Trp 17	25. Baling	26. Recycling	27. New product	28. PET-production (avoided)	29. Recycling (avoided)
CO2	5,37E+00	2,76E+01	1,46E+02	5,55E+01	6,05E+02		-4,32E+03	-3,02E+02
CO2 relative	0,01%	0,04%	0,19%	0,07%	0,78%	0,00%	-5,59%	-0,39%
SO2	6,00E-03	4,59E-02	1,63E-01	9,25E-02	5,78E-01		-4,63E+01	-2,89E-01
SO2 relative	0,00%	0,02%	0,06%	0,03%	0,21%	0,00%	-16,82%	-0,10%
NOx	5,11E-02	7,32E-02	1,39E+00	1,47E-01	1,18E+00		-3,74E+01	-5,88E-01
NOx relative	0,01%	0,02%	0,32%	0,03%	0,27%	0,00%	-8,59%	-0,13%
NMVOC:s								
NMVOC	1,31E-02		3,55E-01		7,09E-03			-3,54E-03
NMVOC, diesel engines	5,19E-03	8,42E-04	1,41E-01	1,70E-03	1,05E-02			-5,27E-03
NMVOC, el-coal		5,53E-04		1,11E-03	6,93E-03			-3,47E-03
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines		1,07E-13		2,16E-13	1,35E-12			-6,73E-13
NMVOC, power plants		2,67E-04		5,38E-04	3,35E-03			-1,67E-03
Total NMVOC	1,83E-02	1,66E-03	4,96E-01	3,35E-03	2,79E-02	0,00E+00	0,00E+00	-1,40E-02
Total NMVOC relative	0,02%	0,00%	0,68%	0,00%	0,04%	0,00%	0,00%	-0,02%
VOC:s								
HC		1,65E-03		3,31E-03	2,06E-02		-7,41E+01	-1,03E-02
VOC								
VOC, coal combustion		1,44E-05		2,91E-05	1,81E-04			-9,04E-05
VOC, diesel engines		3,98E-04		8,02E-04	4,99E-03			-2,49E-03
VOC, natural gas combustion		1,12E-12		2,27E-12	1,41E-11			-7,04E-12
Total VOC	0,00E+00	2,06E-03	0,00E+00	4,14E-03	2,58E-02	0,00E+00	-7,41E+01	-1,29E-02
Total VOC relative	0,00%	0,00%	0,00%	0,00%	0,01%	0,00%	-39,14%	-0,01%
"Other specified hydrocarbons"								
Acetaldehyde					8,53E-02			-4,26E-02
Acetylene								
Aldehydes		3,60E-07		7,25E-07	4,51E-06			-2,26E-06
Alkanes								
Alkenes								
Aromates (C9-C10)		5,27E-06		1,06E-05	6,60E-05			-3,30E-05
Butane					2,92E-03			-1,46E-03
CH4	6,76E-03	1,43E-01	1,83E-01	2,88E-01	1,81E+00			-9,05E-01
Ethane								
Ethene								
Formaldehyde					4,17E-04			-2,09E-04
PAH		7,22E-10		1,45E-09	4,17E-05			-2,09E-05
Pentane					5,00E-03			-2,50E-03
Propane					8,34E-04			-4,17E-04
Propene								
Xylene								
Total "other"	6,76E-03	1,43E-01	1,83E-01	2,88E-01	1,90E+00	0,00E+00	0,00E+00	-9,52E-01
Total "other" relative	0,00%	0,06%	0,08%	0,12%	0,78%	0,00%	0,00%	-0,39%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	30. Other product	31. PET-landfill	Trp 18	32. Paper incineration	Trp 19	33. Wood incineration	Trp 20	34. PP-recycling
CO2		4,84E+01	4,23E+00	4,94E+01	8,13E+00	9,51E+01		1,92E+03
CO2 relative	0,00%	0,06%	0,01%	0,06%	0,01%	0,12%	0,00%	2,48%
SO2		6,57E-03	4,72E-03	8,24E-02	9,07E-03	1,58E-01		3,21E+00
SO2 relative	0,00%	0,00%	0,00%	0,03%	0,00%	0,06%	0,00%	1,16%
NOx		5,25E-02	4,02E-02	1,56E+00	7,73E-02	3,00E+00		5,12E+00
NOx relative	0,00%	0,01%	0,01%	0,36%	0,02%	0,69%	0,00%	1,17%
NMVOC:s								
NMVOC		1,32E-02	1,03E-02		1,98E-02			
NMVOC, diesel engines		1,10E-02	4,08E-03	1,51E-03	7,85E-03	2,91E-03		5,88E-02
NMVOC, el-coal		6,02E-06		9,92E-04		1,91E-03		3,87E-02
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines		1,17E-15		1,93E-13		3,71E-13		7,51E-12
NMVOC, power plants		2,91E-06		4,79E-04		9,22E-04		1,87E-02
Total NMVOC	0,00E+00	2,42E-02	1,44E-02	2,98E-03	2,77E-02	5,74E-03	0,00E+00	1,16E-01
Total NMVOC relative	0,00%	0,03%	0,02%	0,00%	0,04%	0,01%	0,00%	0,16%
VOC:s								
HC		1,79E-05		2,95E-03		5,68E-03		1,15E-01
VOC								
VOC, coal combustion		1,57E-07		2,59E-05		4,98E-05		1,01E-03
VOC, diesel engines		4,33E-06		7,14E-04		1,37E-03		2,78E-02
VOC, natural gas combustion		1,22E-14		2,02E-12		3,88E-12		7,86E-11
Total VOC	0,00E+00	2,24E-05	0,00E+00	3,69E-03	0,00E+00	7,10E-03	0,00E+00	1,44E-01
Total VOC relative	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,08%
"Other specified hydrocarbons"								
Acetaldehyde								
Acetylene								
Aldehydes		3,92E-09		6,46E-07		1,24E-06		2,52E-05
Alkanes								
Alkenes								
Aromates (C9-C10)		5,73E-08		9,45E-06		1,82E-05		3,68E-04
Butane								
CH4		1,48E+01	5,31E-03	2,57E-01	1,02E-02	4,94E-01		1,00E+01
Ethane								
Ethene								
Formaldehyde								
PAH		7,85E-12		1,29E-09		2,49E-09		5,04E-08
Pentane								
Propane								
Propene								
Xylene								
Total "other"	0,00E+00	1,48E+01	5,31E-03	2,57E-01	1,02E-02	4,94E-01	0,00E+00	1,00E+01
Total "other" relative	0,00%	6,10%	0,00%	0,11%	0,00%	0,20%	0,00%	4,11%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	35. New product	36. PP-production (avoided)	37. PP-recycling (avoided)	38. Other products	39. PP-landfill
CO2		-2,05E+03	-9,62E+02		5,06E+01
CO2 relative	0,00%	-2,65%	-1,24%	0,00%	0,07%
SO2		-2,05E+01	-1,60E+00		6,62E-03
SO2 relative	0,00%	-7,45%	-0,58%	0,00%	0,00%
NOx		-1,87E+01	-2,56E+00		5,29E-02
NOx relative	0,00%	-4,28%	-0,59%	0,00%	0,01%
NMVOC:s					
NMVOC					1,33E-02
NMVOC, diesel engines			-2,94E-02		1,11E-02
NMVOC, el-coal			-1,93E-02		6,06E-06
NMVOC, natural gas combustion					
NMVOC, oil combustion					
NMVOC, petrol engines			-3,75E-12		1,18E-15
NMVOC, power plants			-9,33E-03		2,93E-06
Total NMVOC	0,00E+00	0,00E+00	-5,80E-02	0,00E+00	2,44E-02
Total NMVOC relative	0,00%	0,00%	-0,08%	0,00%	0,03%
VOC:s					
HC		-2,43E+01	-5,75E-02		1,80E-05
VOC					
VOC, coal combustion			-5,04E-04		1,58E-07
VOC, diesel engines			-1,39E-02		4,36E-06
VOC, natural gas combustion			-3,93E-11		1,23E-14
Total VOC	0,00E+00	-2,43E+01	-7,19E-02	0,00E+00	2,25E-05
Total VOC relative	0,00%	-12,81%	-0,04%	0,00%	0,00%
"Other specified hydrocarbons"					
Acetaldehyde					
Acetylene					
Aldehydes			-1,26E-05		3,95E-09
Alkanes					
Alkenes					
Aromates (C9-C10)			-1,84E-04		5,77E-08
Butane					
CH4			-5,00E+00		4,85E+01
Ethane					
Ethene					
Formaldehyde					
PAH			-2,52E-08		7,90E-12
Pentane					
Propane					
Propene					
Xylene					
Total "other"	0,00E+00	0,00E+00	-5,00E+00	0,00E+00	4,85E+01
Total "other" relative	0,00%	0,00%	-2,06%	0,00%	19,96%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	Trp 21 (Distribution of beverage)	40. Retailers	Trp 22 (Return)	Trp 23	41. Use (refrigeration)	Trp 24	Trp 25
CO2	2,19E+04				4,85E-02		9,29E+00
CO2 relative	28,33%	0,00%	0,00%	0,00%	0,00%	0,00%	0,01%
SO2	2,45E+01				8,08E-05		1,04E-02
SO2 relative	8,89%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
NOx	2,09E+02				1,29E-04		8,83E-02
NOx relative	47,86%	0,00%	0,00%	0,00%	0,00%	0,00%	0,02%
NMVOC:s							
NMVOC	5,34E+01						2,26E-02
NMVOC, diesel engines	2,81E+01				1,48E-06		8,97E-03
NMVOC, el-coal					9,73E-07		
NMVOC, natural gas combustion							
NMVOC, oil combustion							
NMVOC, petrol engines					1,89E-16		
NMVOC, power plants					4,70E-07		
Total NMVOC	8,15E+01	0,00E+00	0,00E+00	0,00E+00	2,92E-06	0,00E+00	3,16E-02
Total NMVOC relative	111,06%	0,00%	0,00%	0,00%	0,00%	0,00%	0,04%
VOC:s							
HC					2,89E-06		
VOC							
VOC, coal combustion					2,54E-08		
VOC, diesel engines					7,01E-07		
VOC, natural gas combustion					1,98E-15		
Total VOC	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,62E-06	0,00E+00	0,00E+00
Total VOC relative	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
"Other specified hydrocarbons"							
Acetaldehyde							
Acetylene							
Aldehydes					6,34E-10		
Alkanes							
Alkenes							
Aromates (C9-C10)					9,27E-09		
Butane							
CH4	2,78E+01				2,52E-04		1,17E-02
Ethane							
Ethene							
Formaldehyde							
PAH					1,27E-12		
Pentane							
Propane							
Propene							
Xylene							
Total "other"	2,78E+01	0,00E+00	0,00E+00	0,00E+00	2,52E-04	0,00E+00	1,17E-02
Total "other" relative	11,44%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	42. Waste management	43. PP-incineration	44. PET-incineration	45. PE-incineration	46. Cardboard incineration	47. Energy use
CO_2		1,77E+03	3,70E+03	9,53E+02	9,47E+00	
CO_2 relative	0,00%	2,29%	4,79%	1,23%	0,01%	0,00%
SO_2		3,95E-02	1,05E-01	2,12E-02	1,58E-02	
SO_2 relative	0,00%	0,01%	0,04%	0,01%	0,01%	0,00%
NOx		7,46E-01	1,98E+00	4,01E-01	2,99E-01	
NOx relative	0,00%	0,17%	0,45%	0,09%	0,07%	0,00%
NMVOC:s						
NMVOC						
NMVOC, diesel engines		7,24E-04	1,92E-03	3,89E-04	2,90E-04	
NMVOC, el-coal		4,76E-04	1,26E-03	2,56E-04	1,90E-04	
NMVOC, natural gas combustion						
NMVOC, oil combustion						
NMVOC, petrol engines		9,24E-14	2,45E-13	4,97E-14	3,69E-14	
NMVOC, power plants		2,30E-04	6,09E-04	1,23E-04	9,19E-05	
Total NMVOC	0,00E+00	1,43E-03	3,79E-03	7,68E-04	5,72E-04	0,00E+00
Total NMVOC relative	0,00%	0,00%	0,01%	0,00%	0,00%	0,00%
VOC:s						
HC		1,41E-03	3,75E-03	7,60E-04	5,66E-04	
VOC						
VOC, coal combustion		1,24E-05	3,29E-05	6,67E-06	4,96E-06	
VOC, diesel engines		3,42E-04	9,07E-04	1,84E-04	1,37E-04	
VOC, natural gas combustion		9,67E-13	2,56E-12	5,20E-13	3,87E-13	
Total VOC	0,00E+00	1,76E-03	4,69E-03	9,51E-04	7,08E-04	0,00E+00
Total VOC relative	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
"Other specified hydrocarbons"						
Acetaldehyde						
Acetylene						
Aldehydes		3,10E-07	8,20E-07	1,66E-07	1,24E-07	
Alkanes						
Alkenes						
Aromates (C9-C10)		4,53E-06	1,20E-05	2,44E-06	1,81E-06	
Butane						
CH_4		1,23E-01	3,26E-01	6,61E-02	4,92E-02	
Ethane						
Ethene						
Formaldehyde						
PAH		6,20E-10	1,64E-09	3,33E-10	2,48E-10	
Pentane						
Propane						
Propene						
Xylene						
Total "other"	0,00E+00	1,23E-01	3,26E-01	6,61E-02	4,92E-02	0,00E+00
Total "other" relative	0,00%	0,05%	0,13%	0,03%	0,02%	0,00%

D.1 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	48. Alt. energy production	49. Energy use	50. Alt. energy production	Total
CO2	-6,74E+03		-4,52E+03	7,73E+04
CO2 relative	-8,72%	0,00%	-5,85%	100,00%
SO2	-5,78E+00		-3,88E+00	2,75E+02
SO2 relative	-2,10%	0,00%	-1,41%	100,00%
NOx	-8,44E+00		-5,66E+00	4,36E+02
NOx relative	-1,94%	0,00%	-1,30%	100,00%
NMVOC:s				
NMVOC	-9,66E+00		-6,48E+00	4,05E+01
NMVOC, diesel engines	-2,47E-02		-1,66E-02	3,04E+01
NMVOC, el-coal	-1,62E-02		-1,09E-02	6,08E-01
NMVOC, natural gas combustion				
NMVOC, oil combustion				1,56E+00
NMVOC, petrol engines	-3,15E-12		-2,12E-12	1,18E-10
NMVOC, power plants	-7,84E-03		-5,26E-03	2,94E-01
Total NMVOC	-9,71E+00	0,00E+00	-6,51E+00	7,34E+01
Total NMVOC relative	-13,24%	0,00%	-8,88%	100,00%
VOC:s				
HC	-4,83E-02		-3,24E-02	1,88E+02
VOC				1,14E+00
VOC, coal combustion	-4,24E-04		-2,84E-04	1,59E-02
VOC, diesel engines	-1,17E-02		-7,84E-03	4,38E-01
VOC, natural gas combustion	-3,30E-11		-2,21E-11	1,24E-09
Total VOC	-6,04E-02	0,00E+00	-4,05E-02	1,89E+02
Total VOC relative	-0,03%	0,00%	-0,02%	100,00%
"Other specified hydrocarbons"				
Acetaldehyde	-3,13E-05		-2,10E-05	4,27E-02
Acetylene	-1,88E-03		-1,26E-03	-3,12E-03
Aldehydes	-1,06E-05		-7,09E-06	3,96E-04
Alkanes	-4,70E-02		-3,15E-02	-7,42E-02
Alkenes	-3,76E-03		-2,52E-03	-6,23E-03
Aromates (C9-C10)	-3,91E-03		-2,62E-03	4,88E-04
Butane	-2,19E-02		-1,47E-02	4,30E-02
CH4	-9,15E+00		-6,14E+00	2,43E+02
Ethane	-3,76E-03		-2,52E-03	-6,23E-03
Ethene	-9,40E-03		-6,30E-03	-1,56E-02
Formaldehyde	-4,26E-03		-2,86E-03	7,03E-03
PAH	-3,35E-04		-2,24E-04	5,82E-04
Pentane	-3,76E-02		-2,52E-02	7,36E-02
Propane	-1,19E-02		-7,98E-03	3,11E-03
Propene	-3,76E-03		-2,52E-03	-6,23E-03
Xylene				
Total "other"	-9,30E+00	0,00E+00	-6,24E+00	2,43E+02
Total "other" relative	-3,82%	0,00%	-2,57%	100,00%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	1. PET-resin	Trp 1	2. Preform production	Trp 2	3. Bottle production	Trp 3	4. Washing & filling	5. Packaging
CO2	8,71E+03	5,87E+01		1,57E+02	7,52E+03	1,96E+01	2,76E+04	
CO2 relative	13,50%	0,09%	0,00%	0,24%	11,66%	0,03%	42,79%	0,00%
SO2	8,81E+01	6,56E-02		1,75E-01	6,25E+01	2,19E-02	3,60E+01	
SO2 relative	45,55%	0,03%	0,00%	0,09%	32,30%	0,01%	18,60%	0,00%
NOx	7,20E+01	5,59E-01		1,49E+00	2,40E+01	1,86E-01	6,33E+01	
NOx relative	19,52%	0,15%	0,00%	0,40%	6,51%	0,05%	17,17%	0,00%
NMVOC:s								
NMVOC		1,43E-01		3,81E-01		4,76E-02	1,65E-01	
NMVOC, diesel engines	1,79E-02	5,68E-02		1,51E-01	5,93E-02	1,89E-02	6,59E-01	
NMVOC, el-coal	1,18E-02				3,90E-02		4,33E-01	
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines	2,28E-12				7,57E-12		8,41E-11	
NMVOC, power plants	5,68E-03				1,88E-02		2,09E-01	
Total NMVOC	3,54E-02	2,00E-01	0,00E+00	5,32E-01	1,17E-01	6,65E-02	1,47E+00	0,00E+00
Total NMVOC relative	0,05%	0,27%	0,00%	0,73%	0,16%	0,09%	2,01%	0,00%
VOC:s								
HC	1,39E+02				4,65E+00		1,29E+00	
VOC								
VOC, coal combustion	3,07E-04				1,02E-03		1,13E-02	
VOC, diesel engines	8,46E-03				2,81E-02		3,12E-01	
VOC, natural gas combustion	2,39E-11				7,92E-11		8,80E-10	
Total VOC	1,39E+02	0,00E+00	0,00E+00	0,00E+00	4,68E+00	0,00E+00	1,61E+00	0,00E+00
Total VOC relative	120,30%	0,00%	0,00%	0,00%	4,03%	0,00%	1,39%	0,00%
"Other specified hydrocarbons"								
Acetaldehyde							9,69E-05	
Acetylene								
Aldehydes	7,65E-06				2,54E-05		2,82E-04	
Alkanes								
Alkenes								
Aromates (C9-C10)	1,12E-04				3,71E-04		4,12E-03	
Butane							6,78E-02	
CH4	3,04E+00	7,38E-02		1,97E-01	1,01E+01	2,46E-02	1,12E+02	
Ethane								
Ethene								
Formaldehyde							9,69E-03	
PAH	1,53E-08				5,08E-08		9,70E-04	
Pentane							1,16E-01	
Propane							1,94E-02	
Propene								
Xylene								
Total "other"	3,04E+00	7,38E-02	0,00E+00	1,97E-01	1,01E+01	2,46E-02	1,13E+02	0,00E+00
Total "other" relative	1,58%	0,04%	0,00%	0,10%	5,25%	0,01%	58,57%	0,00%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	6. Caps+inserts	Trp 4	7. PP-production	Trp 5	8. LDPE-production	Trp 6	9. Inserts	10. Secondary packaging
CO2	2,10E+03	2,62E+01	1,47E+03	2,25E+01	1,67E+02	2,25E+00		
CO2 relative	3,26%	0,04%	2,28%	0,03%	0,26%	0,00%	0,00%	0,00%
SO2	3,50E+00	2,92E-02	1,47E+01	2,52E-02	1,20E+00	2,52E-03		
SO2 relative	1,81%	0,02%	7,61%	0,01%	0,62%	0,00%	0,00%	0,00%
NOx	5,59E+00	2,49E-01	1,34E+01	2,14E-01	1,61E+00	2,14E-02		
NOx relative	1,51%	0,07%	3,63%	0,06%	0,44%	0,01%	0,00%	0,00%
NMVOC:s								
NMVOC		6,37E-02		5,49E-02		5,49E-03		
NMVOC, diesel engines	6,42E-02	2,53E-02		2,18E-02		2,18E-03		
NMVOC, el-coal	4,22E-02							
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines	8,20E-12							
NMVOC, power plants	2,04E-02							
Total NMVOC	1,27E-01	8,90E-02	0,00E+00	7,67E-02	0,00E+00	7,67E-03	0,00E+00	0,00E+00
Total NMVOC relative	0,17%	0,12%	0,00%	0,10%	0,00%	0,01%	0,00%	0,00%
VOC:s								
HC	1,26E-01		1,74E+01		2,81E+00			
VOC								
VOC, coal combustion	1,10E-03							
VOC, diesel engines	3,04E-02							
VOC, natural gas combustion	8,58E-11							
Total VOC	1,58E-01	0,00E+00	1,74E+01	0,00E+00	2,81E+00	0,00E+00	0,00E+00	0,00E+00
Total VOC relative	0,14%	0,00%	15,00%	0,00%	2,42%	0,00%	0,00%	0,00%
"Other specified hydrocarbons"								
Acetaldehyde								
Acetylene								
Aldehydes	2,75E-05							
Alkanes								
Alkenes								
Aromates (C9-C10)	4,02E-04							
Butane								
CH4	1,09E+01	3,29E-02		2,83E-02		2,83E-03		
Ethane								
Ethene								
Formaldehyde								
PAH	5,50E-08							
Pentane								
Propane								
Propene								
Xylene								
Total "other"	1,09E+01	3,29E-02	0,00E+00	2,83E-02	0,00E+00	2,83E-03	0,00E+00	0,00E+00
Total "other" relative	5,68%	0,02%	0,00%	0,01%	0,00%	0,00%	0,00%	0,00%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	Trp 7	11. Cardboard	Trp 8	12. Multipack-Cardboard	13. LDPE-production	Trp 9	14. Multipack-LDPE
CO2	1,88E+01	2,12E+02	3,38E+00		2,05E+02	2,76E+00	
CO2 relative	0,03%	0,33%	0,01%	0,00%	0,32%	0,00%	0,00%
SO2	2,10E-02	4,41E-01	3,78E-03		1,48E+00	3,09E-03	
SO2 relative	0,01%	0,23%	0,00%	0,00%	0,76%	0,00%	0,00%
NOx	1,79E-01	1,08E+00	3,22E-02		1,97E+00	2,63E-02	
NOx relative	0,05%	0,29%	0,01%	0,00%	0,53%	0,01%	0,00%
NMVOC:s							
NMVOC	4,57E-02	1,02E-01	8,23E-03			6,73E-03	
NMVOC, diesel engines	1,81E-02	5,03E-02	3,27E-03			2,67E-03	
NMVOC, el-coal		2,42E-03					
NMVOC, natural gas combustion							
NMVOC, oil combustion		9,46E-02					
NMVOC, petrol engines		4,70E-13					
NMVOC, power plants		1,17E-03					
Total NMVOC	6,38E-02	2,50E-01	1,15E-02	0,00E+00	0,00E+00	9,40E-03	0,00E+00
Total NMVOC relative	0,09%	0,34%	0,02%	0,00%	0,00%	0,01%	0,00%
VOC:s							
HC		7,20E-03			3,45E+00		
VOC							
VOC, coal combustion		6,32E-05					
VOC, diesel engines		1,74E-03					
VOC, natural gas combustion		4,92E-12					
Total VOC	0,00E+00	9,00E-03	0,00E+00	0,00E+00	3,45E+00	0,00E+00	0,00E+00
Total VOC relative	0,00%	0,01%	0,00%	0,00%	2,97%	0,00%	0,00%
"Other specified hydrocarbons"							
Acetaldehyde							
Acetylene							
Aldehydes		1,58E-06					
Alkanes							
Alkenes							
Aromates (C9-C10)		2,31E-05					
Butane							
CH4	2,36E-02	7,27E-01	4,25E-03			3,48E-03	
Ethane							
Ethene							
Formaldehyde							
PAH		3,16E-09					
Pentane							
Propane							
Propene							
Xylene							
Total "other"	2,36E-02	7,27E-01	4,25E-03	0,00E+00	0,00E+00	3,48E-03	0,00E+00
Total "other" relative	0,01%	0,38%	0,00%	0,00%	0,00%	0,00%	0,00%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	15. New crate/tray	16. Paper production	Trp 10	17. Label printing	Trp 11	18. Glue production	Trp 12
CO_2	3,31E+02	8,92E+02	1,52E+01	3,33E+02	9,39E+00	4,16E+01	3,39E+00
CO_2 relative	0,51%	1,38%	0,02%	0,52%	0,01%	0,06%	0,01%
SO_2	5,51E-01	2,09E+00	1,69E-02	5,54E-01	1,05E-02	6,72E-02	3,79E-03
SO_2 relative	0,28%	1,08%	0,01%	0,29%	0,01%	0,03%	0,00%
NO_x	8,79E-01	3,58E+00	1,44E-01	8,84E-01	8,93E-02	1,38E-01	3,23E-02
NO_x relative	0,24%	0,97%	0,04%	0,24%	0,02%	0,04%	0,01%
NMVOC:s							
NMVOC		8,92E-02	3,69E-02		2,29E-02	9,68E-03	8,25E-03
NMVOC, diesel engines	1,01E-02	7,72E-02	1,47E-02	1,02E-02	9,07E-03	5,00E-03	3,28E-03
NMVOC, el-coal	6,65E-03	1,14E-02		6,68E-03		7,56E-04	
NMVOC, natural gas combustion							
NMVOC, oil combustion		6,24E-01					
NMVOC, petrol engines	1,29E-12	2,22E-12		1,30E-12		1,47E-13	
NMVOC, power plants	3,21E-03	5,52E-03		3,23E-03		3,65E-04	
Total NMVOC	2,00E-02	8,07E-01	5,16E-02	2,01E-02	3,20E-02	1,58E-02	1,15E-02
Total NMVOC relative	0,03%	1,10%	0,07%	0,03%	0,04%	0,02%	0,02%
VOC:s							
HC	1,98E-02	3,40E-02		1,99E-02		2,25E-03	
VOC				5,00E-01			
VOC, coal combustion	1,73E-04	2,98E-04		1,74E-04		1,97E-05	
VOC, diesel engines	4,78E-03	8,22E-03		4,81E-03		5,45E-04	
VOC, natural gas combustion	1,35E-11	2,32E-11		1,36E-11		1,54E-12	
Total VOC	2,48E-02	4,25E-02	0,00E+00	5,25E-01	0,00E+00	2,81E-03	0,00E+00
Total VOC relative	0,02%	0,04%	0,00%	0,45%	0,00%	0,00%	0,00%
"Other specified hydrocarbons"							
Acetaldehyde							
Acetylene							
Aldehydes	4,33E-06	7,44E-06		4,35E-06		4,92E-07	
Alkanes		1,62E-03					
Alkenes							
Aromates (C9-C10)	6,33E-05	5,14E-04		6,36E-05		7,21E-06	
Butane							
CH_4	1,72E+00	3,32E+00	1,91E-02	1,73E+00	1,18E-02	2,01E-01	4,26E-03
Ethane							
Ethene							
Formaldehyde		1,22E-03					
PAH	8,66E-09	1,36E-06		8,71E-09		9,86E-10	
Pentane							
Propane		8,10E-05					
Propene							
Xylene							
Total "other"	1,72E+00	3,33E+00	1,91E-02	1,73E+00	1,18E-02	2,01E-01	4,26E-03
Total "other" relative	0,89%	1,73%	0,01%	0,90%	0,01%	0,10%	0,00%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	19. Transport packaging	Trp 13	20. Planks for pallets	Trp 14	21. Pallets	22. LDPE-production	Trp 15	23. Plastic ligature
CO2		5,55E+01	6,87E+02	5,45E+01		6,96E+01	9,38E-01	
CO2 relative	0,00%	0,09%	1,07%	0,08%	0,00%	0,11%	0,00%	0,00%
SO2		6,19E-02	1,05E+00	6,08E-02		5,01E-01	1,05E-03	
SO2 relative	0,00%	0,03%	0,54%	0,03%	0,00%	0,26%	0,00%	0,00%
NOx		5,27E-01	4,21E+00	5,18E-01		6,68E-01	8,92E-03	
NOx relative	0,00%	0,14%	1,14%	0,14%	0,00%	0,18%	0,00%	0,00%
NMVOC:s								
NMVOC		1,35E-01	7,66E-01	1,33E-01			2,28E-03	
NMVOC, diesel engines		5,36E-02	4,59E-01	5,26E-02			9,06E-04	
NMVOC, el-coal			7,46E-03					
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines			1,45E-12					
NMVOC, power plants			3,60E-03					
Total NMVOC	0,00E+00	1,89E-01	1,24E+00	1,86E-01	0,00E+00	0,00E+00	3,19E-03	0,00E+00
Total NMVOC relative	0,00%	0,26%	1,69%	0,25%	0,00%	0,00%	0,00%	0,00%
VOC:s								
HC			1,77E+00			1,17E+00		
VOC								
VOC, coal combustion			1,95E-04					
VOC, diesel engines			5,37E-03					
VOC, natural gas combustion			1,52E-11					
Total VOC	0,00E+00	0,00E+00	1,78E+00	0,00E+00	0,00E+00	1,17E+00	0,00E+00	0,00E+00
Total VOC relative	0,00%	0,00%	1,53%	0,00%	0,00%	1,01%	0,00%	0,00%
"Other specified hydrocarbons"								
Acetaldehyde								
Acetylene			3,25E-05					
Aldehydes			4,86E-06					
Alkanes			8,09E-04					
Alkenes			6,47E-05					
Aromates (C9-C10)			1,36E-04					
Butane								
CH4		6,97E-02	2,33E+00	6,85E-02			1,18E-03	
Ethane			6,47E-05					
Ethene			1,62E-04					
Formaldehyde			1,94E-05					
PAH			3,80E-07					
Pentane								
Propane			9,71E-05					
Propene			6,47E-05					
Xylene								
Total "other"	0,00E+00	6,97E-02	2,33E+00	6,85E-02	0,00E+00	0,00E+00	1,18E-03	0,00E+00
Total "other" relative	0,00%	0,04%	1,21%	0,04%	0,00%	0,00%	0,00%	0,00%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	Trp 16	24. Grinding	Trp 17	25. Baling	26. Recycling	27. New product	28. PET-production (avoided)	29. Recycling (avoided)
CO2	5,05E+00	2,59E+01	9,64E+01	3,67E+01	4,00E+02		-2,86E+03	-2,00E+02
CO2 relative	0,01%	0,04%	0,15%	0,06%	0,62%	0,00%	-4,43%	-0,31%
SO2	5,64E-03	4,32E-02	1,08E-01	6,12E-02	3,83E-01		-3,07E+01	-1,91E-01
SO2 relative	0,00%	0,02%	0,06%	0,03%	0,20%	0,00%	-15,85%	-0,10%
NOx	4,81E-02	6,88E-02	9,18E-01	9,76E-02	7,78E-01		-2,48E+01	-3,89E-01
NOx relative	0,01%	0,02%	0,25%	0,03%	0,21%	0,00%	-6,72%	-0,11%
NMVOC:s								
NMVOC	1,23E-02		2,35E-01		4,69E-03			-2,35E-03
NMVOC, diesel engines	4,88E-03	7,91E-04	9,32E-02	1,12E-03	6,98E-03			-3,49E-03
NMVOC, el-coal		5,20E-04		7,38E-04	4,59E-03			-2,29E-03
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines		1,01E-13		1,43E-13	8,91E-13			-4,45E-13
NMVOC, power plants		2,51E-04		3,56E-04	2,21E-03			-1,11E-03
Total NMVOC	1,72E-02	1,56E-03	3,28E-01	2,21E-03	1,85E-02	0,00E+00	0,00E+00	-9,24E-03
Total NMVOC relative	0,02%	0,00%	0,45%	0,00%	0,03%	0,00%	0,00%	-0,01%
VOC:s								
HC		1,55E-03		2,19E-03	1,36E-02		-4,91E+01	-6,82E-03
VOC								
VOC, coal combustion		1,36E-05		1,92E-05	1,20E-04			-5,98E-05
VOC, diesel engines		3,74E-04		5,31E-04	3,30E-03			-1,65E-03
VOC, natural gas combustion		1,06E-12		1,50E-12	9,32E-12			-4,66E-12
Total VOC	0,00E+00	1,94E-03	0,00E+00	2,74E-03	1,70E-02	0,00E+00	-4,91E+01	-8,53E-03
Total VOC relative	0,00%	0,00%	0,00%	0,00%	0,01%	0,00%	-42,32%	-0,01%
"Other specified hydrocarbons"								
Acetaldehyde					5,64E-02			-2,82E-02
Acetylene								
Aldehydes		3,38E-07		4,80E-07	2,99E-06			-1,49E-06
Alkanes								
Alkenes								
Aromates (C9-C10)		4,95E-06		7,03E-06	4,37E-05			-2,18E-05
Butane					1,93E-03			-9,66E-04
CH4	6,35E-03	1,35E-01	1,21E-01	1,91E-01	1,20E+00			-5,99E-01
Ethane								
Ethene								
Formaldehyde					2,76E-04			-1,38E-04
PAH		6,78E-10		9,62E-10	2,76E-05			-1,38E-05
Pentane					3,31E-03			-1,66E-03
Propane					5,52E-04			-2,76E-04
Propene								
Xylene								
Total "other"	6,35E-03	1,35E-01	1,21E-01	1,91E-01	1,26E+00	0,00E+00	0,00E+00	-6,30E-01
Total "other" relative	0,00%	0,07%	0,06%	0,10%	0,66%	0,00%	0,00%	-0,33%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	30. Other product	31. PET-landfill	Trp 18	32. Paper incineration	Trp 19	33. Wood incineration	Trp 20	34. PP-recycling
CO2		3,20E+01	1,88E+00	2,20E+01	1,09E+01	1,27E+02		6,42E+02
CO2 relative	0,00%	0,05%	0,00%	0,03%	0,02%	0,20%	0,00%	1,00%
SO2		4,35E-03	2,10E-03	3,66E-02	1,21E-02	2,12E-01		1,07E+00
SO2 relative	0,00%	0,00%	0,00%	0,02%	0,01%	0,11%	0,00%	0,55%
NOx		3,48E-02	1,79E-02	6,92E-01	1,03E-01	4,01E+00		1,71E+00
NOx relative	0,00%	0,01%	0,00%	0,19%	0,03%	1,09%	0,00%	0,46%
NMVOC:s								
NMVOC		8,76E-03	4,57E-03		2,64E-02			
NMVOC, diesel engines		7,30E-03	1,81E-03	6,71E-04	1,05E-02	3,88E-03		1,96E-02
NMVOC, el-coal		3,98E-06		4,41E-04		2,55E-03		1,29E-02
NMVOC, natural gas combustion								
NMVOC, oil combustion								
NMVOC, petrol engines		7,74E-16		8,57E-14		4,96E-13		2,50E-12
NMVOC, power plants		1,92E-06		2,13E-04		1,23E-03		6,23E-03
Total NMVOC	0,00E+00	1,61E-02	6,38E-03	1,33E-03	3,69E-02	7,66E-03	0,00E+00	3,87E-02
Total NMVOC relative	0,00%	0,02%	0,01%	0,00%	0,05%	0,01%	0,00%	0,05%
VOC:s								
HC		1,18E-05		1,31E-03		7,59E-03		3,84E-02
VOC								
VOC, coal combustion		1,04E-07		1,15E-05		6,66E-05		3,36E-04
VOC, diesel engines		2,87E-06		3,18E-04		1,84E-03		9,28E-03
VOC, natural gas combustion		8,10E-15		8,97E-13		5,19E-12		2,62E-11
Total VOC	0,00E+00	1,48E-05	0,00E+00	1,64E-03	0,00E+00	9,50E-03	0,00E+00	4,80E-02
Total VOC relative	0,00%	0,00%	0,00%	0,00%	0,00%	0,01%	0,00%	0,04%
"Other specified hydrocarbons"								
Acetaldehyde								
Acetylene								
Aldehydes		2,59E-09		2,87E-07		1,66E-06		8,39E-06
Alkanes								
Alkenes								
Aromates (C9-C10)		3,79E-08		4,20E-06		2,43E-05		1,23E-04
Butane								
CH4		9,82E+00	2,36E-03	1,14E-01	1,37E-02	6,60E-01		3,34E+00
Ethane								
Ethene								
Formaldehyde								
PAH		5,19E-12		5,75E-10		3,33E-09		1,68E-08
Pentane								
Propane								
Propene								
Xylene								
Total "other"	0,00E+00	9,82E+00	2,36E-03	1,14E-01	1,37E-02	6,60E-01	0,00E+00	3,34E+00
Total "other" relative	0,00%	5,11%	0,00%	0,06%	0,01%	0,34%	0,00%	1,74%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	35. New product	36. PP-production (avoided)	37. PP-recycling (avoided)	38. Other products	39. PP-landfill
CO2		-6,85E+02	-3,21E+02		1,69E+01
CO2 relative	0,00%	-1,06%	-0,50%	0,00%	0,03%
SO2		-6,85E+00	-5,35E-01		2,21E-03
SO2 relative	0,00%	-3,54%	-0,28%	0,00%	0,00%
NOx		-6,23E+00	-8,53E-01		1,76E-02
NOx relative	0,00%	-1,69%	-0,23%	0,00%	0,00%
NMVOC:s					
NMVOC					4,45E-03
NMVOC, diesel engines			-9,81E-03		3,71E-03
NMVOC, el-coal			-6,45E-03		2,02E-06
NMVOC, natural gas combustion					
NMVOC, oil combustion					
NMVOC, petrol engines			-1,25E-12		3,93E-16
NMVOC, power plants			-3,11E-03		9,76E-07
Total NMVOC	0,00E+00	0,00E+00	-1,94E-02	0,00E+00	8,16E-03
Total NMVOC relative	0,00%	0,00%	-0,03%	0,00%	0,01%
VOC:s					
HC		-8,10E+00	-1,92E-02		6,02E-06
VOC					
VOC, coal combustion			-1,68E-04		5,27E-08
VOC, diesel engines			-4,64E-03		1,46E-06
VOC, natural gas combustion			-1,31E-11		4,11E-15
Total VOC	0,00E+00	-8,10E+00	-2,40E-02	0,00E+00	7,53E-06
Total VOC relative	0,00%	-6,98%	-0,02%	0,00%	0,00%
"Other specified hydrocarbons"					
Acetaldehyde					
Acetylene					
Aldehydes			-4,20E-06		1,32E-09
Alkanes					
Alkenes					
Aromates (C9-C10)			-6,14E-05		1,93E-08
Butane					
CH4			-1,67E+00		1,62E+01
Ethane					
Ethene					
Formaldehyde					
PAH			-8,41E-09		2,64E-12
Pentane					
Propane					
Propene					
Xylene					
Total "other"	0,00E+00	0,00E+00	-1,67E+00	0,00E+00	1,62E+01
Total "other" relative	0,00%	0,00%	-0,87%	0,00%	8,43%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	Trp 21 (Distribution of beverage)	40. Retailers	Trp 22 (Return)	Trp 23	41. Use (refrigeration)	Trp 24	Trp 25
CO2	2,14E+04				3,20E-02		5,60E+00
CO2 relative	33,18%	0,00%	0,00%	0,00%	0,00%	0,00%	0,01%
SO2	2,39E+01				5,34E-05		6,25E-03
SO2 relative	12,36%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
NOx	2,04E+02				8,52E-05		5,33E-02
NOx relative	55,27%	0,00%	0,00%	0,00%	0,00%	0,00%	0,01%
NMVOC:s							
NMVOC	5,21E+01						1,36E-02
NMVOC, diesel engines	2,75E+01				9,79E-07		5,41E-03
NMVOC, el-coal					6,44E-07		
NMVOC, natural gas combustion							
NMVOC, oil combustion							
NMVOC, petrol engines					1,25E-16		
NMVOC, power plants					3,11E-07		
Total NMVOC	7,96E+01	0,00E+00	0,00E+00	0,00E+00	1,93E-06	0,00E+00	1,90E-02
Total NMVOC relative	108,92%	0,00%	0,00%	0,00%	0,00%	0,00%	0,03%
VOC:s							
HC					1,91E-06		
VOC							
VOC, coal combustion					1,68E-08		
VOC, diesel engines					4,63E-07		
VOC, natural gas combustion					1,31E-15		
Total VOC	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,39E-06	0,00E+00	0,00E+00
Total VOC relative	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
"Other specified hydrocarbons"							
Acetaldehyde							
Acetylene							
Aldehydes					4,19E-10		
Alkanes							
Alkenes							
Aromates (C9-C10)					6,13E-09		
Butane							
CH4	2,72E+01				1,66E-04		7,04E-03
Ethane							
Ethene							
Formaldehyde							
PAH					8,39E-13		
Pentane							
Propane							
Propene							
Xylene							
Total "other"	2,72E+01	0,00E+00	0,00E+00	0,00E+00	1,66E-04	0,00E+00	7,04E-03
Total "other" relative	14,14%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	42. Waste management	43. PP-incineration	44. PET-incineration	45. PE-incineration	46. Cardboard incineration	47. Energy use
CO2		6,08E+02	2,51E+03	6,18E+02	6,50E+00	
CO2 relative	0,00%	0,94%	3,89%	0,96%	0,01%	0,00%
SO2		1,35E-02	7,11E-02	1,38E-02	1,08E-02	
SO2 relative	0,00%	0,01%	0,04%	0,01%	0,01%	0,00%
NOx		2,56E-01	1,34E+00	2,60E-01	2,05E-01	
NOx relative	0,00%	0,07%	0,36%	0,07%	0,06%	0,00%
NMVOC:s						
NMVOC						
NMVOC, diesel engines		2,48E-04	1,30E-03	2,52E-04	1,99E-04	
NMVOC, el-coal		1,63E-04	8,57E-04	1,66E-04	1,31E-04	
NMVOC, natural gas combustion						
NMVOC, oil combustion						
NMVOC, petrol engines		3,17E-14	1,66E-13	3,22E-14	2,53E-14	
NMVOC, power plants		7,88E-05	4,14E-04	8,01E-05	6,30E-05	
Total NMVOC	0,00E+00	4,90E-04	2,57E-03	4,98E-04	3,93E-04	0,00E+00
Total NMVOC relative	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
VOC:s						
HC		4,85E-04	2,55E-03	4,93E-04	3,88E-04	
VOC						
VOC, coal combustion		4,26E-06	2,23E-05	4,33E-06	3,40E-06	
VOC, diesel engines		1,17E-04	6,17E-04	1,19E-04	9,40E-05	
VOC, natural gas combustion		3,32E-13	1,74E-12	3,37E-13	2,65E-13	
Total VOC	0,00E+00	6,06E-04	3,19E-03	6,16E-04	4,85E-04	0,00E+00
Total VOC relative	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
"Other specified hydrocarbons"						
Acetaldehyde						
Acetylene						
Aldehydes		1,06E-07	5,58E-07	1,08E-07	8,50E-08	
Alkanes						
Alkenes						
Aromates (C9-C10)		1,55E-06	8,16E-06	1,58E-06	1,24E-06	
Butane						
CH4		4,22E-02	2,22E-01	4,29E-02	3,38E-02	
Ethane						
Ethene						
Formaldehyde						
PAH		2,13E-10	1,12E-09	2,16E-10	1,70E-10	
Pentane						
Propane						
Propene						
Xylene						
Total "other"	0,00E+00	4,22E-02	2,22E-01	4,29E-02	3,38E-02	0,00E+00
Total "other" relative	0,00%	0,02%	0,12%	0,02%	0,02%	0,00%

D.2 Inventory results for important air emissions [per 1000 litres of beverage]: 50 cl refillable PET bottles

Inventory results per 1000 litres	48. Alt. energy production	49. Energy use	50. Alt. energy production	Total
CO2	-3,92E+03		-4,83E+03	6,45E+04
CO2 relative	-6,08%	0,00%	-7,49%	100,00%
SO2	-3,37E+00		-4,15E+00	1,93E+02
SO2 relative	-1,74%	0,00%	-2,14%	100,00%
NOx	-4,91E+00		-6,05E+00	3,69E+02
NOx relative	-1,33%	0,00%	-1,64%	100,00%
NMVOC:s				
NMVOC	-5,62E+00		-6,93E+00	4,21E+01
NMVOC, diesel engines	-1,44E-02		-1,77E-02	2,94E+01
NMVOC, el-coal	-9,45E-03		-1,16E-02	5,54E-01
NMVOC, natural gas combustion				
NMVOC, oil combustion				7,18E-01
NMVOC, petrol engines	-1,84E-12		-2,26E-12	1,08E-10
NMVOC, power plants	-4,56E-03		-5,62E-03	2,68E-01
Total NMVOC	-5,65E+00	0,00E+00	-6,96E+00	7,31E+01
Total NMVOC relative	-7,74%	0,00%	-9,53%	100,00%
VOC:s				
HC	-2,81E-02		-3,46E-02	1,15E+02
VOC				5,00E-01
VOC, coal combustion	-2,47E-04		-3,04E-04	1,45E-02
VOC, diesel engines	-6,80E-03		-8,38E-03	3,99E-01
VOC, natural gas combustion	-1,92E-11		-2,37E-11	1,13E-09
Total VOC	-3,51E-02	0,00E+00	-4,33E-02	1,16E+02
Total VOC relative	-0,03%	0,00%	-0,04%	100,00%
"Other specified hydrocarbons"				
Acetaldehyde	-1,82E-05		-2,24E-05	2,83E-02
Acetylene	-1,09E-03		-1,35E-03	-2,41E-03
Aldehydes	-6,15E-06		-7,58E-06	3,61E-04
Alkanes	-2,73E-02		-3,37E-02	-5,86E-02
Alkenes	-2,19E-03		-2,69E-03	-4,82E-03
Aromates (C9-C10)	-2,28E-03		-2,81E-03	8,70E-04
Butane	-1,27E-02		-1,57E-02	4,04E-02
CH4	-5,33E+00		-6,56E+00	1,92E+02
Ethane	-2,19E-03		-2,69E-03	-4,82E-03
Ethene	-5,47E-03		-6,74E-03	-1,20E-02
Formaldehyde	-2,48E-03		-3,05E-03	5,53E-03
PAH	-1,95E-04		-2,40E-04	5,51E-04
Pentane	-2,19E-02		-2,69E-02	6,92E-02
Propane	-6,92E-03		-8,53E-03	4,39E-03
Propene	-2,19E-03		-2,69E-03	-4,82E-03
Xylene				
Total "other"	-5,41E+00	0,00E+00	-6,67E+00	1,92E+02
Total "other" relative	-2,82%	0,00%	-3,47%	100,00%

DATA SHEET

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Abstract:
This report is part of a life cycle assessment (LCA) comparing the potential environmental impacts associated with different existing or alternative packaging systems for beer and carbonated soft drinks that are filled and sold in Denmark. The study compares refillable and disposable glass and PET bottles and steel and aluminium cans and is an update of a previous study carried out in 1992-1996. This report is the technical report on refillable PET bottles.

Terms:
life cycle assessment; packaging systems; beer; soft drinks; recycling; PET bottles

Supplementary notes:
The project comprises the main report (Environmental Project, 399), and 7 supplementary reports:
Refillable Glass Bottles (Environmental Project, 400), Disposable Glass Bottles (Environmental Project, 401),
Aluminium Cans (Environmental Project, 402), Steel Cans (Environmental Project, 403),
Refillable PET Bottles (Miljøprojekt, 404), Disposable PET Bottles (Miljøprojekt, 405),
Energy and Transport Scenarios (Miljøprojekt, 406).
The previous reports were published in Danish: Miljømæssig kortlægning af emballager til øl og læskedrikke (Arbejdsrapport fra Miljøstyrelsen, 62/1995 and 70 - 76/1995),
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Titel:
Life Cycle Assessment of Packaging Systems for Beer and Soft Drinks : Refillable PET Bottles

Undertitel:
Technical Report 5

Forfatter(e):
Person, Lisa; Ekvall, Thomas; Weidema, Bo Pedersen

Udførende institution(er):
Chalmers Industriteknik; Instituttet for Produktudvikling

Resumé:
Rapporten er en del af en livscyklusvurdering, hvor potentielle miljøeffekter fra forskellige eksisterende og alternative emballagesystemer til øl og læskedrikke, påfyldt og solgt i Danmark, sammenlignes. Miljøvurderingen sammenligner retur- og engangsflasker af hhv. glas og PET samt aluminiums- og ståldåser. Denne delrapport handler om genpåfyldelige PET-flasker.

Emneord:
livscyklusvurdering; emballage; drikkevarer; øl; polyetylentereptalater; genanvendelse

Andre oplysninger:
Hører sammen med en hovedrapport: Main Report (Miljøprojekt, 399),
5 andre tekniske delrapporter om de enkelte emballagetyper:
Refillable Glass Bottles (Miljøprojekt, 400), Disposable Glass Bottles (Miljøprojekt, 401),
Aluminium Cans (Miljøprojekt, 402), Steel Cans (Miljøprojekt, 403),
Disposable PET Bottles (Miljøprojekt, 405) og en delrapport om de anvendte energi- og transportscenarier: Energy and Transport Scenarios (Miljøprojekt, 406).
Opdatering af: Miljømæssig kortlægning af emballager til øl og læskedrikke
(Arbejdsrapport fra Miljøstyrelsen, 62/1995 og 70/1995-76/1995) og
Miljøvurdering af emballager til øl og læskedrikke (Arbejdsrapport fra Miljøstyrelsen, 21/1996)

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This report is part of a life cycle assessment (LCA) comparing the potential environmental impacts associated with different existing or alternative packaging systems for beer and carbonated soft drinks that are filled and sold in Denmark. The study compares refillable and disposable glass and PET bottles and steel and aluminium cans and is an update of a previous study carried out in 1992-1996. This report is the technical report on refillable PET bottles.

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