GUA - Gesellschaft für umfassende Analysen

Corporation for Comprehensive Analysis

Gesellschaft für Verpackungsmarktforschung

Sustainable beverage packaging management in Hungary

Analysis of environmental and economic impacts of a unit-based product fee regulation on beverage packaging

Final Report

Vienna, September 2004

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EXECUTIVE SUMMARY

Goal and scope of study

Sustainable development has become a broadly accepted concept to maintain and improve quality of life for this and future generations in a comprehensive way. A crucial part of this concept is the recognition that environment, economy and social aspects are three dimensions, which are often interlinked and which determine the sustainability of activities and measures. Therefore, to realise progress on the way of sustainable development, effects in all three dimensions have to be considered when different strategies are compared and political measures are discussed. Based on the same principles, the recently revised Packaging Directive of the European Union stresses in different passages that new strategies and measures should always consider a comparison of costs and benefits.

This study was carried out by GUA, an Austrian consulting institute for waste management and sustainable product assessment, in co-operation with GVM, a German packaging market research institute. It is dealing with an analysis of the environmental and economic effects of 2 litre one-way and refillable bottles for carbonated soft drinks (CSD), made of PET, including the existing mass-based product fee and the planned unit-based product fee. Associated transport packaging is included in the calculations. Social aspects are included by an analysis of the driving factors of consumer behaviour (see below) and by quantification of social costs of transport.

As the most relevant data for 2 litre PET-bottles for CSD are similar for 1,5 and 2,5 litre PET-bottles for CSD and mineral water, the results are a good approximation for about 83 % of the total market of CSD and mineral water, equivalent to 1.057 Mill litres per year.

The study compares several scenarios for the year 2012 regarding the share of refillable bottles for mineral water and carbonated soft drinks, assuming that the planned unit-based product fee has been implemented or has not been implemented. The analysis and prognosis of the market needed for the definition of such scenarios was carried out by GVM. This part of the study is dealing with a comparison of market trends in various countries, with driving factors of consumer behaviour and with the prognosis of a possible refillable quota in 2012.

Data and assumptions

Most relevant data used for mass and cost balance and for calculation of environmental effects was received directly from industry representatives. Data was evaluated and compared with data and assumptions used in a feasibility study prepared for/by KvVM, the Hungarian ministry of environmental affairs.

The assumption of the share of refillable PET bottles that are taken out of the refillable system due to losses at the consumer (not returned) and at the fillers (sorted out due to quality reasons) is crucial for the results. The losses assumed determine at the same time the number of reuse cycles by the equation:

Number of reuse-cycles =
= 1 / (losses at consumer in % of input at consumer + (1 - losses at consumer in %) x losses at fillers in % of input at fillers)

The following table shows possible and theoretical values for losses and the resulting number of reuse cycles. In this study, the losses at the consumer were assumed with 10 % and the losses at the filler were assumed to be 6 %, giving 6,5 reuse-cycles. The KvVM feasibility study varied the losses at the consumer between 10 and 50 %.

Table 1: Number of reuse cycles according to assumptions regarding losses at consumer and losses at filler. The highlighted values (orange box) were chosen for this study.

	Pessimistic assumpt.			Probable reality			Optimistic / extremely optimistic assumptions					
Losses at consumer	**30%**	**25%**	**20%**	**15%**	**10%**	**5%**	**7%**	**6%**	**5%**	**4%**	**3%**	**2,5%**
Losses at filler (share of returned bottles)	**2%**	**3%**	**4%**	**5%**	**6%**	**8%**	**7%**	**6%**	**5%**	**4%**	**3%**	**2,5%**
Losses at filler in % of total bottles	1,4%	2,3%	3,2%	4,3%	5,4%	7,6%	6,5%	5,6%	4,8%	3,8%	2,9%	2,4%
Total losses	31,4%	27,3%	23,2%	19,3%	15,4%	12,6%	13,5%	11,6%	9,8%	7,8%	5,9%	4,9%
RESULTING number of reuse cycles	**3,2**	**3,7**	**4,3**	**5,2**	**6,5**	**7,9**	**7,4**	**8,6**	**10,3**	**12,8**	**16,9**	**20,3**

The value of the environmental benefit of refillable bottles

The environmental benefit of the refillable system in comparison with the one-way system was calculated in a conservative way, meaning that many uncertain parameters were assumed in favour of the refillable system. Thereby, a maximum of the environmental advantage of the refillable system can be estimated.

Based on this kind of conservative calculation, the maximum advantages of the refillable system are for example:

- Energy saving: 1,58 MJ/litre or 0,64 Mill. GJ per year[1]
- Saving of CO_2 emissions: 55 grams/litre or 22.400 t/a (equivalent to a reduction of total Hungarian CO_2 emissions of 0,04 %)
- Saving of landfill masses: 16,6 g/litre or 6.760 tonnes per year (t/a) or 80.000 m^3/a.

The various environmental benefits that were quantified (energy resources, air emissions, water emissions, waste to landfills) can be aggregated to a total figure, if the costs to realise the *same* environmental benefits by other activities are summed up. Thereby, the maximum value of the environmental benefit of the refillable system can be estimated with 1,5 HUF/litre.

Nevertheless, the environmental benefit of the refillable system can also be zero, for example if the losses at the consumer are assumed to be 30 % (KvVM-study assumed 10 – 50 % loss at consumer), or if the calculation is based on 20 % losses at consumer and less conservative (more balanced) assumptions in various aspects.

The value of the environmental benefit of the 2 litre PET refillable system is therefore within a range of <u>0 – 1,5 HUF/litre</u> with a very high probability.

[1] Benefits per year are calculated by multiplication of results per litre with 407 Mill litres, which is the missing volume of 1,5 and 2,0 litre PET bottles (mineral water and carbonated soft drinks) to reach a 55 % refillable quota instead of the average 16,5% refillable quota of this market segment in 2003.

Comparison of costs of refillable and one-way systems

Beside the environmental effects, also the life cycle costs of one-way and refillable beverage packaging systems were investigated. Table 2 shows that the total life cycle costs of refillable systems are at least 3,5 HUF/litre higher than the total life cycle costs of one way systems. A calculation based on fewer assumptions in favour of refillable bottles would show a higher difference in life cycle costs.

Additionally the table also shows the environmental effects of the systems, expressed in monetary units (see above), and the social costs of traffic (due to traffic accident risks, traffic congestion and traffic noise). One way systems cause less social costs of traffic because they cause less transportation activities.[2]

Soft drinks, 2 litre PET bottles	one-way HUF/l	refillable HUF/l	Difference REF - OW HUF/l
PET bottle (incl. blowing process)	9,6	6,3	-3,3
Shrink film & cardboard / crate	1,0	1,5	0,5
Filling (& reconditioning), storing costs	7,9	11,8	3,9
Transport	3,3	5,9	2,6
Shops incl. takeback	0,1	0,9	0,8
Waste management	1,3	0,3	-1,1
Total business costs	**23,2**	**26,8**	**3,5**
Environmental costs	**3,26**	**1,80**	**-1,46**
Social costs of traffic	**0,55**	**0,80**	**0,24**
Total external costs	**3,82**	**2,60**	**-1,22**

Table 2: Overview on business costs, environmental costs and social costs of one-way and refillable beverage packaging systems.

2 Trucks carry considerable more litres in a one-way system then in a refillable system due to less gross volume of bottles and transport packaging in the one-way system.

Influences of a possible unit-based product fee regulation on the development of the beverage packaging structure (refillable quota)

GVM's main task is to predict the refillable quota for mineral water and carbonated soft drinks (CSD) in Hungary, taking into consideration the impact of the suggested product fee. As this tax will not show its full effect until 2010, the forecast refers to the year 2012.

The trend that one-way shares of beverage packaging will also increase in the future will, due to the introduction of the product fee, remain uninterrupted until 2009, but from 2010 onwards this trend will change. For 2012, we expect a refillable quota between 12 and 23% (per litre) for mineral water compared to 6% without product fee, which in all likelihood will however be below 20%, and a refillable quota of 13 to 19% for CSD, which will most likely be 16% compared to 10% without product fee.

The product fee will directly affect the price of beverages. As the trade tax will be introduced in correlation with gradually increasing requirements of the reuse quota, i.e. that part affecting bottlers will only come into effect from 2010, the relative price effects cannot be calculated on the basis of today's prices. This is why it is necessary to take into account the future inflation rates which will further weaken the price effect. The fact that 25% VAT will be charged on top of the product fee, however, will reinforce the price effect. Overall, more significant effects are to be expected for mineral water than for CSD so that the adaptation pressure for mineral water in favour of refillable systems will be stronger.

In order to assess the overall effect, the driving forces behind the beverage development related to the packaging structure development must be analysed.

An inventory of the Hungarian market produced the first starting points: a steadily growing beverage market, above all in the mineral water segment, reflects the changing drinking habits in Hungary. Drinking water from public supplies including wells is being replaced by industrially filled beverages, and there is a diversification of types and brands on markets of small growth options (beverages without CO_2, lemonades). The changing habits of consumers and their inclination towards European trends, such as dwindling household sizes, convenience orientation and growth of away-from-home consumption, also influence the beverage market. This and other driving forces will spur on the demand for one-way beverage packaging in the future, even if it already has a large share in the case of mineral water and CSD. Large PET bottles are predominant in both beverage sectors, which is why our survey focuses on these.

As far as the future Hungarian trade is concerned, we expect a strong increase in discounters. This development will also reinforce the one-way orientation of the Hungarian beverage market in the future, while simultaneously pointing to price-conscious consumers. For these consumers, in addition to the type of beverage, it is not the type of packaging but mainly the product price that counts when shopping for food and beverages.

Comparison of scenarios with different refillable and recovery quotas in 2012

All compared scenarios are based on a prognosis of the market for 2012 worked out by GVM. The refillable quotas mentioned below are average quotas for 1,5 and 2,0 litre PET bottles for CSD and mineral water, based on litres. The prognosis of the refillable quotas after an implementation of a unit-based product fee led to a range of possible values (minimum, maximum, average). For the scenarios below, average and maximum values were used.

- The reference scenario is based on a prognosis of the refillable quota in 2012, when a unit based product fee is not introduced, which is 10 % (exact value 10,2 %). The corresponding refillable quota in 2003 was 16,5 %.
- Scenario 1: 20 % (exact value 19,8 %) refillable quota in 2012 after an implementation of a unit-based product fee, average prognosis.
- Scenario 2: 25 % (exact value 24,6 %) refillable quota in 2012 after an implementation of a unit-based product fee, maximum prognosis.
- Scenario 3: 30% refillable quota, representing an already very unrealistic situation for 2012.

To make the calculation procedure and the results more clear and simple, the calculations regarding the unit-based product fee were simplified in comparison with the procedure proposed in the amendment of the product fee act:

- Calculations regarding the unit-based product fee are based on the refillable quotas listed above, which are average quotas for 1,5 and 2,0 litre PET bottles for CSD and mineral water, based on litres. According to the proposed amendment of the environmental product fee act, the calculation of refillable quotas and unit-based product fees would be based on the refillable quotas of the *total* market of soft drinks or mineral water. For scenario 2, the prognosis of GVM shows an average refillable quota for the *total* market of CSD and mineral water of 21 % instead of the refillable quota of 25 % used above. That means the unit based product fee would even be higher than the values above, if the values were calculated by the procedure proposed in the amendment of the product fee act.
- To calculate the product fee for retailers, a refillable quota of 55 % was assumed as target (average for 2008 – 2011 of the current KvVM proposal).

The most important result of the comparison is the difference between the reference scenario (no unit-based product fee, 10 % refillable quota in 2012) with scenario 2 (maximum prognosis of refillable quota: 25 % in 2012):

- Value of environmental benefit due to increased refillable quota is 0,57 HUF[3] per average litre or 600 Mill HUF/a.
- Additional costs are 12,22 HUF per average litre or 12.900 Mill HUF/a.

Therefore, the additional costs caused by the unit-based product fee regulation are at least 21 times (!) higher than the realised environmental benefit. This is an **extremely unproportional relation of costs and benefits**.

From a another comparison of different scenarios it can be derived that the environmental benefit of higher *recovery* (60 % instead of 17 % today) and higher *recycling* (42 % instead of 15 % today) is 1,7 times higher than the environmental benefit of rising the refillable quota from 10 % to 25 %. At the same time, the additional costs to increase recovery and recycling are much lower than the additional costs to increase reuse.

Number of scenario	**Reference**	**1**	**2**	**3**
Refillable quota	**10%**	**20%**	**25%**	**30%**
Unit-based product fee included	**No**	**Yes**	**Yes**	**Yes**
Benefit of add. recovery (realised by product fee income) **included**	**No**	**Yes**	**Yes**	**Yes**
	Result Reference HUF/l	**Result Szenario 1 HUF/l**	**Result Szenario 2 HUF/l**	**Result Szenario 3 HUF/l**
PET bottle (incl. blowing process)	9,3	8,9	8,8	8,6
Shrink film & cardboard / crate	1,1	1,1	1,1	1,2
Filling (& reconditioning), storing costs	8,3	8,7	8,9	9,1
Transport	3,6	3,8	4,0	4,1
Shops incl. takeback	0,2	0,3	0,3	0,3
Waste management	1,2	1,1	1,1	1,0
Total business costs	**23,6**	**23,9**	**24,1**	**24,3**
Mass based product fee	**0,2**	**0,2**	**0,1**	**0,1**
Unit based product fee		**14,3**	**11,7**	**9,4**
Total costs including product fees	**23,7**	**38,3**	**36,0**	**33,8**
Environmental costs	**3,12**	**2,61**	**2,55**	**2,49**
Social costs of traffic	**0,58**	**0,60**	**0,62**	**0,63**
Total external costs	**3,70**	**3,21**	**3,16**	**3,12**
Environmental benefit of scenario X compared to reference scen.		0,51	0,57	0,63
Additional costs of scenario compared to reference scenario		14,61	12,22	10,06
Additional costs are ... times higher than value of environm. benefit		**29**	**21**	**16**

Table 3: Comparison of scenarios with different refillable and recovery[3] quotas in 2012

[3] The given environmental benefit also includes benefits of additional recovery up to 60 % and additional recycling up to 42 %, possibly realised by the product fee income.

Summary and Conclusions

1. The results of this study are a good approximation for 83 % of the total market of carbonated soft drinks (CSD) and mineral water.
2. **The environmental benefit of 1,5 and 2,0 litre PET refillable beverage packaging** compared to 1,5 and 2,0 litre PET one-way packaging **is small**. It's value is equivalent to **0 – 1,5 HUF/litre**.
3. The **CO_2 emissions of Hungary** can only be **reduced by less than 0,04 %**, if the refillable quota would rise up to 55 %.
4. The **total life cycle costs of refillable systems are at least 3,5 HUF/litre higher** than the total life cycle costs of one way systems. Additionally, the **unit-based product fee will be at least 15 HUF/l higher for one-way** beverage packaging, if the refillable quota does not exceed 25 % (see below).
5. Market research shows many reasons why the **consumer increasingly prefers one-way beverage packaging**.
6. Analysis of the possible **influences of the unit-based product fee** on the beverage market show that the **refillable quota will possibly rise to a maximum of 25 %** in 2012 (average possible maximum for mineral water and CSD, 1,5 and 2,0 litre bottles).
7. Compared with a reference scenario of 10 % refillable quota in 2012 (if no unit-based product fee is implemented), the environmental benefit of a 25 % refillable quota is 0,57 HUF/litre[4], while the additional costs (including unit-based product fee) are 12,22 HUF/litre.
8. Therefore, the **additional costs** caused by the unit-based product fee regulation **are at least 21 times higher than the realised environmental benefit**. This is an **extremely unproportional relation**, which is **not in line with the principles of sustainable development**.
9. **Environmental benefits from measures within the sector of beverage packaging can be realised much more easily and effective by raising the recovery and recycling quota** than by raising the refillable quota.
10. The achievable environmental **benefits of higher recovery and recycling are even higher** then the achievable environmental benefits of refillable bottles.

[4] The given environmental benefit also includes benefits of additional recovery and recycling, possibly realised by the product fee income.

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Main report

Vienna, Wiesbaden
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1.1 Goal and scope of study

The goal of this study is to analyse the environmental and economic impacts of a unit-based product fee regulation, which is currently discussed in Hungary. To perform this analysis, several issues have to be investigated:

- costs and environmental effects of one-way and refillable systems
- influences of a possible unit-based product fee regulation on the development of the beverage packaging structure (refillable quota)
- comparison of scenarios with different shares of refillable bottles, based on a prognosis for possible refillable quotas in 2012.

Two different institutes have produced this report:

- GUA, an Austrian consulting institute for waste management and sustainability assessment
- GVM, a German market research institute

Scope of GUA-part:

- Analysis of 2 litre one-way and refillable PET bottles for soft drinks. Associated transport packaging is included in the analysis.
- Analysis of costs and environmental effects of these one-way and refillable beverage packaging systems.
- Analysis of the environmental and economic impact of unit-based product fee regulation by comparison of different scenarios.

Scope of GVM-part:

- Factors that influence the development of the beverage market
- Main driving forces of one-way beverage packaging
- Comparison of market trends in various European countries
- Impact of the product fee on beverage prices (including VAT)
- Forecast of the market and refillable quotas for mineral water and CSD for 2012

This study is a first step to assess environmental and economic impacts of one-way and refillable beverage packaging systems and of the planned unit-based product fee regulation. The short time available to work on the subject so far made it necessary to use many estimations and assumptions, which can be improved later on. Nevertheless, uncertain data was assumed in favour of the refillable system in most cases (see chapter 2.1).

1.2 Coverage of the Hungarian beverage market by the investigations of this study

Investigations of market trends and possible impacts of the unit-based product fee regulation are carried out for mineral water and for carbonated soft drinks. For these analyses, the total market of these beverage sectors is considered.

A detailed analysis of costs and environmental effects is carried out for 2 litre one-way and refillable PET bottles for soft drinks. 55,5 % of all carbonated soft drinks are filled in such bottles (see chapter 5.3.4). Nevertheless, most important input data are very similar for 2 litre PET bottles for mineral water and 1,5 litre bottles for soft drinks and for mineral water (see examples below). Therefore the results are a good approximation for all mineral water and soft drinks filled in 1,5 or 2,0 litre PET bottles. In 2003, the market share of mineral water and carbonated soft drinks delivered in PET bottles of 1,5 and 2,0 litres (including a small amount in 2,25 and 2,5 litres) was **83 %** of the total volume of mineral water and carbonated soft drinks (see chapter 5.5-1).

	Market share in 1,5 - 2,5 litre PET	**Total market in Mill litres**
Mineral water	89,9%	586
Carbonated soft drinks	76,4%	694
Weighted average / Sum	**82,6%**	**1.280**

Comparison of crucial data for 1,5 and 2,0 l bottles		
	one-way	**refillable**
Bottle mass [gram / litre]		
2 litre PET for soft drinks	24,4	63,2
1,5 litre PET for mineral water	24,0	64,0
Litres per pallet		
2 litre PET for soft drinks	768	512
1,5 litre PET for mineral water	756	576

2.1 Data and assumptions for environmental analysis of one-way and refillable systems – general comments

Most relevant data used for mass and cost balance and for calculation of environmental effects was received directly from industry representatives. Data was evaluated and compared with data and assumptions used in a feasibility study prepared for/by KvVM (2004).

The environmental benefit of the refillable system in comparison with the one-way system is calculated in a **conservative** way, meaning that many **uncertain parameters are assumed in favour of the refillable system**. Thereby, a maximum of the environmental advantage of the refillable system can be estimated.

List of conservative assumptions (selected examples):

- Process definition and costs:
  - No water emissions from reconditioning of refillable bottles are considered at the moment
  - Equal transport costs per km for one-way and refillable bottles, despite more loading time in refillable system
  - 125 km average distance from fillers to shops seems to be a rather low value
  - Assumption of current landfill share also for 2012 (lower landfill share for residual waste decreases environmental benefit of refillable bottles).
- Valuation of environmental benefit:
  - 15 EUR/t for CO_2 emissions instead of 9 EUR/t (value for Hungary in 2006)
  - Partly double counting of trace emissions: also partly covered by measures reducing CO_2
  - Plus 20 % for emissions not yet covered, even if important additional emissions only increase valuation by only 1 %
- Scenarios:
  - Utilisation of product fee income by MEA to increase recovery and recycling is assumed, even if this is not mandatory
  - PET recovery is increased up to 60 %. In reality paper and glass will contribute more and PET will contribute less to a total recovery quota.

2.2 Packaging masses and transport units

Data on packaging masses and transport units were provided by the Hungarian soft drinks association. The figures are average values derived from data provided by the three most important fillers.

Packaging masses [gram/piece]	one-way	refillable
Bottle & cap	48	128
Crate	-	2000
Shrink film (transport packaging)	52	-
Cardboard (transport packaging)	350	-

Transport units	one-way	refillable
Litres per bottle	2,0	2,0
Bottles per unit (crate/shrink film)	8	8
Units per pallet	48	32
Resulting litres per pallet	768	512

Packaging masses [gram/litre]	one-way	refillable
Bottle & cap	24,0	64,0
Crate	-	125,0
Shrink film (transport packaging)	3,3	-
Cardboard (transport packaging)	1,4	-

2.3 Assumptions regarding losses at consumers and fillers – reuse cycles

The assumption of the share of refillable PET bottles that are taken out of the refillable system due to losses at the consumer (not returned) and at the fillers (sorted out due to quality reasons) is crucial for the results. The losses assumed determine at the same time the number of reuse cycles by the equation:

Number of reuse-cycles = 1 / (losses at consumer in % of input at consumer + (1 - losses at consumer in %) x losses at fillers in % of input at fillers)

The following table shows possible and theoretical values for losses and the resulting number of reuse cycles. In this study, the losses at the consumer were assumed with 10 % and the losses at the filler were assumed to be 6 %, giving 6,5 reuse-cycles. The KvVM feasibility study varied the losses at the consumer between 10 and 50 %.

	Pessimistic assumpt.			Probable reality		
Losses at consumer	**30%**	**25%**	**20%**	**15%**	**10%**	**5%**
Losses at filler (share of returned bottles)	**2%**	**3%**	**4%**	**5%**	**6%**	**8%**
Losses at filler in % of total bottles	1,4%	2,3%	3,2%	4,3%	5,4%	7,6%
Total losses	31,4%	27,3%	23,2%	19,3%	15,4%	12,6%
RESULTING number of reuse cycles	**3,2**	**3,7**	**4,3**	**5,2**	**6,5**	**7,9**

	Optimistic / extremely optimistic assumptions					
Losses at consumer	**7%**	**6%**	**5%**	**4%**	**3%**	**2,5%**
Losses at filler (share of returned bottles)	**7%**	**6%**	**5%**	**4%**	**3%**	**2,5%**
Losses at filler in % of total bottles	6,5%	5,6%	4,8%	3,8%	2,9%	2,4%
Total losses	13,5%	11,6%	9,8%	7,8%	5,9%	4,9%
RESULTING number of reuse cycles	**7,4**	**8,6**	**10,3**	**12,8**	**16,9**	**20,3**

2.4 Data & assumptions regarding the irregular exchange of the pool of refillable bottles and crates

Due to the regular losses of refillable bottles and crates at the consumer and filler, new bottles and crates have to be introduced into the refillable system regularly. Additionally to this regular exchange, the total pool of bottles and crates is exchanged for example every 20 years, because the design of bottles and crates is changed. This irregular exchange of the total pool can partly be done by the regular introduction of new bottles and crates. The remaining share is an additional amount of new bottles needed in the system. Based on the data and assumptions listed below, the irregular pool exchange increases the total regular introduction of new bottles during 20 years by 2,9 % and total the regular introduction of new crates (which is very low due to the assumption of 50 reuse-cycles) by 51 %.

Calculation of new bottles & crates needed due to irregular exchange of total pool	bottle	crate
Ratio maximum sales (summertime) divided by average sales	1,7	1,7
Time (weeks) until bottle (crate) comes back to filler during maximum sales	7,0	7,0
From that the following can be derived:		
Ratio refillable pool (litres) divided by sales per year (litres)	24%	24%
Average reuse-cycles per year	4,1	4,1
Lifetime of bottle (crate)	1,6	12,1
Total number of reuse-cycles is	6,5	50
Total mass of new bottles (crates) introduced regularly into the system	15,4%	2,0%
Pool of refillable bottles (crates) is exchanged every ... years	20	20
Total time of exchange can happen within ... years	1,0	2,0
Share of the exchange done by regular introduction of new bottles (crates)	63%	16%
Share of the exchange additionally to regular introduction of new bottles (crates)	37%	84%
New bottles (crates) needed for 1 piece in the pool in 20 years	12,7	1,6
Ratio of additional new bottles (crates) due to pool exchance div. by regular introd. of new b. (c.)	**2,9%**	**50,7%**

2.5 Basic data and assumptions within waste management

Data for mass balance of recycling	
Separate collection of	
PET bottles	17%
Shrink film	0%
Cardboard	35%
Output of sorting to recycling	
PET bottles	90%
Cardboard	95%
Residues of recycling process	
PET bottles	10%
Cardboard	4%
Crate	2%
Substitution factor recycling	
PET bottles	0,95
Shrink film	1,00
Cardboard	0,60
Crate	1,00

Efficiency of energy recovery	
MSWI	
Power	12%
Heat	33%
Industrial energy recovery	
Power	15%
Heat	70%

Data regarding waste management was provided by Ökopannon. In 2003 about 15 % of all PET bottles consumed on the market were recycled. If the loss during the prior sorting processes is assumed to be 10 %, then the share of PET bottles separately collected is 16,7%. Shrink films are currently not collected separately.

In Hungary 35 % of waste paper and cardboard is collected separately for recycling in the household sector. For cardboard waste arising in shops (cardboard in between one-way shrink film layers on pallet), the same share for separate collection was assumed than in households, even if the average share of separate collection of cardboard in the commercial sector will be higher than in the household sector (the chosen assumption is therefore "conservative for refillable").

Bottles and crates, sorted out at fillers, are assumed to be 100 % recycled due to the concentrated and pure waste fraction and its positive economic value.

The amounts of recycling residues are typical values for the respective recycling processes. The substitution factor is the ratio of the substituted primary material (due to the use of secondary raw material coming from recycling processes) divided by the amount of secondary raw material produced in recycling processes. Products of energy recovery substitute gas-steam co-generation plants (conservative simplification).

Average efficiency of municipal solid waste incineration (MSWI) was estimated based on the range of produced power and heat in the MSWI plant in Budapest. Residues of sorting processes were assumed to go to industrial energy recovery processes (e.g. cement kiln).

Due to data provided by Ökopannon, residual waste collected in Hungary is treated by the following processes: 11% MSWI, 1% industrial energy recovery, and direct landfilling for the rest with a small share of mechanical-biological pre-treatment. In this study, a simplified split of 12 % MSWI and 88 % direct landfilling was assumed.

2.6 Mass balance of the investigated beverage packaging systems

Based on the data presented above, a mass balance for both investigated beverage packaging systems was worked out, showing input and output flows for every relevant process within the total life-cycle of the beverage packaging products analysed in this study.

The table showing the detailed mass balance for each of the investigated beverage packaging systems for a reference quantity of 100 Mill litres is shown in annex 1. The conservative calculation shows for example that the refillable system produces 16,6 kg less waste masses going to landfill per 1.000 litres (see input of process “landfill”).

All further calculations are based on this mass balance:

- Waste amounts going to landfill are directly derived from the mass balance.
- To calculate the energy demand of a certain beverage packaging system, specific energy demands per kg material or per litre soft drink are multiplied with the respective mass flows of the mass balance.
- Emissions of primary production processes (per kg material) are taken directly from existing inventories and are multiplied with amounts of materials in the investigated systems. Emissions resulting from the consumption of fuels are derived from fuel amounts in the energy balance and specific emission factors. Other emissions to air and water are derived from a combination of the mass balance with emission data per kg material.
- To calculate the total life cycle costs of a certain beverage packaging system, specific costs per kg material or per litre soft drink are multiplied with the respective mass flow of the mass balance.

2.7 Specific energy demand of processes in the investigated systems

Table 2.7-1 shows the fuels consumed by the processes in the investigated one-way and refillable beverage packaging systems. To convert electricity into primary fuels, the fuel mix for Europe was used [ETH 1996]. The Hungarian electricity production has a slightly higher share of nuclear power (approx. 40 % instead of 37 %) and less hydropower. Hydropower has only a share between 1 % and 2 % of the total energy consumption of the system. Using a mix of Hungarian and European electricity production would therefore change the results only very little.

The calculation of the fuel demand for the transport between fillers and shops is based on:

- 768 litres per pallet in the one-way system, 512 litres per pallet in the refillable system (see chapter 2.2)
- 10 pallets per truck for 10 tonnes maximum loading capacity, and 29 (one-way, limited by gross weight) and 32 pallets for 24 tonnes maximum loading capacity; assumed share of 67 % trucks with 24 tonnes maximum loading capacity
- 125 average transport distance between filler and shop
- Diesel consumption in kg per 100 km = 21,025 + 0,38 x loading mass for smaller trucks and 23,12 + 0,38 x loading mass for big trucks
- In the one-way system, 40 % of the return trips are assumed to be used for other purposes. This share can vary between 0 % and 80 %. The German Umweltbundesamt (2002) also assumed 40 % in their latest study on beverage packaging.

Recycling processes produce secondary raw material, which substitutes a certain amount of primary raw material. In this model, the substituted primary production is taken into account by the respective energy credits (negative values for energy demand = saved energy due to substituted primary production). It is assumed that PET and PE recyclates substitute the same materials (see chapter 2.5 for substitution factors). Recycled corrugated cardboard is used for cardboard production, where it substitutes primary wood pulp.

Table 2.7-1: Specific energy demand of processes in the investigated systems

Sources of data on energy consumption listed below:

SRU 250: see bibliography “ETH & EMPA (1996)”. GUA: primary data collected and calculated by GUA in various projects. Energy demand of reconditioning and filling was received from fillers.

Process	**data source**	**reference unit**	lignite	hard coal	natural gas	crude oil	heavy fuel oil	diesel	wood	hydropower	uranium	electricity
fuel unit →			[kg]	[kg]	[m3]	[kg]	[kg]	[kg]	[kg]	[MJ]	[g]	[kWh]
Primary production												
PET bottles (incl. transp.)	SRU 250	kg	0,130	0,603	0,771	1,080	0,057	0,032		0,550	0,002	0,669
LDPE film	SRU 250	kg	0,110	0,120	1,160	0,820				0,540	0,004	
HDPE crate	SRU 250	kg	0,076	0,077	1,050	0,790				0,390	0,003	
Corrug. cardboard	SRU 250	kg	0,055	0,036	0,096	0,110			0,739	1,620	0,005	
Wood pulp	SRU 250	kg					3,090	0,600				12,220
Filling one-way bottles	Ind. data	1.000 l			3,330							4,270
Reconditioning & filling	Ind. data	1.000 l			0,467							25,000
Transport to shops incl. return trip, OW		1.000 l						4,543				
Transport to shops incl. return trip, REF		1.000 l						6,473				
Waste management												
Residual waste collection	GUA	kg						0,008				
Separate collection PET	GUA	kg						0,057				
Separate coll. cardboard	GUA	kg						0,011				
Sorting PET	GUA	kg										0,067
Recycling PET	SRU	kg			0,020							0,168
Recycling cardboard	SRU	kg			0,191		0,030	0,000				0,101
Recycling crates	GUA	kg										0,103

Table 2.7-2: Consumption of primary energy of one-way and refillable systems (conservative calculation) for carbonated soft drinks in 2 litre PET bottles

Consumption of primary energy per 1.000 litres	Unit	natural lignite	natural hard coal	natural gas	crude oil	heavy fuel oil	diesel	wood, etc.	hydropoower	nuklear (uranium)	**Total**
Original unit		[kg]	[kg]	[m3]	[kg]	[kg]	[kg]	[kg]	[MJ]	[g]	
Gross heating value	MJ/unit	9,5	19,0	39,0	45,6	42,3	45,4	16,9	1,0	451,0	
One-way	orig. unit	6,63	17,29	22,19	25,61	2,01	5,78	1,02	30,82	0,29	
Refillable	orig. unit	6,13	9,73	5,70	6,59	1,54	7,74	0,00	26,88	0,36	
One-way	MJ	63	329	865	1168	85	262	17	31	131	**2.951**
Refillable	MJ	58	185	222	300	65	352	0	27	164	**1.373**
Difference OW - REF	MJ	5	144	643	867	20	-89	17	4	-32	**1.578**

The values presented in the table above were calculated by a combination of the mass balance (see annex 1) with the specific energy demands given above. The conservative calculation shows that the refillable system needs 1,58 MJ less primary energy per litre.

2.8 Calculation of emissions caused by the beverage packaging systems investigated

Emissions of primary production processes (per kg material) are taken directly from existing inventories (APME inventory for PET bottles, LDPE film and HDPE crates, SRU 250 inventory for corrugated cardboard) and are multiplied with amounts of materials in the systems.

Air emissions of other processes, resulting from the consumption of fuels, are derived from fuel amounts in the energy balance and specific emission factors. These emission factors include also emissions of the “precombustion” phase, i.e. emissions from production and transport of fuels.

Table 2.8-1: Air emissions in gram per kg or per m^3 fuel including precombustion phase

	Hard coal	Natural gas	Heavy fuel oil	Diesel	Wood
Reference unit of fuel	[kg]	[m3]	[kg]	[kg]	[kg]
Dust	2,10E+00	1,23E-01	2,48E+00	1,48E+00	2,22E+00
CH_4	1,17E+01	6,46E+00	4,71E+00	4,37E+00	7,25E-02
C_xH_y	5,55E-01	5,38E-01	8,99E+00	2,24E+01	9,64E-02
CO_2 fossil	2,84E+03	2,29E+03	3,76E+03	3,59E+03	2,99E+00
CO	3,14E+00	9,70E-01	1,30E+00	1,97E+01	1,15E+01
N_2O	3,48E-02	2,47E-02	7,63E-02	8,67E-02	1,13E-02
SO_x als SO_2	1,63E+01	1,29E+00	5,21E+01	5,41E+00	4,04E-01
NO_x als NO_2	6,99E+00	2,34E+00	9,52E+00	6,46E+01	1,95E+00

Water emissions coming from reconditioning of refillable bottles were neglected (assumption in favour of refillable bottles) due to the very small contribution of water emissions to the total value of the environmental benefits.

Example: CO_2 emissions caused by one-way and refillable bottles (conservative calculation)

Table 2.8-2: CO_2 emissions caused by one-way and refillable PET bottles along the total life cycle per litre carbonated soft drink sold on the market. The conservative calculation shows that the refillable system produces 55 g less CO_2 emissions per litre.

CO2 emissions in gram / 1.000 litres	one-way	refillable	difference
Primary production	117.337	59.104	58.233
Filling (& reconditioning)	11.815	25.595	-13.781
Transport to shops	16.310	23.237	-6.927
Separate collection & sorting	1.135	1.047	87
Recycling	2.620	1.375	1.245
Residual waste collection	753	184	568
MSW incineration	10.840	2.757	8.084
Substituted primary product.	-7.617	-18.877	11.261
Substituted energy conversion	-4.602	-917	-3.685
Total CO_2-emissions	**148.591**	**93.504**	**55.086**

2.9 Transformation of the environmental benefit of the refillable system to an aggregated value

The various environmental benefits that were quantified (energy resources, air emissions, water emissions, waste to landfills) can be aggregated to a total figure, if the **costs to realise the *same* environmental benefits by other activities** are summed up. This is one method to calculate the "external" (environmental) costs of activities, called the avoidance costs approach. The resulting figure represent the costs needed to compensate the environmental effects by reducing emissions, etc. by the same amount as caused by the assessed activity.

Most measures to reduce CO_2 emissions reduce the consumption of fossil fuels usually at the same time. Therefore the valuation of the consumption of fossil fuels is already included in the costs to reduce CO_2 emissions. To value also other energy resources consumed (nuclear power, hydropower, wood), in this study avoidance costs for CO_2 and all air emissions are multiplied with the factor 1+(consumption of nuclear power + hydropower + wood)/(total fossil fuel consumption), which is equal to 1,065. By this procedure, the non-fossil fuels are more or less treated as fossil fuels in the valuation process, which is again an assumption in favour of the refillable system.

The tables below present the avoidance costs used in this study and the results for the aggregated environmental effects of the processes in the investigated systems in monetary units. Examples on the following pages show the underlying calculation procedure for the three most important influences on the total result (PET primary production, transport, landfill).

An analysis of the environmental costs of PET primary production (see page 17) shows that **water emissions** contribute only with **0,5 %** to the total environmental costs of PET primary production. Because of this small influence, water emissions were not longer quantified within the environmental valuation. The only remaining process with relevant water emissions beside primary production is "reconditioning" (washing) of refillable bottles. Neglecting these water emissions is again a simplification in favour of refillable bottles.

In this study, the following air emissions beside CO_2 were included for quantification and valuation of environmental effects: dust, SO_X, NO_X, CO, CH_4, C_XH_Y and N_2O. The example on page 17 shows for PET primary production, that an additional consideration of Cd, Pb, Hg, Zn and HCl increases the total environmental costs of PET primary production only by 0,2 %! Therefore the inclusion of additional emissions in the described valuation process will change the total result only within the range of a few per cent. Nevertheless, to perform a conservative calculation, the environmental costs of the systems investigated were multiplied with a factor 1,2 (i.e. increased by 20 %) to get an estimate for the possible maximum of environmental costs, when a very big number of emissions would be included.

In the same way as described above, also the benefit of reducing waste masses in landfills was transformed into monetary values by calculating costs of another measure to reduce masses in landfills by the same amount. Therefore costs for (later) excavation of a landfill, followed by rough mechanical sorting and treatment in an incineration plant, including disposal of inert residues and of a small amount of residues from flue gas cleaning, were calculated. These costs sum up to 145 EUR/tonne waste (GUA & IFIP, 1998). Additionally to these external costs, CH4 emissions from disposed paper were included in the calculation. Other emissions will not be produced in relevant amounts from PET, LDPE and cardboard in landfills. (The gate fee used for landfills in this model additionally represents a modern landfill with high standards regarding the control of emissions to air and water.)

Table 2.9-1: Avoidance costs used in this study

Avaidance costs, given in EUR/tonne					
Fossil fuels, CO_2 emissions			**Water emissions**		
CO_2	15	(1)	CSB	716	(7)
Air emissions			P	11.930	(7)
Staub	257	(2)	N tot.	1.432	(7)
SO_X	1.780	(2)	AOX	17.895	(7)
NO_X	1.925	(3)	Hg	1.789.500	(7)
CO	76	(4)	Cr	71.580	(7)
CH_4	2.035	(5)	Ni	71.580	(7)
C_XH_Y	2.035	(2)	Pb	71.580	(7)
N_2O	1.925	(5)	Cu	35.790	(7)
Sum of Pb, Hg, Cd, Zn	7.711	(6)	**Waste to landfill**		
HCl	1.593	(6)	1 tonne	145	(8)

1 According to the Hungarian Ministry of Economy, CO_2 reduction costs will be in a range of 8,5 – 9,0 EUR/t in 2006 and 2007. In this study, 15 EUR/t was used to establish a conservative calculation.

2 Teufel et al, 1991, quoted in Schneider & Dreer (1997)

3 Szednyj & Schindler (2004)

4 Fritsche et al. quoted in GUA/TU-Wien (2001)

5 Values taken from C_XH_Y and NO_X as an estimation for CH_4 and N_2O respectively

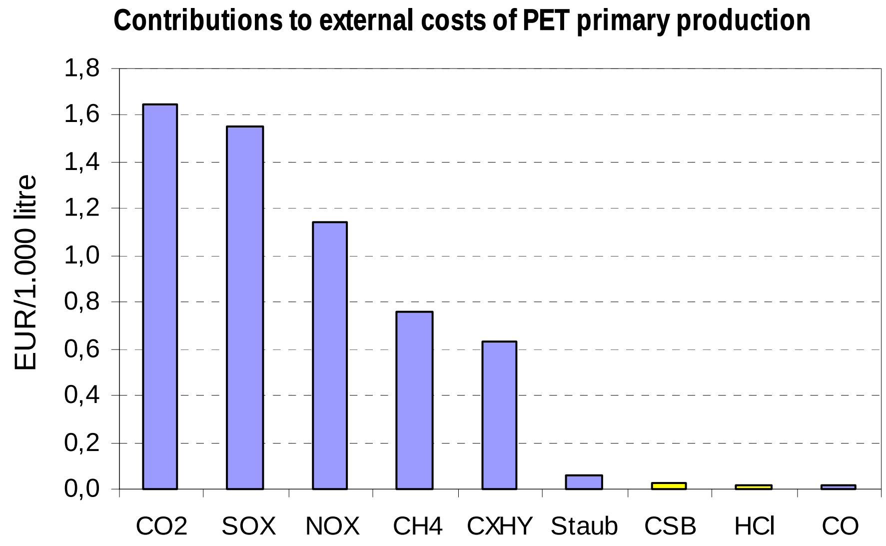
6 Calculated by data from Stubenvoll et al. (2002)

7 German act on taxes for waste water emissions,

8 GUA & IFIP (1998)

Example 1: Avoidance costs for emissions of PET primary production

Calculation of external costs of PET primary production						
	emissions in gram per kg PET	emissions in gram per litre CSD	avoidance costs in EUR per tonne	av. costs x factor for non-fossil fuels	value of emissions in EUR per 1.000 l	relative contribution to total ext.costs
Emissions included in the valuation of the study						
CO_2	4.272	103	15	16	1,646	
Staub	9,44E+00	2,28E-01	257	274	0,062	
SO_X	3,39E+01	8,17E-01	1.780	1.896	1,549	
NO_X	2,31E+01	5,57E-01	1.925	2.050	1,142	
CO	6,68E+00	1,61E-01	76	81	0,013	
CH_4	1,45E+01	3,50E-01	2.035	2.166	0,758	
C_XH_Y	1,21E+01	2,91E-01	2.035	2.166	0,631	
N_2O	1,71E-04	4,12E-06	1.925	2.050	0,000	
Subtotal					**5,800**	**99,3%**
Additional air emissions						
Sum of Pb,	1,03E-04	2,49E-06	7.711	7.711	0,000	
HCl	3,58E-01	8,64E-03	1.593	1.593	0,014	
Subtotal					**0,014**	**0,2%**
Water emissions						
CSB	1,56E+00	3,76E-02	716	716	0,027	
P as P_2O_5	2,48E-03	5,99E-05	2.604	2.604	0,000	
N tot.	2,65E-03	6,40E-05	1.432	1.432	0,000	
AOX	7,22E-10	1,74E-11	17.895	17.895	0,000	
Hg	2,17E-06	5,23E-08	1.789.500	1.789.500	0,000	
Cr	1,82E-08	4,39E-10	71.580	71.580	0,000	
Ni	3,71E-04	8,96E-06	71.580	71.580	0,001	
Pb	1,04E-06	2,51E-08	71.580	71.580	0,000	
Cu	3,72E-04	8,98E-06	35.790	35.790	0,000	
Subtotal					**0,028**	**0,5%**
Total external costs of emissions listed above					**5,842**	**100,0%**



The table on the left shows, how external costs of 5,8 EUR per 1.000 litres (equivalent to 1,44 HUF/litre) were calculated for the primary production of PET one-way bottles (conservative calculation). The remaining part of 0,08 HUF/litre (see table table 2.10-1) comes from the primary production of shrink film and corrugated cardboard.

Examples 2 and 3: Emissions from transport; waste masses to landfill

External costs of transport between fillers and shops for PET refillable bottles:

The amount of diesel consumed (6,47 kg/1.000 litres) was calculated based on the data given in chapter 2.7. Multiplication of the diesel mass with emission factors (2.8-1) lead to the emissions listed in the table on the right. Further multiplication with specific avoidance costs results in total external costs of 1,68 EUR per 1.000 litres, equivalent to 0,42 HUF/litre (compare with table 2.10-1).

External costs of transport for PET refillable bottles

	emissions in gram per litre CSD	avoidance costs in EUR per tonne	av. costs x factor for non-fossil fuels	value of emissions in EUR per 1.000 l
CO_2	23,2367	15	16	0,371
Staub	0,0096	257	274	0,003
SO_X	0,0350	1.780	1.896	0,066
NO_X	0,4181	1.925	2.050	0,857
CO	0,1275	76	81	0,010
CH_4	0,0283	2.035	2.166	0,061
C_XH_Y	0,1450	2.035	2.166	0,314
N_2O	0,0006	1.925	2.050	0,001
Total				**1,684**

External costs of waste going to landfills:

The refillable system produces 16,6 gram/litre less waste disposed on landfills than the one-way system (conservative calculation). 16,6 gram/litre x 145 EUR/tonne to reduce waste masses in landfills x 248 HUF/EUR = 0,6 HUF/litre. The additional effects of methane emissions from paper in landfills (132 g methane per kg paper in 50 years, institute for waste management, Technical University of Vienna) is very small (0,00007 HUF/l).

2.10 Summary: Value of the environmental benefit of refillable bottles

Based on data and conservative assumptions, estimations and extrapolations described above, an maximum estimation of external costs of one-way and refillable systems were calculated (see table 2.10-1). Thereby, the maximum value of the environmental benefit of the refillable system can be estimated with 1,5 HUF/litre.

Nevertheless, the environmental benefit of the refillable system can also be zero, for example if the losses at the consumer are assumed to be 30 % (KvVM-study assumed 10 – 50 % loss at consumer), or if the calculation is based on 20 % losses at consumer and less conservative (more balanced) assumptions in various aspects.

The value of the environmental benefit of the 2 litre PET refillable system is therefore within a range of <u>0 – 1,5 HUF/litre</u> with a very high probability.

Table 2.10-1: External costs of analysed processes

External (environmental) costs in HUF/litre	one-way	refillable	difference
Primary production	1,52	0,78	-0,74
Filling (& reconditioning)	0,09	0,26	0,17
Transport to shops	0,29	0,42	0,12
Separate collection & sorting	0,02	0,02	0,00
Recycling	0,02	0,01	-0,01
Residual waste collection	0,01	0,00	-0,01
MSW incineration	0,08	0,02	-0,06
Landfill	0,79	0,19	-0,60
Substituted primary product.	-0,09	-0,21	-0,12
Substituted energy conversion	-0,03	-0,01	0,02
Total external costs	**2,72**	**1,50**	**-1,22**
Factor to include monetisation of additional emissions			1,20
Conservative valuation of refillable benefit			**-1,46**

2.11 Basic data to determine the social costs of traffic

The social costs of traffic were taken from RDC & PIRA (2001):

Social costs of traffic		
Accident risk equivalent	17	Euro/1000 km
Congestion	86	Euro/1000 car km equivalent
Noise	3	Euro/1000 car km equivalent
Total	**106**	**Euro/1000 km**

Kilometres per litre (21 km per 1.000 litres for one-way bottles, 30 km/1.000 litres for refillable bottles) were calculated using basic data described in chapter 2.7, including an initial transport of 400 km for PET preforms (one-way) and new PET refillable bottles.

3.1 Total life cycle costs of beverage packaging systems – general comments

In parallel to the environmental effects, also total life cycle costs of one-way and refillable beverage packaging systems were investigated. Thereby costs and benefits of different scenarios can finally be compared.

It is important to understand that this study deals with costs, not with prices. Prices are not only influenced by costs, but also by market conditions, including conditions of competition. Also the deposit for refillable bottles and crates was not considered. Again a certain deposit value does not necessarily represent the (change in) costs, if a refillable bottle or a crate is not returned. In this study, the actual costs of new crates and refillable bottles, as well as saved costs of reconditioning are considered for the share of refillable bottles and crates, which is not returned to shops.

The costs included in the cost calculation of this study are basically packaging related costs that change, when one-way bottles are replaced by refillable bottles or vice versa. Constant costs like costs of the drink itself, overhead costs of filling and constant costs in shops have not been considered. These costs are not related to packaging materials and to a certain logistic system, and they are subtracted to zero when the difference between one-way and refillable systems is calculated.

To consider the influence of refillable bottles and crates that are not returned by the consumer or that are sorted out by the filler, the cost calculation of the refillable system is split into three parts: 1) the refillable bottles and crates are returned to the filler and used again; 2) the refillable bottles or crates are returned, but are sorted out by the filler due to quality reasons and are substituted by new products 3) the refillable bottles are not returned to the shops. The actual costs of the refillable system is then calculated by using a mix of the three situations described, according to the losses at consumer and filler assumed in this study.

3.2 Costs of packaging materials, filling and reconditioning

Data on costs of packaging products were received from the soft drinks association in Hungary, based on an inquiry at the three most important fillers. The values were taken from recent invoices.

Also data for filling, reconditioning and storing costs for fillers were received from industry.

	KvVM study, part 1	KvVM study, part 2	Data used in this study
2 litre one way bottle			
mass (gram/pc)	42	42	45
price (HUF/pc)	26,0	25,6	**19,2**
2 litre refillable bottle			
mass (gram/pc)	100	100	125
price (HUF/pc)	61,0	60,9	**80,0**
Crate			
mass (gram/pc)	2.000	2.000	2.000
price (HUF/pc)	1.120	800	**800**

Costs of packaging, reconditioning and filling, given in HUF per litre	One-way system	Refillable system reality mix	refillable bottle 0% loss	refillable bottle 100% loss at consumer	refillable bottle 100% loss at filler	crates 0% loss	crates 100% loss at filler
Factors for reality mix of refillable system			85%	10%	5%	98%	2%
Effect of pool exchange					0,4%		1,0%
bottle incl. blowing process	9,6	6,3	0,0	40,0	40,0		
shrink film	0,8						
cardboard	0,2						
crate		1,5				0,0	50,0
filling & reconditioning	7,9	11,4	11,8	7,9	11,8		
storing costs for fillers	0,0	0,4	0,4	0,0	0,4		
Total	**18,5**	**19,6**	**12,2**	**47,9**	**52,2**	**0,0**	**50,0**

3.3 Costs of transport from fillers to shops, costs of takeback, storing costs in shops

Transport costs were calculated based on specific transport costs of 225 HUF/km (given by industry) and the general data for transport given in chapter 2.7. The assumption of equal transport costs per km for one-way and refillable bottles, despite more loading time in the refillable system, is in favour of the refillable system.

	Unit	One-way system	Refillable system
specific transport costs	HUF/km	225	225
transport costs with truck for 10 tonnes	HUF/litre	5,9	11,0
transport costs with truck for 24 tonnes	HUF/litre	2,0	3,4
transport costs mix (33,3% trucks for 10 t)	HUF/litre	3,3	5,9

Costs to take back and sort empty refillable bottles and crates were calculated based on 12 HUF/crate for staff costs (industry data; if gross wage per month is assumed to be 155.000 HUF, then the resulting time for taking back and sorting of one crate and 8 bottles is 23 seconds), equivalent to 0,75 HUF per litre for 100% return rate or 0,68 HUF/l for 90 % return rate.

Additionally, costs of stock area before selling and storing costs for returned empty bottles and crates were estimated, but the values are very small:

Costs of stock area before selling: 0,09 HUF/l for one-way, 0,13 HUF/l for refillable system, calculated based on 9.600 HUF/m^2.a, storing height equivalent to 1,5 pallets and an assumed average storing time of bottles in stock area of 4 days). For refillable bottles, an additional amount of 0,13 HUF/l was assumed for storing costs for empty bottles and crates.

3.4 Waste management costs

Separate collection, sorting and recycling of PET bottles:

The total sum paid by Ökopannon for collection, sorting and recycling is interpreted as costs of collection and fixed costs of sorting. The revenue for the recycling product (110 – 140 HUF/kg for cleaned PET flakes) does not only cover the process costs of recycling, but also enables the recyclers to pay about 35 – 40 HUF/kg for sorted bottles. The estimated staff costs for sorting out PET bottles are about the same value. It is therefore assumed that the revenue for sorted bottles cover the variable sorting costs and the payment by Ökopannon covers collection costs and fixed costs of sorting. The advantage of this simplified model is that the costs used will not change much per kg collected material with higher rates of recovery and recycling. Costs for separate collection of PET bottles and fixed costs of sorting plants are about 126.000 HUF/t. The value used for Hungary is therefore about 50 % lower than the respective Austrian.

Detailed investigations in Austria showed that collection of PET bottles together with residual waste is about 33 % cheaper due to a lower net volume of PET bottles within residual waste. The costs for PET bottles in residual waste collection have been multiplied with 0,5 (see ratio of costs for separate collection and sorting in Austria and Hungary) to get an estimate for possible costs in Hungary. For refillable bottles, no reduction of costs in residual waste compared to separate collection is considered, because these bottles are more rigid and therefore demand a larger net volume.

For municipal solid waste incineration, the current Hungarian gate fee cannot be used, because this value does not contain annuities due to investment costs any more. As an estimate, optimised MSWI costs for Austria are reduced by 30 % (less staff-intensive process than collection, where costs are 50 % less than in Austria). In the same way, costs for modern Hungarian landfills in 2012 (reference year of the scenarios) are estimated by reducing Austrian costs by 30 %.

Due to very small amounts in the mass balance, separate collection of paper, sorting and recycling of paper and energy recovery give only very small contributions to the total waste management costs of the system. If Austrian costs are used for these processes, they cover less than 1,5 % of the waste management costs of the total system of one-way PET bottles. Therefore specific costs for Hungarian conditions were not investigated.

Waste management costs used in this study	HUF/t
Separate collection and sorting (fixed costs) PET	**61.000**
Additional recycling net costs PET	**0**
Separate collection and sorting HDPE	**0**
Additional recycling net costs HDPE	**-37.200**
Residual waste collection one-way packaging	**27.000**
Residual waste collection refillable packaging	**40.600**
MSWI	**20.800**
Landfill	**13.900**

4 Overview on business costs, environmental costs and social costs of one-way and refillable beverage packaging systems

Table 4-1 gives an overview on the total life cycle business costs of one-way and refillable beverage packaging systems. Additionally, the environmental costs and the social costs of transport are shown. It turns out that the business costs of refillable systems are at least 3,5 HUF/litre higher than the total life cycle costs of one way systems. A calculation based on fewer assumptions in favour of refillable bottles would show a higher difference in life cycle costs.

Additionally the table also shows the environmental effects of the systems, expressed in monetary units and the social costs of traffic.

In comparison, the additional costs of the 2 litre PET refillable system are at least 2,4 times higher than the environmental benefit of the system or 2,9 times higher than the total external benefit (= quantified environmental + social effects) of the refillable system. The values shown in Table 4-1 are the basis for calculation of scenarios in chapter 6.

Table 4-1: business costs, environmental costs and social costs of one-way and refillable beverage packaging systems

Soft drinks, 2 litre PET bottles	**one-way** **HUF/l**	**refillable** **HUF/l**	**Difference REF - OW** **HUF/l**
PET bottle (incl. blowing process)	9,6	6,3	-3,3
Shrink film & cardboard / crate	1,0	1,5	0,5
Filling (& reconditioning), storing costs	7,9	11,8	3,9
Transport	3,3	5,9	2,6
Shops incl. takeback	0,1	0,9	0,8
Waste management	1,3	0,3	-1,1
Total business costs	**23,2**	**26,8**	**3,5**
Environmental costs	**3,26**	**1,80**	**-1,46**
Social costs of traffic	**0,55**	**0,80**	**0,24**
Total external costs	**3,82**	**2,60**	**-1,22**

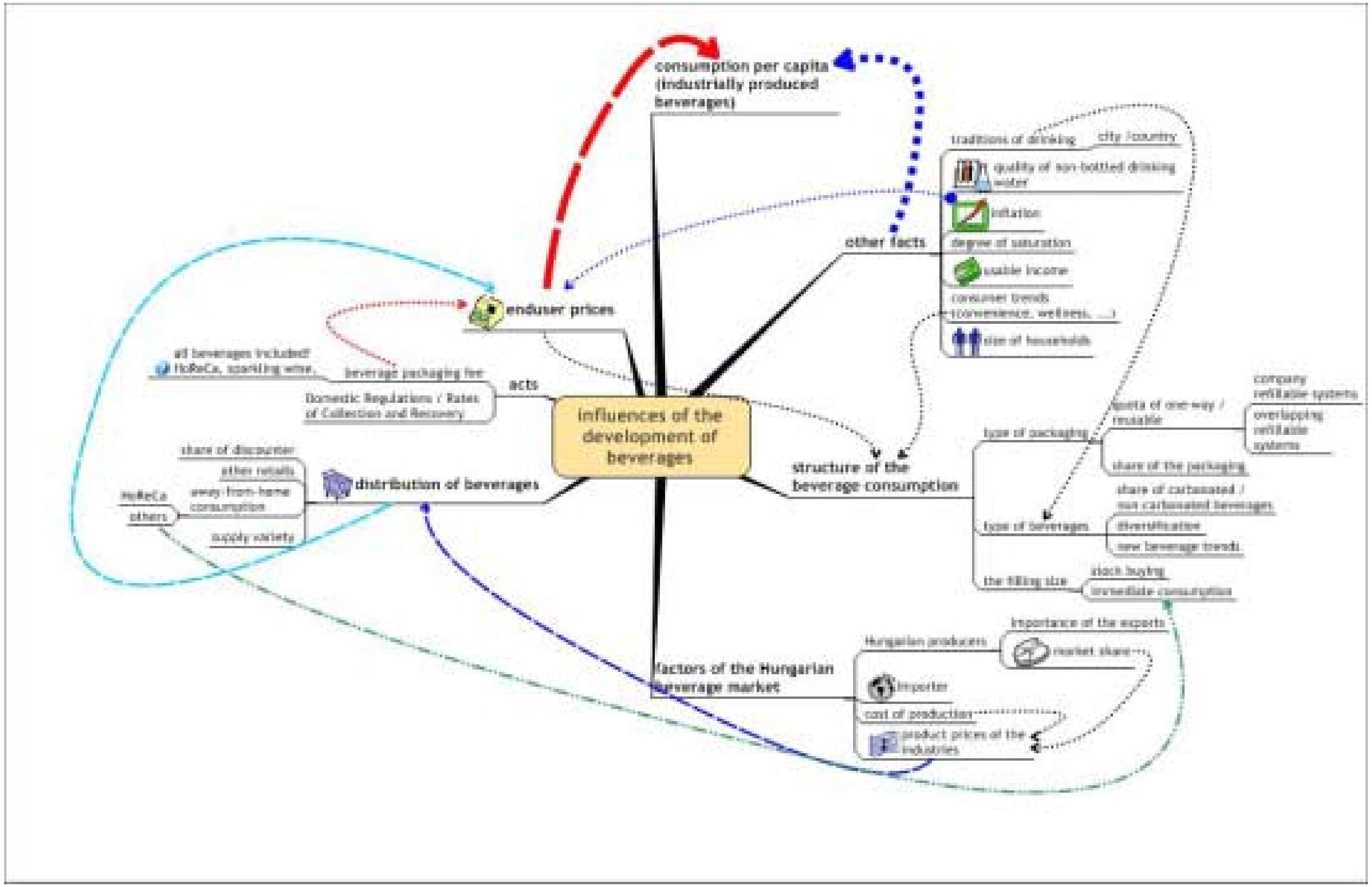
5. Influences of a Possible Unit-based Product Fee Regulation on the Development of the Beverage Packaging Structure (Refillable Quota)

- The aim of the new Hungarian product fee is the "reduction of the waste output" and also a control effect in favour of refillable packaging for beverages.
- All beverages are generally affected by the fee. The investigations shall, however, focus on mineral water and carbonated soft drinks (CSD), large PET bottles (2,0 l) to be more precise.
- GVM's task is to examine the product fee's impact on the packaging structure. To do so, the following steps are required:
    1. The **general factors that influence** the beverage market shall be presented.
    2. The **important driving forces for one-way beverages** shall be described. In so doing, we shall show that the general trend towards one-way packaging in the beverage industry has several causes.
    3. The **description of the Hungarian beverage market** compared to other European countries shall form the basis for further investigations into the product fee's impact. Within the context of this procedure, we will point out market trends which will have a decisive influence on future developments.
    4. The product fee has a direct impact on the price of beverages. Therefore, the **price effects** shall be quantified.
    5. **The impact** of mineral water and CSD **on the packaging structure** shall be assessed on the basis of the portrayed arguments. As a 2012 scenario was selected (10 year perspective), the assessment of refillable quotas shall be preceeded by a forecast of the beverages trend (quantity, structure, prices).

5.1 Factors that Influence the Beverage Development

- For **consumers**, beverages make up a significant part of their consumption. Besides the basic supply (growth) the diversification of drinking demands plays an increasingly important role (pleasure, wellness, health, convenience).
- The consumption‘s structure is also influenced by the place of consumption. Immediate consumption and away-from-home consumption are key words of a trend which also has an impact on the packaging structure.
- Beverages are one of today‘s most important fast-moving consumer goods. Therefore they hold an incredible significance for **commerce** - on the one hand with regard to turnover and on the other hand with regard to pricing politics as a customer magnet.
- **Manufactures of beverages** must fulfil various consumer demands but also comply with the trade requirements by offering a mix of beverage types and packaging.
- Beverages make up a considerable amount of the packaging quantity and are thus of significant relevance for disposal issues. For this reason beverages often tend to be the object of **governmental action in waste politics**.
- Figure 5.1-1 gives an overview of different driving forces for market trends.

Figure 5.1-1: Versatile Influences on the Beverage Market



5.2 Main Driving Forces of One-way Beverage Packaging

We first need to understand the driving forces of one-way packaging for beverages in order to be able to ascertain the product fee's effects on one-way packaging:

1. Growing importance of **away-from-home consumption**
2. Consumer **demand for product variety** (by type, filling volumes and brands) has intensified
3. Increasing **price sensitivity of consumers**
4. Decreasing **size of households** (number of persons / more single households)
5. Strong **growth in discount distribution** and private labels
6. General spreading of **convenience-oriented values**
7. Comparative **costs of one-way packaging** are declining (compared to returnable packaging)
8. **Retailers' product ranges** are getting broader

5.2.1 Away-from-Home Consumption

- Immediate consumption has an increasing share in beverage consumption.
- Consumers increasingly buy and consume beverages away from home: on the road, at work, on holidays, after sports …
- For immediate consumption and away-from-home consumption, consumers prefer convenient beverage packaging of appropriate filling volume.
- Therefore, away-from-home consumption is strongly dominated by one-way and small-sized beverage packaging. One-way beverage packaging is gaining in importance.

5.2.2 Demand for Product Variety

- Consumers demand a broader variety of beverages:
  - in terms of types of beverages
  - in terms of brands
  - in terms of filling volumes
  - in terms of types of packaging
- The increasing diversity of beverages cannot be supplied, distributed and stored by means of returnable packaging.
- Thus, households prefer one-way beverage packaging which is more differentiated in terms of filling volumes, types of beverages and brands.

5.2.3 Consumer Price Sensitivity

- Today, consumers are more price sensitive than in the past.
- This mainly applies to bulk purchases. Here, consumers are price-conscious and deliberately choose between different suppliers (retailers) and product offers.
- In general, prices for one-way beverage packaging are falling.
- On the other hand, prices for returnable packaging are rising.
- Consequently, consumers are increasingly opting for one-way beverage packaging.
- To avoid misunderstandings: for some beverages (e.g. mineral water), returnable packaging systems are still less expensive than one-way packaging systems.

5.2.4 Household Sizes

- The average number of persons per household is decreasing. Most striking is the growth of one-person households (singles, elderly people).
- At the same time, the household space for storing food and beverages is declining. To be more precise, consumers have less space at their disposal for storing food and beverages.
- Returnable beverage packaging distributed in crates is designed for storing beverages.
- Therefore, households are increasingly opting for one-way beverage packaging appropriately differentiated by filling volumes, types and brands.

5.2.5 Discount Distribution

- For several reasons, the share of discounters in the distribution of beverages has increased.
- On the whole, the small range of discounters (or other lean distribution concepts) is not designed for returnable beverage packaging.
- As discounters are gaining in importance, the share of one-way beverages is increasing.

5.2.6 Convenience-oriented Values

- Generally speaking, the new generations are more convenience-oriented than the previous ones.
- Consumers may more or less spend their lifetime consuming. Most of them do not want to spend valuable time on preparing for consumption.
- The handling of returnable beverage packaging (storing, taking back) takes time.
- This is why consumers prefer one-way beverage packaging.

5.2.7 Costs of One-way Packaging

- Generally speaking, the prices for one-way beverage packaging are falling.
- On the other hand, prices for returnable packaging are rising.
- Fillers of one-way packaging realise economies of scale as their output is growing.
- As a result, the growing market share of one-way packaging coincides with a reduction in production costs.

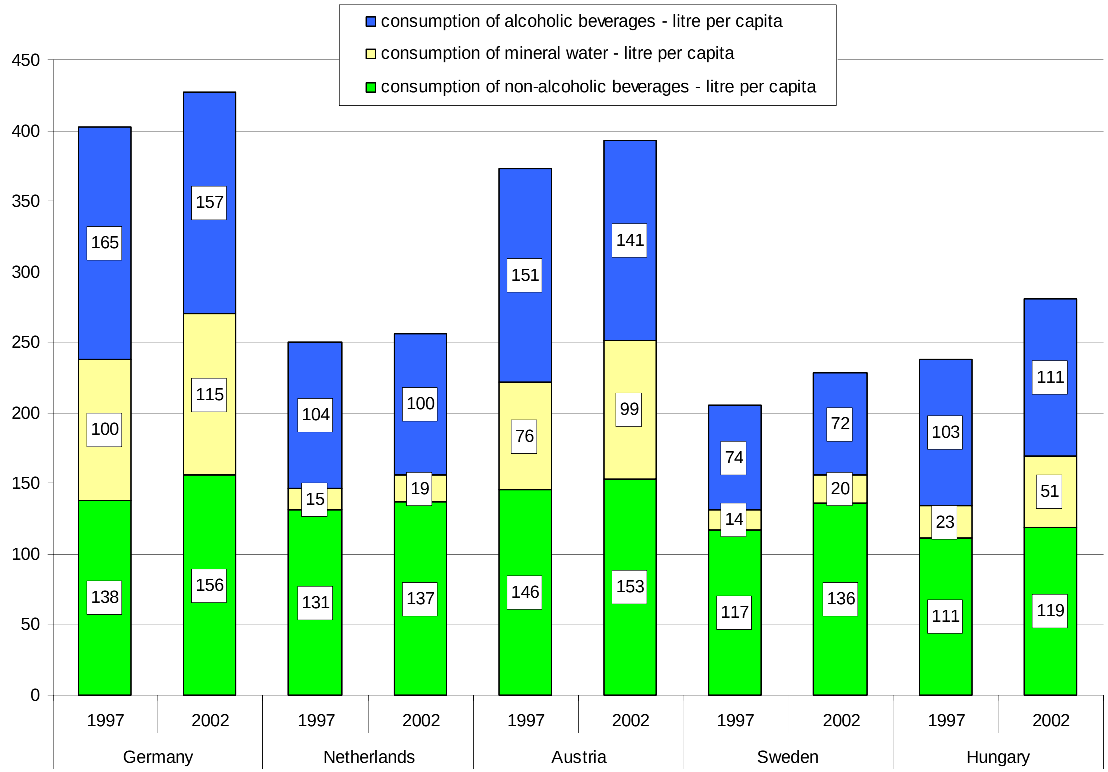
5.2.8 Retailers' Product Range

- Households ask for a larger variety of beverages.
- Retailers must match the increasing preference in diversity by means of a differentiated supply of beverages.
- Retailers must supply a wider product range and store this in a very small space.
- One-way beverage packaging needs less space and manpower (storage, handling) than returnable packaging.
- Thus, the share of one-way beverage packaging in the retailers' product range is increasing.

5.3 Comparison of Market Trends in Various European Countries - 1

- The consumption of beverages per capita in Europe is very varied but on the increase in most countries.
- The main reasons for the different levels are:
  - The tradition of using water from the public drinking water supply.
  - The significance of privately prepared beverages like tea and coffee, but also drinks made from syrups.
  - The social acceptance of alcoholic beverages.
- A fundamental reason for the increase in non-alcoholic beverages is that the consumption of food and beverages is shifting out of the households. The trend of dwindling household sizes is a second, related reason.
- In an international comparison, the per capita beverage consumption in Hungary has increased considerably in the last years. From 1997 to 2002, consumption increased by 18%, whereas reference countries such as Germany, Sweden, Austria and the Netherlands showed a significantly lower growth.
- In this time period, the overall level increased from 238 to 280 l/capita.
- In contrast to the other reference countries, between 1997 and 2002 the share of **alcoholic beverages** in Hungary increased (+8%), whereas the decreasing consumption, in particular of beer, in most European countries prevented the consumption rates from growing.
- Nevertheless, the most significant surges in growth were caused by non-alcoholic beverages. From 1997 to 2002, the per capita consumption increased by 26%.

Figure 5.3-1: Development of Beverage Consumption in Various Countries from 1997 to 2002



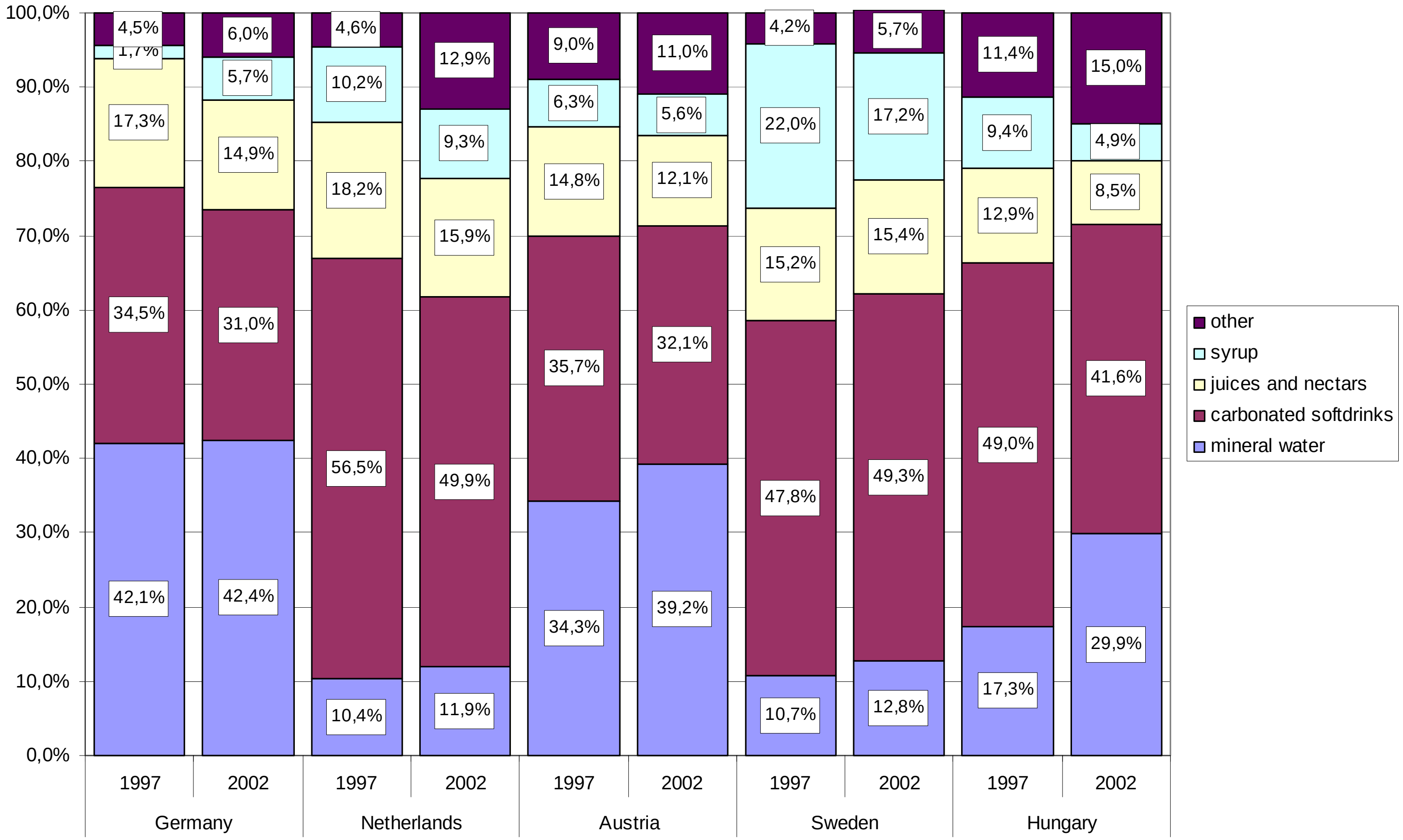
5.3.1 Market Development of Non-alcoholic Beverages in Hungary – Mineral Water

- **Non-alcoholic beverages**: In 2003, the consumption amounted to 176 l/capita, i.e. 65 l more than in 1993. This corresponds to a growth of 59,6%.
- **Mineral water** represents the most important beverage segment in the sector of non-alcoholic beverages. Consumption has almost increased eightfold since 1993 with a growth rate of 50.8 l per inhabitant.
- The last three years in particular were marked by another strong surge of growth. Thus, from 2000 to 2003, the consumption rate increased by 23,6 l per inhabitant.
- This means that compared to the other European countries, Hungary has moved from the group of “minor consumers" of industrially filled water (Sweden: 20,0 l/capita, Netherlands: 18,6 l/capita, Great Britain: 19,9 l/capita, Denmark: 16,0 l/capita) to the group of “major consumers" (Germany: 114,7 l/capita, Spain: 110,1 l/ capita, Austria: 98,9 l/ capita, France: 143,7 l/capita).
- The reason for this trend seems to be that the traditional basic supply of beverages from public drinking water (including wells) is eroding in favour of industrially produced beverages.
- As consumption is still however much lower in Hungary than in the other countries, we expect this trend to continue over the next few years and predict another **significant increase in the per capita consumption**.

5.3.2 Market Development of Non-alcoholic Beverages in Hungary – Soft Drinks, Juices, etc.

- If one studies the trend for all **other non-alcoholic beverages**, it appears that, in an international comparison, Hungary also has a lower consumption rate than the reference countries. Therefore one can assume that there is a high potential for development in consumption. This is also emphasised by the fact that the consumption of syrup for making beverages in the household has decreased considerably (1997: 9,4% share of all non-alcoholic beverages incl. mineral water; 2002: 4,9%).
- It was not until the beginning of the last 10 years that the per capita consumption of **carbonated soft drinks** increased in leaps and bounds. Today‘s level was obtained as early as the mid-90s. With 68,7 l/capita, Hungary has a low consumption rate in an international comparison. Most countries achieve 77-96 l/capita.
- The **trends for future developments** (without taking into account the new product fee) of non-alcoholic beverages (excluding mineral water) are as follows:
  - Generally restrained growth
  - Further decrease in syrup
  - Strong growth in ice tea
  - Substitution of juices by other still beverages (e.g. ACE wellness drinks); both with potential for development
  - Moderate growth in carbonated soft drinks.

Figure 5.3-2: Structure of Non-alcoholic Beverages in Various Countries from 1997 to 2002



5.3.3 Trade Structure

- “Hungary has been one of the most important expansion markets for the western retail groups since the early 1990s and many of the continent’s big names are present there, although a few local players are still holding their own” (source: Food&Drink, 7 January 2004).
- Over the last few years, hypermarkets and discounters have become much more popular in Hungary (14%, 20% in 2000 to 29%, 21% in 2003), supermarkets are the big losers (17% in 2000 to 11% in 2003) (GfK, source: Food&Drink, 19 February 2004).
- “But the (GfK) survey also revealed that the **relatively low number of discount stores** in Hungary also had an impact on the figures – many of those shoppers who opted for one of the other store formats said they would choose to shop in a discount store instead if there was one in their local neighbourhood”.
- The share of discounters will grow faster than other retail types in the next 10 years (Lidl e.g. plans 100 new stores). Consequently the share of one-way packaging for beverages will increase.

5.3.4 Packaging Structure of Mineral Water and Carbonated Soft Drinks

- The packaging market in the beverage sectors of mineral water and CSD in Hungary is dominated by PET.
- The share of returnable packaging amounts to a mere 9,4% for mineral water and 16,4% for CSD (consumption in litre).
- If one studies the refill quota to units, mineral water reaches a quota of 12,1% and CSD approx. 22%.
- The consumption focuses on large packaging (1,5 l and larger). In 2003, the share of bottles from 1,5 l amounted to 89,9% for mineral water and 82,1% for CSD (including 5,7% for vending machines).
- This indicates a still relatively low share of away-from-home consumption and a potential for growth in the away-from-home sector.

Figure 5.3-3: Share of packaging type at 2003 beverage consumption

Packaging type	Mineral waters in %	Carbonated drinks in %
Glass	**4,1%**	**3,7%**
One-way	2,6%	2,3%
Returnable	1,5%	1,4%
Plastic:	**95,9%**	**88,6%**
One-way	87,9%	73,5%
Returnable	7,9%	15,0%
Metal container	**0,0%**	**2,1%**
Tetra and similar blocks/bricks		
Vending machines (diluted for consumption)		**5,7%**

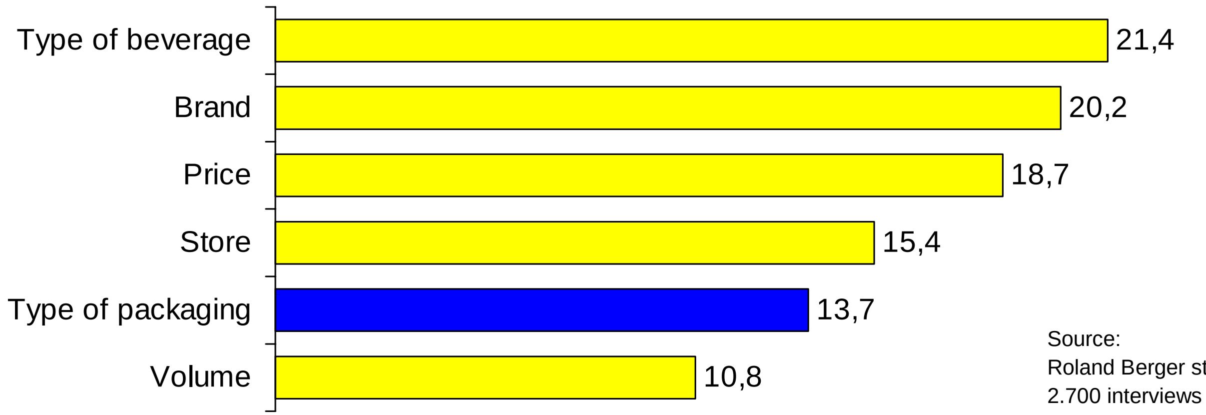
Figure 5.3-4: Share of packaging size at 2003 beverage consumption

Packaging size	Mineral waters in %	Carbonated drinks in %
less than 0,35 liter	4,0%	5,5%
between 0,36-0,5 liter	5,4%	9,3%
between 0,51-0,99 liter	0,3%	0,1%
1 liter	0,3%	3,1%
1,5 liters	72,3%	8,1%
2 liters	17,3%	55,5%
more than 2 liters	0,3%	18,5%

5.3.5 The Significance of Packaging for the Purchase of Beverages

- A GfK survey within the context of a Roland-Berger study (for the German market) shows that the type of packaging is of minor significance for the buying decision when making bulk purchases.
- What counts is the type of beverage followed by brand and price. This is why we think that the specific packaging properties will only present a low resistance line for consumer reorientation.
- We assume that **in Hungary** the consumers‘ **price sensitivity** has a stronger impact than the brand loyalty. According to Mr. Renynghe (Marketing Director of the Borsodi Brewery), Hungarian consumers are less loyal to their brands than customers in western Europe (Budapest Newspaper, 16 March 2003).
- Should **one-way and refillable alternatives** for the different types of beverages be marketed, the price will probably be an important criterion for the buying decision. **Brand loyalty** will only play a role in the event of relatively low price differences (+/- 20%).

Figure 5.3-5: Criteria of buying decision for beverages



Source:
Roland Berger strategy Consultants, GfK;
2.700 interviews in Germany

5.4 The Impact of the Product Fee on Beverage Prices (including VAT)

- An additional value added tax of 25% will be charged on top of the product fee. This increases the price effect by 20%.
- **The fee refers to units:** Although the fee regulation distinguishes between two filling size groups (up to 1,5 l (1,0 l for glass) and over 1,5 l), the charges for small packaging will be somewhat higher than for large packaging.
- The fee will be charged in the form of an **absolute extra charge** (not as a relative charge like VAT). This means that beverages in the low-price segment (mainly mineral water) will be charged much higher. On the other hand, the fee for spirits will hardly play a role at all.
- **The fee is graded according to the material:** Glass has the lowest rate for the recovery part. However, **the recovery part of the fee is of minor significance** as it is assumed that the recycling quota of 50% will be complied with for all materials, which leads to an 80% reduction of the fee.
- The requested refillable quotas are specified according to the **types of beverages**. The reuse part of the fee depends on the short-fall of the obtained refillable quota with reference to the stipulated quota. Types of beverages with a high specified refillable value such as beer (75% from 2010) and water or soft drinks (55% from 2010) will have to bear a considerably higher tax burden if they are less than the stipulations.
- Over the years, **inflation** will cause a **slowdown** in the relative price effect.

5.4.1 Price Changes Caused by the Product Fee

- The following figures show the quantitative effects of the product fee on the prices.
- For the assessment of the price effects we must take into consideration that today‘s prices will rise due to inflation. The tax share of prices will thus decrease (figure 5.4-1).
- The product fee won‘t show its full impact before 2010 because the bottlers must only then compensate for the difference to the stipulated refillable quota. Figure 5.4-2 shows the correlation between inflation rate and the different tax rates for the different years.
- Figures 5.4-3 to 5.4-5 show the impacts on product prices as soon as all the tax components have come into effect. To simplify the matter, the calculation is based on a universal requirement of the refillable quota (e.g. the target quota for fillers).
- The 2004 beverage prices have been integrated in the calculation. The prices have been extrapolated by 1.5 (medium scenario) in order to take into account inflation up until the year 2012 (average scenario).
  - Figure 5.4-3 shows the impact of the assumed shortfall in the refillable quota on beverage prices.
  - Figure 5.4-4 shows the impact of the product fee on beverage prices.
  - Figure 5.4-5 shows the impact of the product fee on the different types of beverages.

Figure 5.4-1: Inflation Scenarios from 2005 and 2012

Beverage prices will rise due to inflation. The blue line shows a szenario starting in 2005 at the actual inflation rate of 7%. The rate will fall to 3% by 2010, which is the rate of the European Stability pact.

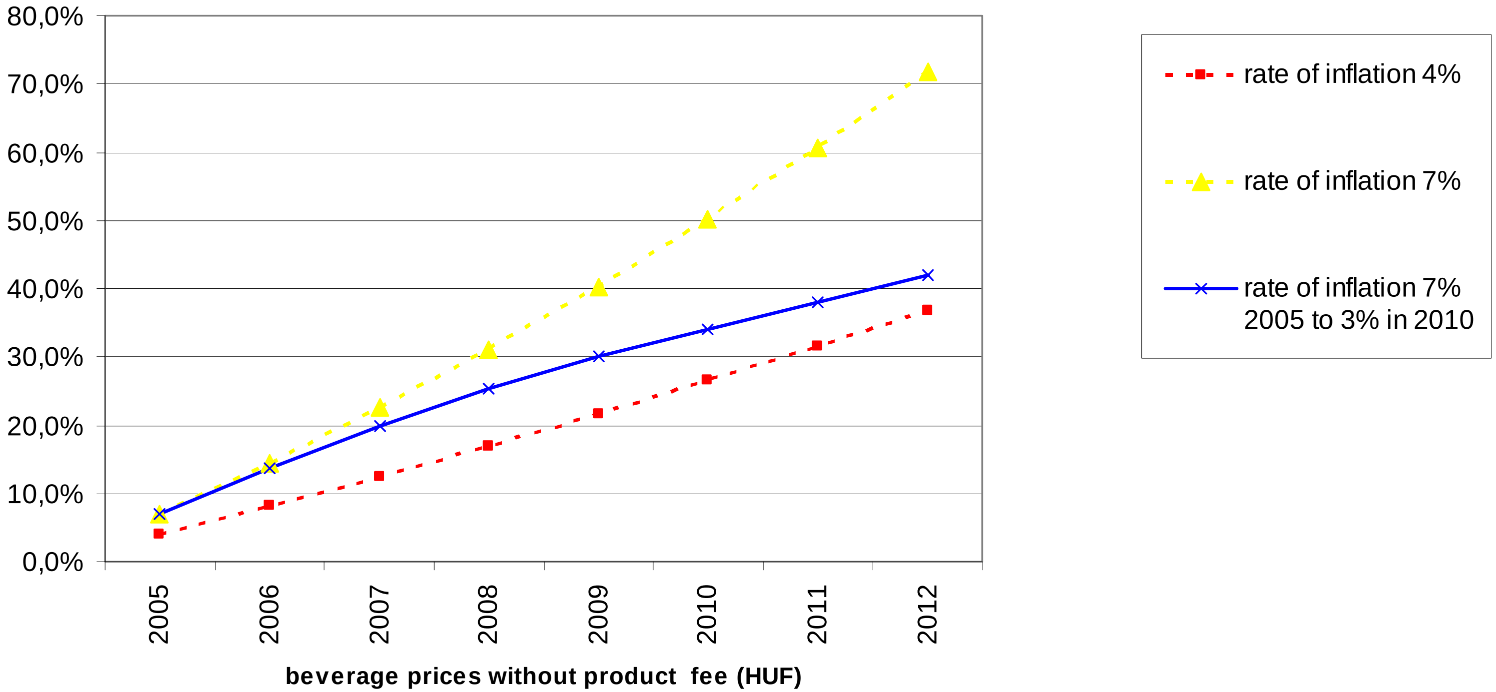
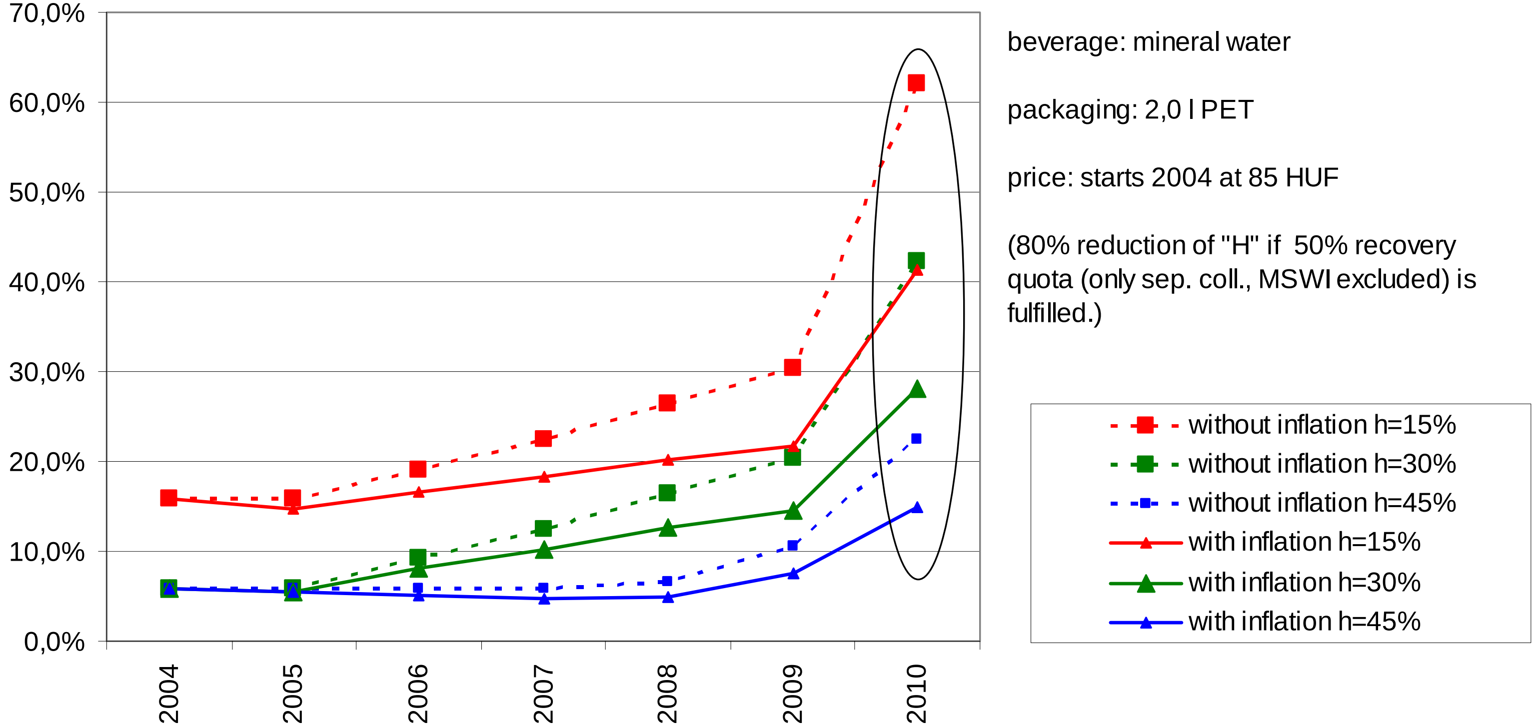


Figure 5.4-2: Price Effect of the Product Fee from 2004 to 2010

Beverage prices will rise from 2004 to 2010 with the increase of the reuse quota for the retail trade. In 2010, when the filling industrie have to comply reuse quotas so that the price effect will be at its highest.



beverage: mineral water

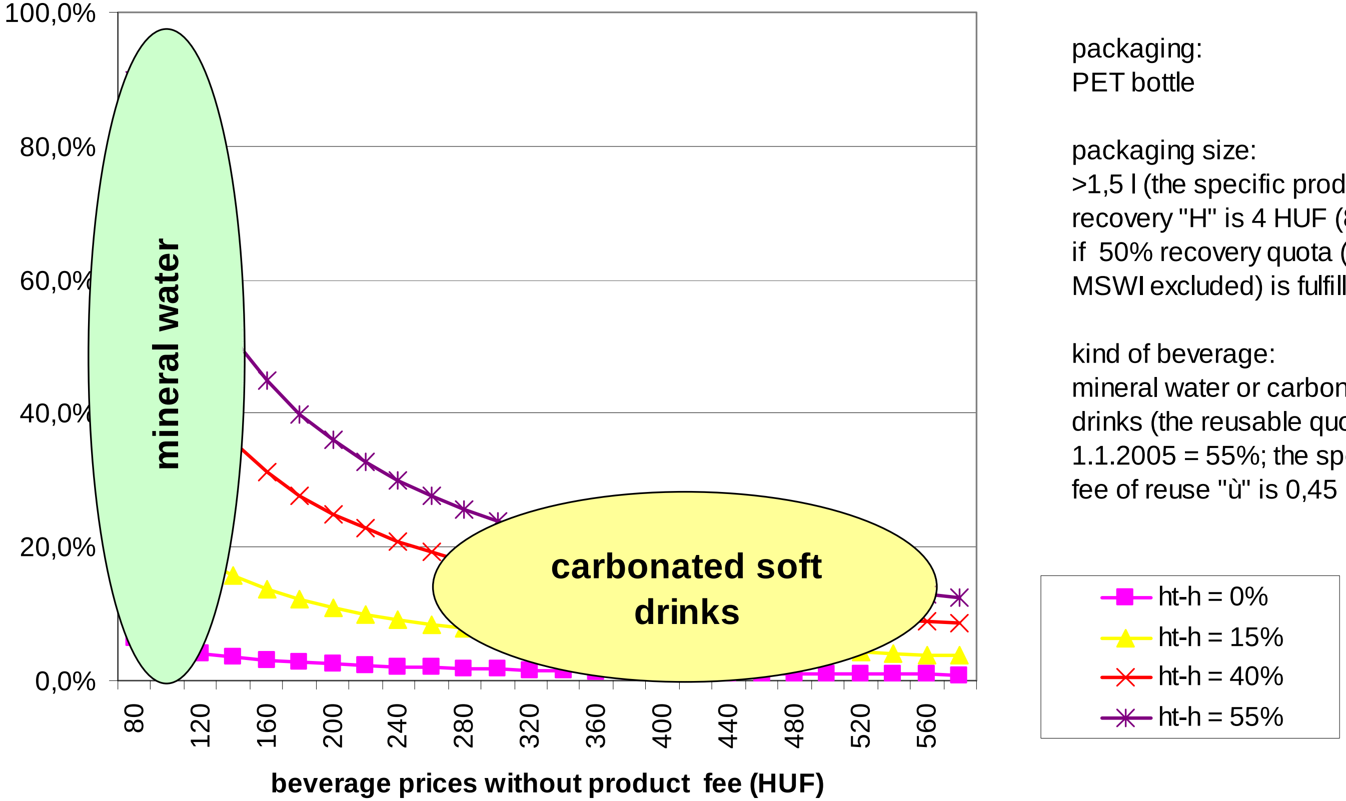
packaging: 2,0 l PET

price: starts 2004 at 85 HUF

(80% reduction of "H" if 50% recovery quota (only sep. coll., MSWI excluded) is fulfilled.)

Figure 5.4-3: Impact of the Assumed Shortfall in the Refillable Quota on Beverage Prices

The price effects of the product fee are substantially higher for mineral water than for carbonated soft drinks.



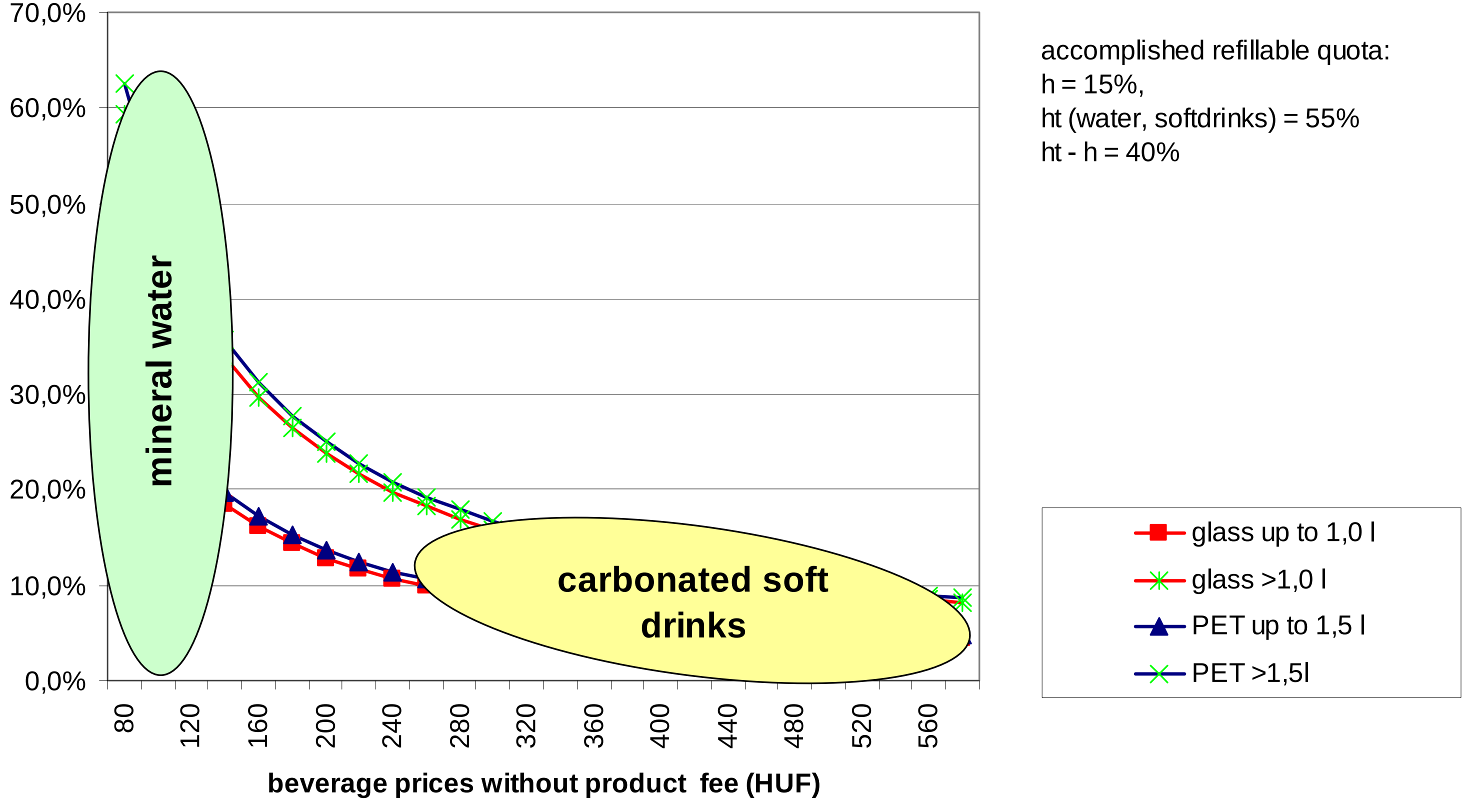
packaging:
PET bottle

packaging size:
>1,5 l (the specific product fee for recovery "H" is 4 HUF (80% reduction if 50% recovery quota (only sep. coll., MSWI excluded) is fulfilled.)

kind of beverage:
mineral water or carbonated soft drinks (the reusable quota from 1.1.2005 = 55%; the specific product fee of reuse "ù" is 0,45 HUF)

Figure 5.4-4: Impact of the Product Fee for Beverage Prices on the Type of Packaging

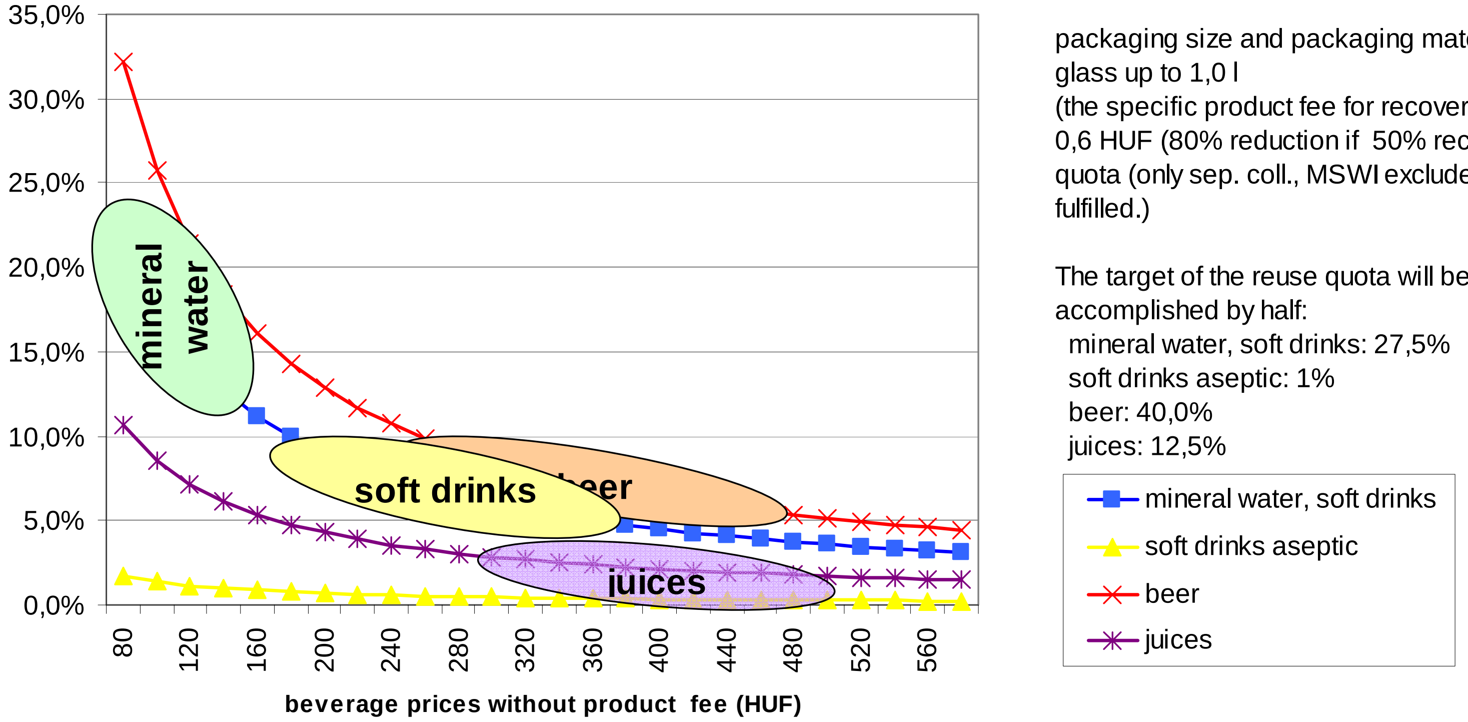
The impact of the material specific amount of the product fee on beverage prices is not significant.



accomplished refillable quota:
h = 15%,
ht (water, softdrinks) = 55%
ht - h = 40%

Figure 5.4-5: Impact of the Product Fee for Beverage Prices on the Type of Beverage

The price effects are different for the different types of beverage. If the reusable quotas have reached 50% of the targets, a further increase in the reuse quota will be unlikely (excluding water).



packaging size and packaging material: glass up to 1,0 l
(the specific product fee for recovery is 0,6 HUF (80% reduction if 50% recovery quota (only sep. coll., MSWI excluded) is fulfilled.)

The target of the reuse quota will be accomplished by half:
- mineral water, soft drinks: 27,5%
- soft drinks aseptic: 1%
- beer: 40,0%
- juices: 12,5%

5.5 Forecast of the Market and Refillable Packaging for Mineral Water and CSD up to 2012 - 1

Factor	Starting position	Without product fee	Influence of the product fee
Beverage consumption	The consumption of non-alcoholic beverages has been increasing constantly over the last years. The rapid development as far as public drinking water is concerned indicates an erosion of traditional consumer behaviour. The growth of CSD is rather restrained.	We assume that the per capita consumption of mineral water will increase by approx. 70% by 2012. The increase for CSD, however, will only amount to 10%.	By 2009, the growth of the per capita consumption of mineral water will decline slightly due to price rises. From 2010, the price effect will be considerable. Consumption in 2012 will only increase by 58% compared to 2003. The product fee will hardly have any influence in the case of CSD (+9%).
Filling volume	Consumption focuses on large packaging (1,5 l and larger). In 2003, the share of bottles from 1,5 l amounts to 89,9% for mineral water and to 82,1% for CSD (including 5,7% for vending machines). The average filling volume for mineral water is 1,23 l and 1,28 l for CSD per packaging (including vending machines).	Away-from-home consumption will make up a bigger share in the case of mineral water in particular. The share of large bottles will decrease: to 86% for mineral water and to 77% for CSD. Thus the average filling volume will also decrease.	As charges for small packaging will be relatively high, the away-from-home market will not develop as strongly. There will be a shift to larger packaging. We thus assume that large bottles will have a share of 88% for mineral water and 79% for CSD in 2012. The average filling volume will slightly increase again from 2010.

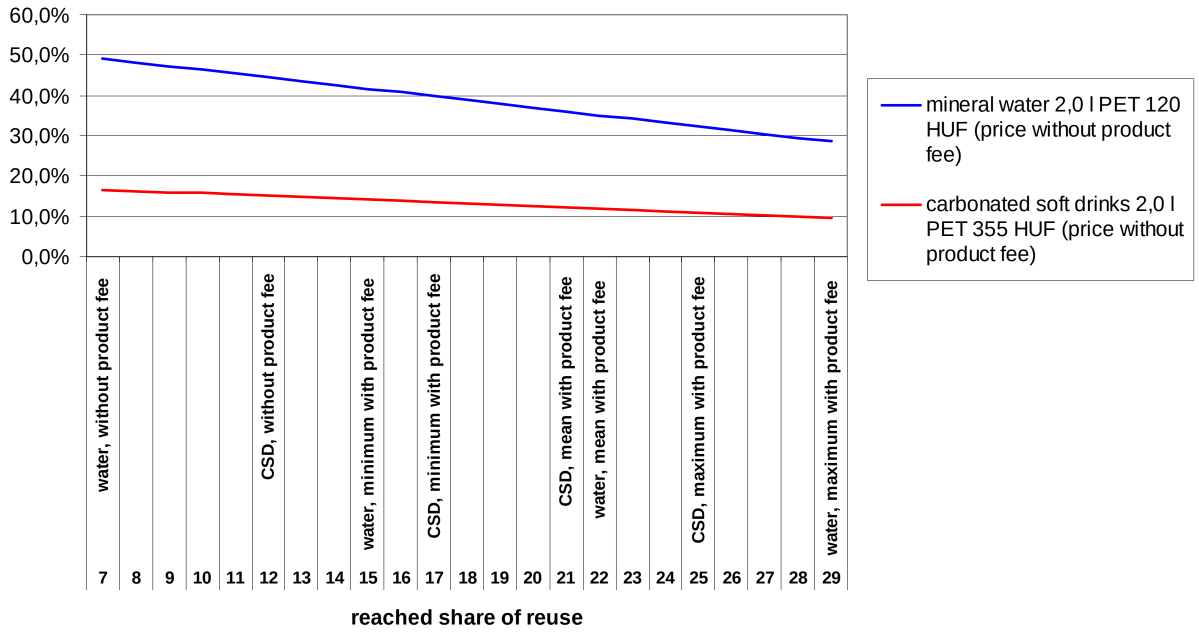
5.5 Forecast of the Market and the Refillable Packaging for Mineral Water and CSD up to 2012 - 2

Factor	Starting position	Without product fee	Influence of the product fee
Refillable packaging	The refillable quota starts at a relatively low level. We believe that this is also related to the relatively high frequency of small outlets on the Hungarian market who find refillable systems rather unappealing due to the high space requirements. This is underlined by the lack of specialised drinks dealers.	The international development shows that the trend is in favour of one-way systems for many trading companies and manufacturers. However, the dwindling household sizes and convenience requirements of consumers also reinforce this trend. Despite the high level of one-way systems we assume that the market share of one-way bottles will further increase, particularly in the case of mineral water. The decline of refillable systems will be more pronounced for CSD than for mineral water.	Up to 2009, there will only be a slight shift towards refillable systems because the price rises are relatively low when inflation is taken into account. Mineral water, however, will be more greatly affected than CSD. There will be a considerable shift towards refillable systems for mineral water from 2010 due to strong price rises. However, up to 2012, no more than 23% of refillable bottles will be achieved on the basis of the filling volume. As the price effect will be much lower for CSD, the replacement of one-way systems by refillable systems will also be less pronounced. The 2003 level will be achieved again by 2012.

5.5.1 Effect of the Product Fee on Beverage Prices for 2,0 l PET in 2012

- Figure 5.5-1 shows the price effect of the product fee on end consumer prices for mineral water and CSD in 2,0 l PET bottles, which are the focus of the survey. The stipulated reuse quota amounts to 55%.
- The price rise effect is almost three times higher for mineral water in comparison with CSD.

Figure 5.5-1: Effect of the product fee on beverage prices for 2,0 l PET in 2012



Please note: The price effect arises in comparison with the without "product fee" scenario but not compared to the previous year.

5.5.2 Forecast of the Refillable Quota for Mineral Water

- In the case of mineral water, the effect of the product fee will not be strong enough to compensate for the “natural” decline in the refillable quota by 2009.
- From 2010, a significant impact of the product fee on the refillable quota of mineral water is expected.
- Even if a maximum refillable quota (litre) of 23% in 2012 is indicated in figure 5.5-1, a quota below 20% is the most likely outcome.

Figure 5.5-1: Development of the refillable quota (per unit)

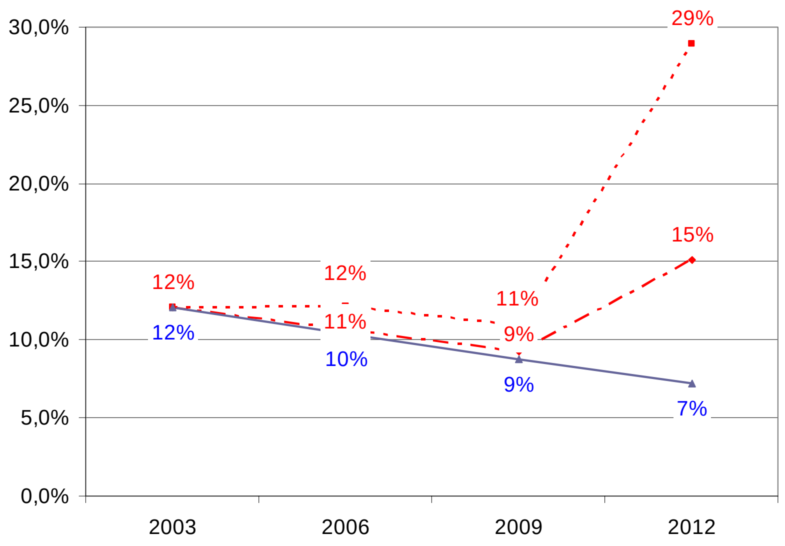
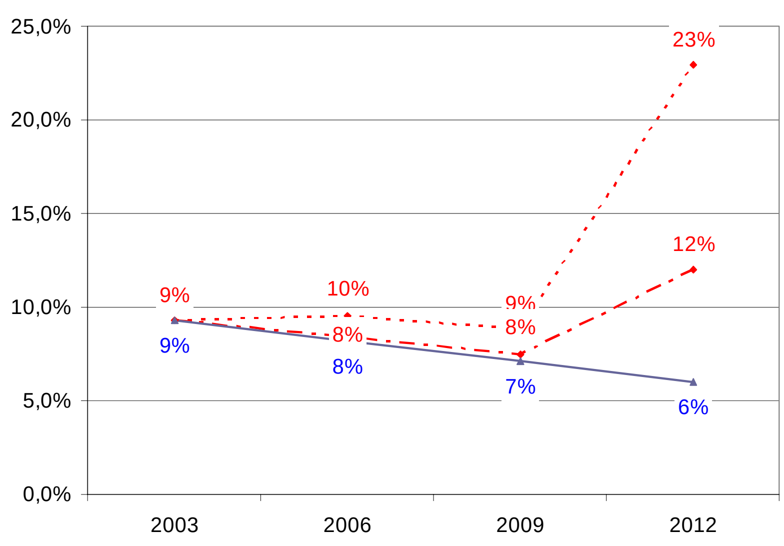


Figure 5.5-2: Development of the refillable quota (per litre)



refillable quota mineral water effects of the product fee minimum
refillable quota mineral water effects of the product fee maximum
refillable quota mineral water without product fee maximum

5.5.3 Forecast of the Refillable Quota for Carbonated Soft Drinks

- In the case of carbonated soft drinks, the effect of the product fee will not be strong enough to compensate for the "natural" decline in the refillable quota by 2009.
- From 2010, the impact of the product fee on the refillable quota will be reinforced.
- Even with a fully established product fee, we expect a refillable quota of 16% (litre) to be a reasonable outcome.

Figure 5.5-3: Development of the refillable quota (per unit)

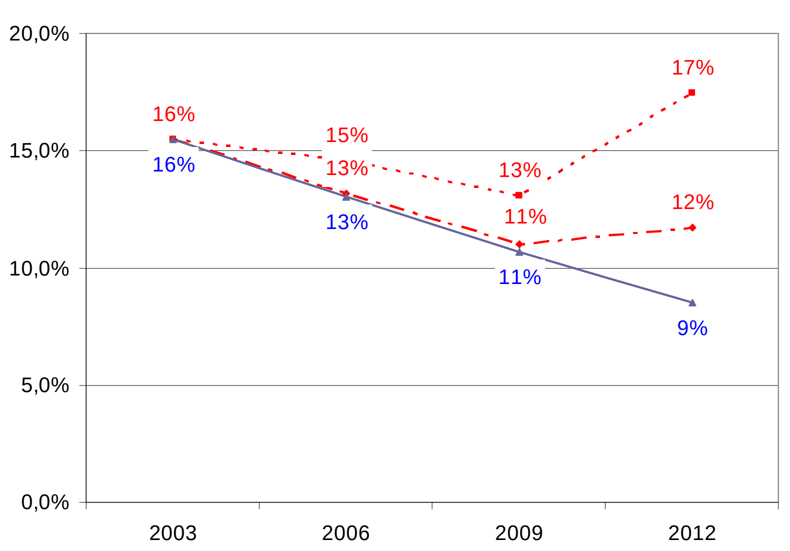


Figure 5.5-4: Development of the refillable quota (per litre)

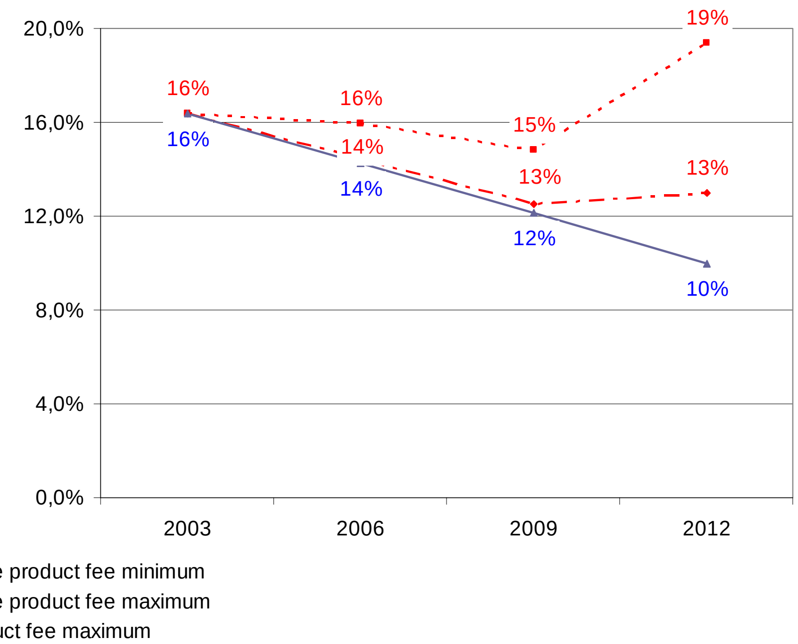


Figure 5.5-5 Forecast of the Refillable Quota for 1,5 l and 2,0 l PET

mineral water (basic unit)	Ref PET 1,5 and 2,0l without product fee	Ref PET 1,5 and 2,0l with product fee (max.)	mineral water (basic litre)	Ref PET 1,5 and 2,0l without product fee	Ref PET 1,5 and 2,0l with product fee (max.)
2003	9,0%	9,0%	2003	8,6%	8,6%
2006	7,9%	9,2%	2006	7,6%	8,8%
2009	6,9%	8,6%	2009	6,6%	8,2%
2012	5,8%	22,2%	2012	5,5%	21,2%

CSD (basic unit)	Ref PET 1,5 and 2,0l without product fee	Ref PET 1,5 and 2,0l with product fee (max.)	CSD (basic litre)	Ref PET 1,5 and 2,0l without product fee	Ref PET 1,5 and 2,0l with product fee (max.)
2003	23,0%	23,0%	2003	23,2%	23,2%
2006	20,0%	22,4%	2006	20,2%	22,6%
2009	17,0%	20,8%	2009	17,2%	21,0%
2012	14,0%	27,2%	2012	14,1%	27,5%

- The tables below show the predicted refillable quotas for PET bottles of 1,5 to 2,0 l in size. The reference value is the total amount of PET bottles (refillable and one-way) of this size.
- The data are included in the calculations in the GUA part of the survey.

6 Comparison of scenarios with different refillable and recovery quotas

Scenarios are defined and calculated to compare different possible situations with and without the influence of the planned unit based product fee. By comparison of the scenarios (calculation of the difference) the additional costs due to the product fee and due to changes between the share of one-way and refillable bottles can be compared to the benefit caused by a unit based product fee.

All compared scenarios are based on a prognosis of the market for 2012 worked out by GVM. The refillable quotas mentioned below are average quotas for 1,5 and 2,0 litre PET bottles for CSD and mineral water, based on litres. The prognosis of the refillable quotas after an implementation of a unit-based product fee led to a range of possible values (minimum, maximum, average). For the scenarios below, average and maximum values were used.

– The reference scenario is based on a prognosis of the refillable quota in 2012, when a unit based product fee is not introduced, which is 10 % (exact value 10,2 %). The corresponding refillable quota in 2003 was 16,5 %.
– Scenario 1: 20 % (exact value 19,8 %) refillable quota in 2012 after an implementation of a unit-based product fee, average prognosis.
– Scenario 2: 25 % (exact value 24,6 %) refillable quota in 2012 after an implementation of a unit-based product fee, maximum prognosis.
– Scenario 3: 30% refillable quota, representing an already very unrealistic situation for 2012.

The already existing product fee regulation says that the Ministry for the Environment *can* make use of the product fee income by financing activities to increase recycling and recovery. Even if this utilisation of the product fee income is not mandatory, the scenarios of this study assume that the product fee income is used to increase recovery of PET bottles up to 60 % and to increase recycling of PET bottles up to 42 % (70 % of separately collected bottles are assumed to be recycled). The environmental benefit of this additional recovery and recycling is considered in the scenarios without additional costs.

6.1 Summary of GVM prognosis with and without unit based product fee

Table 6.1-1: Prognosis of refillable quotas, based on litres, for carbonated soft drinks and mineral water. The market volumes also include bottles with 2,25 and 2,5 litres.

	Refill. quota	Prognosis of refillable quotas for 2012				
	for 1,5 & 2,0 litre PET	for 1,5 & 2,0 litre PET	for 1,5 & 2,0 litre PET	for 1,5 & 2,0 litre PET	for total market	
	status quo (2003)	without product fee	with prod. fee, average estim.	with prod. fee, maximim estim.	with prod. fee, maximim estim.	Total market in Mill litres
Mineral water	8,6%	5,5%	16,2%	21,2%	23,0%	586
Carbonated soft drinks	23,2%	14,1%	22,9%	27,5%	19,0%	694
Weighted average/Sum	**16,5%**	**10,2%**	**19,8%**	**24,6%**	**20,8%**	**1.280**

In the scenarios assessed and compared in this study, the unit based product fee is calculated based on the refillable quotas reached for 1,5 and 2,0 litre bottle. The table above shows that the refillable quota of the *total* market would even be lower, and therefore the unit based product fee would even be higher than assumed for the following calculation.

6.2 Calculation of product fee values and of scenario results

The calculation of scenario results is based on the refillable quotas listed above and the values in table 4-1: Scenario result = share of one-way bottles x result for one way system + share of refillable bottles x share of refillable system.

Calculation of mass based product fee: Values for plastics (30,4 HUF/kg) and paper (13,7 HUF/kg) were multiplied with packaging masses per litre. Values for refillable bottles were divided by the number of reuse-cycles. For all packaging materials only 20 % of the total value was considered (it was assumed that also in 2012 the total recovery of *all* packaging materials will exceed 50 %, which enables an exemption of 80 %).

Calculation of unit based product fee as "H-part" + "U-part":

For the H-part, 20 HUF/unit (for plastic bottles between 1,5 and 5,0 litres) were used, and again an exemption of 80 % was considered due to an assumed total recovery quota of *all* packaging materials of more than 50 %. The value for refillable bottles were divided by the number of reuse-cycles. The U-part was only calculated for one-way bottles: 0,45 HUF/unit (for plastic bottles between 1,5 and 5,0 litres) were multiplied with the shortfall in refillable quota in per cent. The U-part is to be paid two times: by the filler and be the retailer. Example: Refillable quota reached is 25 %; target for fillers and retailes is 55 %; U-part is 0,45 x 30 x 2 = 27 HUF/unit or 13,5 HUF/litre.

To make the calculation procedure and the results more clear and simple, the calculations regarding the unit-based product fee were simplified in comparison with the procedure proposed in the amendment of the product fee act:

Calculations regarding the unit-based product fee are based on the refillable quotas listed above, which are average quotas for 1,5 and 2,0 litre PET bottles for CSD and mineral water, based on litres. According to the proposed amendment of the environmental product fee act, the calculation of refillable quotas and unit-based product fees would be based on the refillable quotas of the *total* market of soft drinks or mineral water. For scenario 2, the prognosis of GVM shows an average refillable quota for the *total* market of CSD and mineral water of 21 % instead of the refillable quota of 25 % used above. That means the unit based product fee would even be higher than the values above, if the values were calculated by the procedure proposed in the amendment of the product fee act.

To calculate the product fee for retailers, a refillable quota of 55 % was assumed as target (average for 2008 – 2011 of the current KvVM proposal).

Example: Refillable quota = 25 %

Product fee based on packaging mass			
	PET one-way **HUF / litre**	PET refillable **HUF / litre** div. by no. of reuse-cycles	Difference **HUF / litre**
Bottle & Cap	0,15	0,06	
Crate		0,02	
Cardboard	0,00		
Shrink film	0,02		
Total	**0,17**	**0,08**	**0,09**

Product fee based on beverage packaging units			
	PET one-way **HUF / litre**	PET refillable **HUF / litre** div. by no. of reuse-cycles	Difference **HUF / litre**
Fee "H"	2,0	0,3	1,7
Fee "U"	13,5	0,0	13,5
Total	**15,5**	**0,3**	**15,2**

In this example (maximum prognosis regarding refillable quota, when the unit based product fee was implemented) the total product fee for one-way bottles is 15,7 HUF/litre and the total product fee for refillable bottles is 0,4 HUF/litre. The product fee expenses are therefore 15,3 HUF/litre higher for one-way bottles than for refillable bottles.

6.3 Result of scenarios and comparison of scenarios

Table 6.3-1: Results of the scenarios investigated and comparison of scenarios 1-3 with reference scenario.

Number of scenario	**Reference**	**1**	**2**	**3**
Refillable quota	**10%**	**20%**	**25%**	**30%**
Unit-based product fee included	**No**	**Yes**	**Yes**	**Yes**
Benefit of add. recovery (realised by product fee income) **included**	**No**	**Yes**	**Yes**	**Yes**
	Result Reference HUF/l	**Result Szenario 1 HUF/l**	**Result Szenario 2 HUF/l**	**Result Szenario 3 HUF/l**
PET bottle (incl. blowing process)	9,3	8,9	8,8	8,6
Shrink film & cardboard / crate	1,1	1,1	1,1	1,2
Filling (& reconditioning), storing costs	8,3	8,7	8,9	9,1
Transport	3,6	3,8	4,0	4,1
Shops incl. takeback	0,2	0,3	0,3	0,3
Waste management	1,2	1,1	1,1	1,0
Total business costs	**23,6**	**23,9**	**24,1**	**24,3**
Mass based product fee	**0,2**	**0,2**	**0,1**	**0,1**
Unit based product fee		**14,3**	**11,7**	**9,4**
Total costs including product fees	**23,7**	**38,3**	**36,0**	**33,8**
Environmental costs	**3,12**	**2,61**	**2,55**	**2,49**
Social costs of traffic	**0,58**	**0,60**	**0,62**	**0,63**
Total external costs	**3,70**	**3,21**	**3,16**	**3,12**
Environmental benefit of scenario X compared to reference scen.		0,51	0,57	0,63
Additional costs of scenario compared to reference scenario		14,61	12,22	10,06
Additional costs are ... times higher than value of environm. benefit		**29**	**21**	**16**

6.4 Discussion of results

The results of the comparison of scenarios are explained by the following example: The reference scenario (10 % refillable quota in 2012; no unit based product fee) shows average business costs including mass based product fee of 23,7 HUF/l and at the same time environmental effects equivalent to 3,12 HUF/l. Scenario 2 (25 % refillable quota as maximum estimation for the average of 1,5 and 2,0 litre bottles for carbonated soft drinks and mineral water in 2012; unit based product fee was introduced) shows average business costs including mass based and unit based product fee of 36,0 HUF/l and at the same time environmental effects equivalent to 2,55 HUF/l.

This means that the additional costs of scenario 2, compared with the reference scenario, are 12,22 HUF/litre, while the environmental benefit of scenario 2, compared with the reference scenario, is equivalent to 0,57 HUF/litre (the environmental benefit of additional recycling and recovery, realised by utilisation of the product fee income, is already included). In other words, the **additional costs to achieve a refillable quota of 25 % instead of 10 % by the unit based product fee are 21 times higher than the environmental benefit**. As the refillable quota of 25 % is already the maximum of the prognosis worked out by GVM, and the calculation is in many ways conservative (i.e. in favour of refillable bottles), the factor 21 is a minimum value.

If for example social costs of traffic are also included in the comparison, then the additional costs are 23 times higher than the benefit. If the **product fee income is not used** to increase recycling and recovery, then only the **environmental benefit of rising the refillable quota from 10 % to 25 %** remains, which is only **0,22 HUF per average litre**. Then the additional costs are **56 times higher** than the benefit.

Beside the scenarios described above also two scenarios with the *same* refillable quota (15 %), but different recycling and recovery quotas (status quo or **60 % recovery, 42 % recycling for PET bottles**) were compared. The result: An **environmental benefit equivalent to 0,38 HUF/litre is realised by additional average costs of 0,35 HUF/litre**. This shows that the **environmental benefit of increased recovery and recycling is 1,7 times higher** than the environmental benefit of rising the refillable quota from 10 % to 25 %. At the same time, the additional costs to increase recovery and recycling are actually proportional (!) to the environmental benefit, and they are much lower than the additional costs to increase reuse.

7 Summary and Conclusions

1. The results of this study are a good approximation for 83 % of the total market of carbonated soft drinks (CSD) and mineral water.
2. The **environmental benefit of 1,5 and 2,0 litre PET refillable beverage packaging** compared to 1,5 and 2,0 litre PET one-way packaging **is small**. It's value is equivalent to **0 – 1,5 HUF/litre**.
3. The **CO_2 emissions of Hungary** can only be **reduced by less than 0,04 %**, if the refillable quota would rise up to 55 %.
4. The **total life cycle costs of refillable systems are at least 3,5 HUF/litre higher** than the total life cycle costs of one way systems. Additionally, the **unit-based product fee will be at least 15 HUF/l higher for one-way** beverage packaging, if the refillable quota does not exceed 25 % (see below).
5. Market research shows many reasons why the **consumer increasingly prefers one-way beverage packaging**.
6. Analysis of the possible **influences of the unit-based product fee** on the beverage market show that the **refillable quota will possibly rise to a maximum of 25 %** in 2012 (average possible maximum for mineral water and CSD, 1,5 and 2,0 litre bottles).
7. Compared with a reference scenario of 10 % refillable quota in 2012 (if no unit-based product fee is implemented), the environmental benefit of a 25 % refillable quota is 0,57 HUF/litre (including benefits of additional recovery and recycling, possibly realised by the product fee income), while the additional costs (including unit-based product fee) are 12,22 HUF/litre.
8. Therefore, the **additional costs** caused by the unit-based product fee regulation **are at least 21 times higher than the realised environmental benefit**. This is an **extremely unproportional relation**, which is **not in line with the principles of sustainable development**.
9. **Environmental benefits from measures within the sector of beverage packaging can be realised much more easily and effective by raising the recovery and recycling quota** than by raising the refillable quota.
10. The achievable environmental **benefits of higher recovery and recycling are even higher** then the achievable environmental benefits of refillable bottles.

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Annex: Mass balance of one-way and refillable beverage packaging systems for 100 Mill. litres (I)

Carbonated soft drinks, 2 litre PET bottles	PET-OW	PET-REF
PRIMARY PRODUCTION BEVERAGE PACKAGING		
Input	**2812**	**1340**
raw materials beverage packaging	**2345**	**975**
raw materials crate		**365**
raw materials cardboard	**147**	
raw materials shrink film	**321**	
Output	**2812**	**1340**
beverage packaging	**2345**	**975**
crate		**365**
cardboard	**147**	
shrink film	**321**	
packaging		
beverage packaging	2412	1010
crate		373
cardboard	137	
shrink film	327	
production waste to recycling		
beverage packaging	0	0
crate		0
cardboard	0	
shrink film	0	
production waste to disposal		
beverage packaging	36	15
crate		5
cardboard	2	
shrink film	4	
material loss production (vitiated air/waste water)		
beverage packaging	-103	-49
crate		-13
cardboard	7	
shrink film	-10	
BEVERAGE PRODUCTION HUNGARY		
Input	**2876**	**19640**
beverage packaging	**2412**	**6767**
crate		**12873**
cardboard	**137**	
shrink film	**327**	
primary production packaging		
beverage packaging	2412	1010
crate		373
cardboard	137	
shrink film	327	
return flow refillable III		
beverage packaging		5757
crate		12500
cardboard		
shrink film		

Carbonated soft drinks, 2 litre PET bottles	PET-OW	PET-REF
BEVERAGE PRODUCTION HUNGARY		
Output	**2876**	**19640**
beverage packaging	**2412**	**6767**
crate		**12873**
cardboard	**137**	
shrink film	**327**	
sales at home		
beverage packaging	2400	6400
crate		12500
cardboard	137	
shrink film	325	
waste from use, seperate collected		
beverage packaging	12	367
crate		373
cardboard	1	
shrink film	2	
waste from use, to residual waste		
beverage packaging	0	0
crate		0
cardboard	0	
shrink film	0	
RETAIL		
Input	**2862**	**37157**
beverage packaging	**2400**	**12157**
crate		**25000**
cardboard	**137**	
shrink film	**325**	
sales at home		
beverage packaging	2400	6400
crate		12500
cardboard	137	
shrink film	325	
return flow refillable I		
beverage packaging		5757
crate		12500
Output	**2862**	**37157**
beverage packaging	**2400**	**12157**
crate		**25000**
cardboard	**137**	
shrink film	**325**	
consumption at home		
beverage packaging	2400	6400
crate		12500
cardboard	0	
shrink film	0	
return flow refillable II		
beverage packaging		5757
crate		12500
transport packaging, seperate collected		
cardboard	48	
shrink film	0	
transport packaging, to residual waste		
cardboard	89	
shrink film	324	

Carbonated soft drinks, 2 litre PET bottles	PET-OW	PET-REF
CONSUMPTION		
Input	**2400**	**18900**
Inlandsverbrauch		
beverage packaging	**2400**	**6400**
crate		**12500**
cardboard	**0**	
shrink film	**0**	
Output	**2400**	**18900**
beverage packaging	**2400**	**6400**
crate		**12500**
cardboard	**0**	
shrink film	**0**	
return flow refillable I		
beverage packaging		5757
crate		12500
packaging waste, seperate collected		
beverage packaging	400	107
cardboard	0	
shrink film	0	
packaging waste, to residual waste		
beverage packaging	2000	536
cardboard	0	
shrink film	0	
RECONDITIONING REFILLABLE BOTTLES		
Input		**18257**
return flow refillable II		
beverage packaging		5757
crate		12500
Output		**18257**
beverage packaging		**5757**
crate		**12500**
rejects return flow		
beverage packaging		0
crate		0
return flow refillable III		
beverage packaging		5757
crate		12500

Annex: Mass balance of one-way and refillable beverage packaging systems for 100 Mill. litres (II)

Carbonated soft drinks, 2 litre PET bottles	PET-OW	PET-REF
SEPERATE COLLECTION		
Input	**463**	**847**
beverage packaging	**412**	**474**
crate		**373**
cardboard	**49**	
shrink film	**2**	
packaging waste sep. coll.		
beverage packaging	400	107
cardboard	0	
shrink film	0	
transport packaging sep. coll.		
cardboard	48	
shrink film	0	
reject return flow		
beverage packaging		0
crate		0
waste from use sep. coll.		
beverage packaging	12	367
crate		373
cardboard	1	
shrink film	2	
Output	**463**	**847**
beverage packaging	**412**	**474**
crate		**373**
cardboard	**49**	
shrink film	**2**	
sep. coll. secondary materials to sorting		
beverage packaging	400	107
crate		0
cardboard	0	
shrink film	0	
sep. coll. secondary materials to recycling		
beverage packaging	12	367
crate		373
cardboard	48	
shrink film	2	
SORTING & RECYCLING		
SORTING PLASTICS		
Input	**400**	**107**
sep. coll. plastics to sorting		
beverage packaging	400	107
shrink film	0	
Output	**400**	**107**
plastics to material recycling fraction		
beverage packaging	360	107
shrink film	0	
plastics to thermal recycling fraction		
beverage packaging	40	0
shrink film	0	

Carbonated soft drinks, 2 litre PET bottles	PET-OW	PET-REF
SORTING CARDBOARD		
Input	**0**	
sep. coll. secondary materials to sorting	0	
Output	**0**	
sep. coll. secondary materials to recycling	0	
waste from sorting (residual materials) to re	0	
MATERIAL RECYCLING PLASTICS		
Input	**374**	**847**
beverage packaging	**372**	**474**
crate		**373**
shrink film	**2**	
sep. coll. plastics from sorting		
everage packaging in material recycling fraction	**360**	107
shrink film in material recycling fraction	0	
sep. coll. plastics directly to recycling		
beverage packaging	**12**	367
crate		373
shrink film	2	
Output	**374**	**847**
recycled material to packaging productionR	0	0
PET	0	0
LDPE	0	
HDPE		0
PC		
recycled materials for other primary product	337	792
PET	335	426
LDPE	2	
HDPE		366
PC		
residual materials from plastics recycling	37	55
PET	37	47
LDPE		
HDPE		7
PC		
vitiated air/waste water	0	0
PET	0	0
LDPE	0	
HDPE		0
PC		
MATERIAL RECYCLING CARDBOARD		
Input	**49**	
sep. coll. Cardboard from sorting	0	
sep. coll. cardboard directly to recycling	48	
Output	**47**	
recycled material to packaging productionR	0	
recycled materials for other primary product	47	
residual materials from plastics recycling	2	
vitiated air/waste water	0	

Carbonated soft drinks, 2 litre PET bottles	PET-OW	PET-REF
ENERGY RECOVERY		
Input	**40**	**0**
plastic beverage packaging to thermal plast	40	0
shrink film to thermal plastic fraction	0	
Verbunde to thermal plastic fraction		
residual materials from composite recycling		
Output	**40**	**0**
ash&slag	0	0
vitiated air/waste water	40	0
MUNICIPAL SOLID WASTE COLLECTION		
Input	**2496**	**611**
beverage packaging	**2074**	**598**
crate		**13**
cardboard	**93**	
shrink film	**329**	
packaging waste in MSW		
beverage packaging	2000	536
cardboard	0	
shrink film	0	
residual materials from sorting and recycling		
beverage packaging	37	47
crate		7
cardboard	2	
shrink film	0	
waste from primary production to disposal		
beverage packaging	36	15
crate		5
cardboard	2	
shrink film	4	
waste from use to MSW		
beverage packaging	0	0
crate		0
cardboard	0	
shrink film	0	
transport packaging to MSW		
cardboard	89	
shrink film	324	
Output	**2496**	**611**
beverage packaging	**2074**	**598**
crate		**13**
cardboard	**93**	
shrink film	**329**	
MSW to landfill		
beverage packaging	1825	527
crate		11
cardboard	82	
shrink film	289	
MSW to incineration plant		
beverage packaging	249	72
crate		2
cardboard	11	
shrink film	39	

Annex: Mass balance of one-way and refillable beverage packaging systems for 100 Mill. litres (III)

Carbonated soft drinks, 2 litre PET bottles	PET-OW	PET-REF
MSW INCINERATION PLANT (MSWI)		
Input	**299**	**73**
residual waste to MSWI		
beverage packaging	249	72
crate		2
cardboard	11	
shrink film	39	
Output	**299**	**73**
ash&slag	2	0
vitiated air/waste water	297	73
from MSWI to recycling		
LANDFILL		
Input	**2198**	**538**
MSW to landfill		
beverage packaging	1825	527
crate		11
cardboard	82	
shrink film	289	
ash&slag	2	0
Output	**0**	**0**
vitiated air/waste water	0	0
stock increase	**2198**	**538**
SUBSTITUTED PRIMARY PRODUCTION		
used amount recycled materials		
PET-Flakes	335	426
PC-Flakes		
LDPE-Granulate	2	
HDPE-Granulate		366
waste paper pulp	47	
Recycled Aluminium		
Recycled tin plate		
replaced amount of primary material		
PET-Flakes	318	405
PC-Flakes		
LDPE-Granulate	2	
HDPE-Granulate		366
wood pulp	37	
Aluminium		
Tin plate		