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# ECONOMIC ANALYSIS OF INTENDED BEVERAGE CONTAINER DEPOSIT SYSTEM IN THE CZECH REPUBLIC (PET BOTTLES AND CANS)

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# I. ANNOTATION

Specification of this study is based on the conditions defined in the annex No. 1 of the contract between IEEP, Institute for Economic and Environmental Policy at the Faculty of Economics and Public Administration of the University of Economics in Prague and the Ministry of Environment of the Czech Republic from 9th June 2008. According to this specification, the study should concentrate on the following topics:

- Cost and revenue analysis of the deposit system of the beverage containers (beverage PET bottles and beverage cans) with the aim of 80 % recycling of their total quantity – for introduction and realization of the system.
- Cost and revenue analysis of the deposit system of the beverage containers (beverage PET bottles and beverage cans) with the aim of 85 % and 90 % recycling of their total quantity – for introduction and realization of the system.
- Net cost analysis (after revenue deduction) and their projection in the final price for the consumer.
- Cost and revenue analysis of the sorted waste collection from the beverage containers by different recycling rates. Influence of beverage container (beverage PET bottles and beverage cans) deposits on costs and revenues of the sorted collection of the whole container waste commodity.
- Cost analysis of cleaning of environment from freely scattered waste in environment, totally and the share of beverage containers (littering). Possible savings of these costs on imposition of deposits.

The analysis should be based on the standard Scandinavian model of the deposit system which will relate to the beverage PET bottles and beverage cans in the CR. A part of the analysis should be the analysis of possible cost savings and economic effectiveness of the system as well. In the framework of this analysis, the task group will not consider so-called substitutional effects of the deposits or replacement of the deposit beverage containers by containers which are outside the scope of the deposits. In particular the basic substitutional effects of the deposits are concerned:

- change of beverage mix (replacement of beverages in the deposit beverage containers by the substitutes in the beverage containers without the deposit – e.g. juices, nectars in a beverage carton);
- change of container mix (replacement of the deposit beverage containers by the containers without the deposit – e.g. replacement of the deposit cans or PET by the non-deposit lightweight glass containers or beverage cartons);

- individual import (in border areas preference of the purchase of beverages in the non-deposit containers, reduction of domestic consumption)

Although it follows from German experience and other studies that these effects play an important role in considerations of the impact of the deposits on the current beverage market, nevertheless, according to the requirements of the submitter of this study, they will not be taken into consideration in evaluation of costs and benefits of implementation of the deposits in the Czech Republic. However, we draw attention to the fact that the comprehensive evaluation of these effects can have a completely essential importance for performance of the deposits of the one-way beverage containers – especially in effort to solve, by the deposits, the problem of freely scattered waste in public area[1] and total impact on waste sorting. The impact of the deposits on producers and importers of beverages cannot be investigated regardless of the substitutional effects as well, and therefore it is necessary to pay due attention to this problem.

Some basic facts in consumer behaviour in waste sorting and reactions to eventual deposit imposition are evident from the results of the consumer behaviour study carried out by the company Markent in July 2008[2]. The confirmation of the substantial substitutional effect of the Czech society is especially concerned.

From the inquiry into the change of consumer behaviour on the deposit imposition it follows that 26 % of respondents will definitely buy products only in the non-deposit containers and 49 % will rather buy products in the non-deposit containers, only 4 % will definitely not buy products in the non-deposit containers and 20 % will rather not.[3] Up to 79 % of respondents are willing, up to the amount of contribution of 4 CZK, to prefer the same beverage in the non-deposit container and 77 % of respondents other beverage in the non-deposit container.[4] Even if it can be assumed that the real numbers will be a little lower, from the realized inquiries it follows that the consumers are not willing to buy the deposit containers and they will search for ways to avoid the deposits.

Besides these substitutional effects, innovations on the beverage market can be expected as well – especially in the area of production of beverage containers for the different types of beverages. An example could be the beverage containers with a higher volume than the maximum volume for the deposits (the case of Germany, but not Sweden any more where no upper volume limit of the beverage container for the deposits is fixed) or the new beverage containers for classical beverages (e.g. usage of tubes). The innovation has the same sense in all the cases – to provide the consumer with the

[1] In Germany, in the period after imposition of the deposit for the one-way beverage containers, it came to a significant decrease in utilization of the one-way, but also refillable glass containers and cans and, on the contrary, to an increase of importance of the one-way and refillable PET bottles and beverage cartons. On the deposit imposition, only the container mix was changed, but the littering volume was not decreased – only its structure changed. As the study Prognos (2008) states, afterwards: "*the deposit beverage containers almost disappeared from the waste resulting from the city cleaning in consequence of the collection by inflexible people and so, subjectively perceived, the cities appear cleaner; at the same time, the littering contains more broken glass today*".

[2] Markent: Systém sběru použitých obalů, July 2008.

[3] Ibid., p. 70.

[4] Ibid., p. 46.

possibility of choice in case of beverage consumption, namely between the deposit and non-deposit container.

Procedure

Solution procedure was chosen with regard to the requirements of the Ministry of Environment of the CR (below only ME). While the draft study reflected the standard conditions for processing of the analysis RIA (*Regulatory Impact Assessment*), further on, by request of ME, it came to adjustment of the procedure into a "standard economic cost and revenue analysis" of the deposit system without any further specifications.

The task group set, as the main target of this project, to create a model which enables, on the basis of the input information, to model costs and benefits of the deposit imposition for the one-way beverage containers under conditions of the Czech Republic. The following text will try to assess, in individual steps, the key aspects of the deposit system on the basis of knowledge of the Swedish deposit system and on the basis of knowledge of other European countries' experience (expert studies of the renowned institutions at the European level) which implemented the deposit systems in the past. A part of every step will be definition of the system parameters chosen which enter the created model. In formulating these parameters, we draw on experience of representatives of the Swedish deposit system (see below), on national specifications of the Czech Republic and information provided by respective persons in the Czech Republic. For every cited piece of information we mention the source we were drawing on to enable the reader, in case of his interest, to create his own view of the source and to formulate his interpretation.

From the principle of modelling it follows that the outputs are of a variant nature. Through the choice of other system parameters it is possible to model alternative outputs. However, the task group has chosen the inputs of the model in such a way that the individual parameters correspond as much as possible to the conditions of the Czech Republic. The output of the model will be three basic variants of costs and benefits of the deposit system – a minimum cost variant, a real variant and a maximum cost variant. At the same time, the parameters will be defined which (as it will be evident from the model) are, from the viewpoint of the model output, of a marginal nature (or they have a minimum influence on costs and benefits) and, on the contrary, the parameters which are fully essential.

Parameter identification is based, on the one hand, on retrieval of expert literature and general information on functioning of the Swedish deposit system for the one-way beverage containers, but, on the other hand, this information was supplemented by qualitative data retrieved within the controlled dialogues with the key representatives of the Swedish deposit system. Among the questioned subjects were:

- Katarina Lundell (marketing manager of the company Returpack Svenska AB)
- John Strand (managing director of the company REPA)
- Thord Görling (executive of the department Material of the company FTI)

The stated dialogues were realized on **30th June and 1st July 2008 in Stockholm**. The study tour of the representatives of the task group to Sweden brought important information on functioning of the deposit system in practice including qualitative information which is not available from the publicly accessible sources and which contributes to the discussion on transferability of the Swedish experience into conditions of the Czech Republic.

The survey of the key parameters of the Swedish system combines data provided by the company Returpack with generally available data. These data represent a starting point for a deposit system proposal under conditions of the Czech Republic.

# II. PURPOSE OF DEPOSIT SYSTEM

Imposition of the deposits for the one-way beverage containers is connected with specific political aims. From retrieval of expert studies (e.g. study Apeal, 2008) and pronouncements of representatives of the states which factually implemented the deposits the following political aims can be identified:

a. stabilization event. increase of **share of refillable beverage containers on the market** (see e.g. Germany);
b. removal event. reduction of the problem of freely scattered waste in public area (so-called **littering**)(see e.g. Sweden, Norway)
c. reduction of **environmental impact** of the one-way beverage containers and their replacement by the environmentally milder refillable beverage containers
d. increase of **recycling rate** of the container waste compared to the current waste sorting systems

At this moment we will not discuss whether event. to what extent these aims of the deposit implementation were actually fulfilled (see in the individual chapters of the text), but we will concentrate on the principle of this policy instrument in the area of waste management and on its role under conditions of the Czech Republic. If we summarize expressions of the official representatives of the Czech Republic, then the main goal of the deposits should particularly be the decrease of quantity of freely scattered waste in public area.

The principle of the deposits is their incentive function. Through the price signals they motivate consumers to environmentally desirable behaviour (whether the non-littering in public area, or the returning of the beverage containers into the trade network, and therefore implicitly the contribution to the higher recycling of the beverage containers are concerned). Nevertheless, the price signals do not operate in an isolated environment. On the contrary. The efficiency of the deposits is an interaction of economical motives (deposit amount – e.g. in comparison to beverage price), but also extra-economical motives. The importance to pay attention to these motives as well is confirmed by the Swedish experience.

The main purpose of the deposits in Sweden was to prevent littering and to motivate consumers to return the beverage containers into trade network. The fact whether the consumer behaves really in this way does not depend only on the deposit amount, but also on the environment (consumer habits, culture, upbringing and education, sense of ecology etc.) which the consumer makes a decision in. It comes out of the medium-term results of the Swedish system that a very important motive of the consumer's decision are just his consumer habits – the fact whether he consumes the beverage "at home" or "on the way". Whereas it is typical for the beverages consumed "at home" that the consumer returns them during his next visit to the shop and regains the deposit in this way, again the beverages consumed "on the way" become a part of littering more probably.

As the Swedish experience indicates, for the consumption "at home" the consumers choose the beverages in PET bottles > 1 l and also cans whereas for the consumption "on the way" they choose the beverages in PET bottles ≤ 1 l (these beverage containers are smaller and therefore better storable and in addition to it the consumers fill them up persistently and use them repeatedly – e.g. at sport, trips etc.)[5]. These consumer habits are reflected in the return rate of the beverage containers too. As it is evident from the following table, the high return rate is typical for the beverage containers consumed "at home". It is interesting that the return rate does not correspond to the deposit amount because even with the deposit in an amount of only 50 öre the return rate for cans reaches 88 %.

**Table 1 Rate of return of beverage containers in Sweden**

| | 2005 | 2006 | 2007 | AIM | Deposit |
|---|---|---|---|---|---|
| aluminium cans | 86 % | 85 % | 88 % | 90 % | 50 öre |
| PET smaller than 1 l | 75 % | 72 % | 72 % | 90 % | 1 SEK |
| PET larger than 1 l | 93 % | 90 % | 90 % | 90 % | 2 SEK |

source: Returpack (2008)

It is evident from this table that the return rate reflects rather the consumer habits than the deposit amount (which is confirmed by the statements of the Returpack representative as well). Not only the policy in determining the deposit amount for individual types of the beverage containers, but also the general policy which determines the consumer habits of households should be adjusted to this fact. At the same time this fact indicates also one of the solutions of the littering problem – collection containers in places with a higher frequency of consumers' movement (Hiltbrunner, 2007).

In connection with the return rate of the deposit containers it is necessary to mention one more reality which is not evident from the stated table, though which is very important for its interpretation. The return rate of cans includes even those cans which are collected in the framework of the sorted collection organized by the company REPA. Thus the return percentage is a combination of the proportion of cans returned within the deposit system and within the current waste sorting system!

[5] In the Czech Republic the consumers choose, for the consumption "at home", particularly the beverages in PET bottles > 1 l whereas for the consumption "on the way" they choose the beverages in PET bottles ≤ 1 l and cans. The main difference between the Czech Republic and Sweden are accordingly the consumer habits of the consumers in case of cans!

# III. ONE-WAY BEVERAGE CONTAINER DEPOSITS IN EUROPE AND PARAMETERS OF SWEDISH MODEL

The deposits on the one-way beverage containers were implemented in the past by several states (Denmark, Finland, Estonia, Norway, Germany and Sweden) experiences of which can be used in case of the deposit imposition under conditions of the Czech Republic. Nevertheless these experiences and concrete parameters of the deposit system cannot be considered as an image of the process of designing the deposits in the Czech Republic. They represent only a model solution which has to be adjusted to the market conditions that are exclusively typical for the Czech Republic only (e.g. question of trade structure and distribution nature).

The presupposed study is based on the Scandinavian (Swedish) model of the deposits on the beverage cans and PET bottles. This model is herewith characterized by a number of parameters typical for the country which the deposit system was implemented in. This fact made the task group take a decision to identify these parameters and to discuss a potential of their transposition into conditions of the Czech Republic, even before the very costs and benefits analysis of the deposit system for the one-way beverage containers in the Czech Republic.

## III.A Returpack System

The Swedish deposit system is characterized by some general specifications which determine the effectiveness of the deposit system for the one-way beverage containers. One of these specifications is the deposit system for the refillable beverage containers (the same would be the case of the Czech Republic) before the implementation of the deposits on the one-way beverage containers. This fact facilitates the implementation of the new system not only for consumers who are used to returning the beverage containers back in the shop (though it is necessary to say at the same time that the consumers had no other possibility of handling the beverage containers because at the time of the deposit implementation the sorted collection system was not widespread), but to certain extent also for fillers of the beverage containers and for sellers that can use the already created infrastructure in a partial way.

Another important specification of the Swedish deposit system which to certain extent cuts down the costs of the whole system is the border crossing trade with the beverages between Sweden and Norway. As the study Perchards (2008) states, thanks to the high prices of the beverages in Norway, Norwegians buy the beverages in Sweden in a large extent (particularly canned beer), but they usually do not return the beverage containers in Sweden any more. As Norway also implemented the deposit system, Norwegian machines are programmed to accept the Swedish beverage containers, nevertheless they do not pay the deposit. It is clear that whereas the operator of the Swedish system gets the deposit which it does not need to pay out to the consumers subsequently and it uses it to cover the operational costs of the system, the Norwegian system counts the Swedish cans and subsequently hands them over for recycling. The number of the recycled Swedish cans in Norway is calculated in

the return rate in Sweden. However, such an arrangement is possible only thanks to the fact that both countries have the deposit system for the one-way beverage containers.

The Swedish deposit system relates to the aluminium cans and PET bottles, but at the present time Sweden extends the scope of the deposit on all metal and plastic beverage containers too. One of the reasons is also the fact that the importers often bought the steel cans which subsequently got out of reach of the deposits. On the contrary, milk, milk drinks, juices and nectars got out of scope of the system on the ground of fear of hygienic problems (bacteria and bad smell). The deposits on the beverage containers have no minimum or maximum volume limit though the deposit increases with the volume.

The operator of the deposit system for the one-way beverage containers in Sweden is the non-profit company Returpack Svenska AB (the operation profit is returned into the system in form of lower administrative fees or in form of investments in system improvement) which is owned by:

- 50 % by a trade organization associating Swedish breweries and producers of light beverages and packed waters (Brewers of Sweden)
- 25 % by a federation of Swedish grocers (Swedish grocer's federation)
- 25 % by a federation of Swedish food retail sales (Swedish food retail federation – SSLF)

The company Returpack secures operation of the whole deposit system – deposit accounting, settlement of all fees (manipulation or transport), transport of the beverage containers itself or communication among system participants. From the viewpoint of functionality, it is divided according to the type of the beverage container which it bears the responsibility for into two sections: *AB Returpack – PET* managing the deposit system for the one-way PET bottles (in operation only since 1994) and *AB Returpack* which is responsible for cans (in operation already since 1984). The operation of the company Returpack and of the whole deposit system for the one-way PET bottles and cans is secured through the **administrative fees** settled by producers, fillers of the beverage containers and importers according to number and type of the beverage container placed on the market (274 mil. SEK in the year 2007), further **revenues from the sale of the secondary raw materials** (216 mil. SEK in the year 2007) and finally the **non-collected deposits** (the deposits from the beverage containers which the consumers did not return in collection points) (1,198 mil. SEK in the year 2007).

The whole deposit system for the one-way beverage containers begins at the moment when the producers event. importers (*soft drink manufactures and breweries*) put the beverage container produced or imported by them into circulation. As soon as they do it they are obliged to settle the **deposit** amount to the company Returpack according to the type of material (PET of aluminium event. steel cans) and the volume (in case of PET up to and over 1 litre of volume). Besides the deposit they

pay, in the Returpack system, so-called **administrative fee** which covers the operation of the whole system. In the year 2008 the administrative fees amount to[6]:

- can 0 SEK
- PET ≤ 1l 0.22 SEK excluding tax
- PET > 1l 0.52 SEK excluding tax

An important part of this administrative fee is also the **fee for sorting** of the coloured PET bottles and steel cans which amounts to 0.05 SEK for the PET bottles regardless of the volume of the beverage container and 0.25 SEK for the steel cans (fees are paid excluding tax). Thus the individual payments of liable persons in the Returpack system are as follows (excluding tax):

| | | |
|---|---|---|
| - aluminium can | deposit | 0.45 SEK |
| | **TOTAL** | **0.45 SEK** |
| - steel can | deposit | 0.45 SEK |
| | sorting fee | 0.25 SEK |
| | **TOTAL** | **0.70 SEK** |
| - PET bottle ≤ 1l (clear) | deposit | 0.89 SEK |
| | administrative fee | 0.22 SEK |
| | **TOTAL** | **1.11 SEK** |
| - PET bottle > 1l (clear) | deposit | 1.79 SEK |
| | administrative fee | 0.52 SEK |
| | **TOTAL** | **2.31 SEK** |
| - PET bottle ≤ 1l (coloured) | deposit | 0.89 SEK |
| | administrative fee | 0.22 SEK |
| | sorting fee | 0.05 SEK |
| | **TOTAL** | **1.16 SEK** |
| - PET bottle > 1l (coloured) | deposit | 1.79 SEK |
| | administrative fee | 0.52 SEK |
| | sorting fee | 0.05 SEK |
| | **TOTAL** | **2.36 SEK** |

[6] Since 1st July 2008 the administrative fee has been reduced by 5 öre for PET bottles regardless of volume!

Besides these instruments, nevertheless, the liable persons have to count with the **costs of participation in recycling system**. For this participation the producers, fillers event. importers are obliged to settle the fee in an amount of 10.000 SEK which is the income of Swedish Board of Agriculture.

Through settlement of the fee the producers, fillers event. importers become a part of the Returpack system and obtain specific EAN codes which are unique and applicable only under conditions of the Swedish market. Besides these codes the beverage containers must bear indication of the Returpack system and a mark with the deposit amount.

Note No. 1

In case that the beverage container (PET bottle or can) is produced on the territory of Sweden, no additional costs arise for labelling of the beverage containers by stated identification marks (EAN code, indication of participation in the Returpack system and mark with the deposit amount). Nevertheless, in case of import of beverages from abroad it is necessary to supplement the beverage container with these identification marks and thus to seal the current EAN code by a new code which is typical for the Swedish market. Similar sealing of unsatisfactory identification marks on the beverage containers occurred in the Czech Republic in the years 2002 – 2004 when the importers' costs of this activity represented 1 CZK for a beverage container[7]. The task group estimates that currently the costs of sealing the identification marks under conditions of the Czech Republic would amount to 1 – 1.20 CZK for a beverage container.

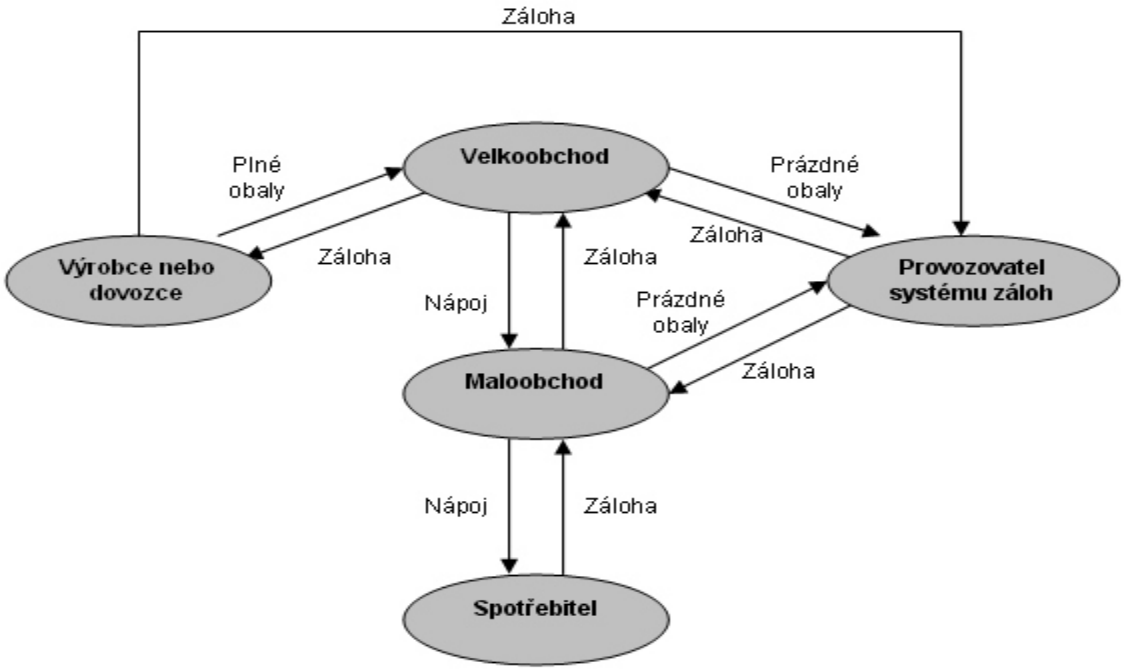
The increase of costs of placing a beverage on the market in the Czech Republic relates also to the risk of decrease of competitiveness of such products on the Czech market and thus the stated activity can be understood as a barrier in entry to the Czech market.

At the moment of obtaining the identification marks it is possible to place the beverage container into circulation and a closed circle of the deposits and production among the individual parts of the trade chain begins. As it was already stated above the liable persons, in the first instance, pay the deposit to the company Returpack. In the other step (through sale of the beverage to the final consumer) nevertheless the producers, fillers event. importers regain the deposit from the seller (physically the deposit is now in the hands of the company Returpack). As soon as the seller sells the beverage to the final consumer, it regains the deposit again. Even at this moment the deposit paid by the final consumer is always in the hand of the company Returpack; other parts of the whole chain (producers, importers and sellers) are in a balanced situation – the paid out deposit was returned to them from the consumers (i.e. in terms of the deposits they are neither debtors, nor creditors). In case that the final consumer shows an interest and returns the deposit beverage container in the shop, the deposit is paid

[7] Inquiry: Vinné sklepy Roztoky s.r.o.; UniConsulting s.r.o.

to him from the sources of the seller that however claims it subsequently from the company Returpack and thus the whole circulation is closed (as it is clear from the following picture).

**Picture 1 Deposit flow among system subjects**




source: Perchards (2008)

## III.B Return of Beverage Containers from Consumers

The system of repurchase of the beverage bottles by shops from consumers in Sweden has one completely specific characteristic – **the seller is not obliged to receive the beverage containers from the consumer!** Thus the repurchase of the beverage containers is a quite **voluntary** decision of the seller.

Why do we consider this eventuality as essential for functioning of the whole deposit system in the Czech Republic? The main reason is § 8 and 9 of the law No. 477/2001 Coll. on containers. According to the stated paragraphs the deposits on the one-way beverage containers (PET bottles and cans) would become the returnable deposit container whereas according to § 9 of this law: "*a person who places the products in the returnable deposit containers on the market or into circulation would be obliged to buy out these returnable deposit containers without any limitation of quantity and without connecting this buyout with the purchase of goods*". However this is at variance with voluntariness of repurchase of the one-way PET bottles and cans which is typical for the Swedish system. Therefore the question is whether it will come, within the Czech Republic, to repeal of the stated paragraph wording of the law on containers in effort to comply with customs of the Swedish model or whether this paragraph wording will be preserved.

Voluntariness of repurchase in Sweden has a significant impact on effectiveness of the whole system. Thanks to the fact that the sellers do not need to receive the one-way beverage containers the

Swedish system is more effective than e.g. the deposit system in Germany. Voluntariness means that the repurchase is provided only by those sellers this activity is economically advantageous for. Repurchase of bottles is a service to consumers which can involve a competitive advantage against those sellers that do not operate the repurchase. And to the contrary. The sellers the repurchase of the beverage containers is, on different grounds, unsuitable for (e.g. financial, spatial or personal reasons) do not operate this activity whereby nevertheless they are exposed to the risk that the consumer prefers a shop with the accompanying repurchase of the beverage containers.

Thanks to this measure a smaller number of collection points is integrated in the Swedish system (contrary to Germany), which results in lower logistical costs within the whole system (even this fact results in higher effectiveness of the whole system). Thus the decision in the Czech Republic on preservation or change of § 9 of the law on containers will in an important way influence the number of collection points and accordingly costliness of the whole system.

The decision on force of § 9 of the law on containers will influence fulfilment of the target of the **littering** decrease too. In case of removal of the one-way beverage containers from force of § 9 of the law on containers and accordingly of possibility of the shop to choose whether to repurchase the one-way beverage containers or not, there arises a risk that the consumer will have no possibility in locality of his residence (especially small villages are concerned) to return the beverage container and obtain the deposit. In such a case the consumer will compare benefit of the fact that he returns the container in a larger shop which is more distant from his place of residence (the deposit amount) with the costs of this decision (transport costs, time spent on the way etc.). Thus littering can become an alternative of a situation when the costs of the decision exceed the expected benefits.

Voluntariness has another important consequence in Sweden – possibility of trade to dictate the conditions of repurchase of the one-way beverage containers. Repurchase is e.g. coupled to purchase in the given shop. Failing that the deposit may not be paid out.

Thus principle of voluntariness of repurchase of the one-way beverage containers in Sweden with regard to the existence of § 9 of the law No. 477/2001 Coll. on containers has two variants of solution:

- preservation of § 9 – in such a case the system would have a character of the German deposit system for the one-way beverage containers (with a corresponding increase of logistical costs); solution would be to remove the one-way beverage containers from force of this §;
- change (removal) of § 9 – in such a case the deposit system would have a character of the Swedish system whereas it will not come to violation of the principle of voluntariness of repurchase, but the consumer will be disadvantaged because his possibilities to return the beverage containers in the shop will be restricted.

Note No. 2

If the consumer does not run across the shop which buys out the one-way beverage

containers, he tends in a larger extent either to freely litter the beverage container in public area, or to throw it into a wastebasket in public area. However these baskets are subsequently poked by seekers of the deposit containers. Thus both reactions of the consumer increase so-called littering. This fact led operators of the Swedish system to considerations of implementation of special baskets for the deposit beverage containers. If the consumer throws the deposit beverage container in such special basket in public area, then the disadvantage of such behaviour which is a difficult access to the valuable beverage containers (with regard to the content of other materials) is eliminated. Poking of baskets in order to obtain the valuable beverage containers would subsequently not increase the littering problem of waste scattered around the wastebaskets. The special wastebaskets placed next to the standard wastebaskets would accordingly secure better access to these beverage containers especially for underprivileged individuals and subsequently their return to the shops where the beverage containers are bought out.

The stated behaviour explains, by the way, the lower recycling rate of the PET bottles with the volume less than 1l as the beverage containers typical for so-called consumption "*on the way*" are concerned. Exactly these beverage containers end in the wastebaskets in public area because the consumers seek the easiest way of getting rid of this "waste" in proportion to the deposit amount. On the contrary, the PET bottles with the volume higher than 1l are typical for consumption at home and therefore the willingness to return these beverage containers in the shop within further purchase is higher.

According to Swedish experience the principle of voluntariness has one more completely essential consequence for assessment of impacts of the system on the individual "players" – consumers prefer the large shops to the small ones because they have a greater certainty of return of the deposit (currently the turnover in relation wholesale: retail sale is 85:15[8]; in the Czech Republic it is approximately 55:45). In case of non-existence of the principle of voluntariness and accordingly preservation of § 9 of the law No. 477/2001 Coll. on containers, a hypothesis can be pronounced that most purchases would take place in the large shops whereas the small shops would be preferred for return.

The decisive factor as to whether this behaviour will be the case is the nature of consumer habits of the Czech households and the trade network in the Czech Republic. As it will be clear from the chapter VI. Trade and other chapters, a less concentrated trade network is typical for the Czech Republic (than it is the case e.g. in Sweden) and the consumer habits of the Czech households are different as well. The pronounced hypothesis is confirmed by some smaller shops in the Czech Republic, addressed in the framework of this project, which state that during the first months of the

[8] 80:20 in Germany (see Prognos).

year 2008 the amount of the repurchased refillable deposit beverage containers exceeds the sold amount approximately by 9 % (in January even by roughly 25 %), in the year 2007 in average almost by 12 %. With regard to the fact that no broadcast inquiry was concerned, this experience cannot be overestimated, though, at the same time, this is an important signal of the manner in which a Czech household would deal with the one-way beverage containers on the deposit imposition which has to be taken into consideration.

Increased demands on some shops can lead, under conditions of voluntary participation, to the situation that they refuse to repurchase the beverage containers from the consumer. The following note presents another possible reason why the shop, in case of preservation of the principle of voluntariness, can decide not to operate the repurchase of the one-way beverage containers. The reason very closely relates to the security of the whole system.

Note No. 3

For the manual repurchase of the beverage containers only visual control of identification of the beverage container is typical. However, in such a case there is a risk that the seller accepts even such beverage containers which are equipped by false identification marks. Nevertheless the seller does not obtain the deposit which it subsequently claims from the system (Returpack) operator because the system operator accounts for the deposit only for those beverage containers which are part of the system. The manually collected beverage containers are recounted and identified in a special appliance (Petimeter) which subsequently rejects those beverage containers which do not belong to the system. The situation when the seller obtains, from the system operator, less than it paid out to the consumers makes the deposit system particularly for small sellers largely unpopular.

In such a case it either will not collect the beverage containers (thereby it would deprive itself of the consumers who prefer the purchase in shops where they can return the deposit beverage containers at the same time), or it will accede to the purchase of the technical appliance which facilitates identification for it (bar code reader). It will pay this appliance from its sources which will partially be compensated to it by so-called manipulation fee which is reimbursed to the sellers by the system operator for every collected bottle.

It follows from the Swedish experience that the risk of non-accounting for a certain portion of the deposits must be carried by the sellers because otherwise the system would be considerably prone to misuse (e.g. input of the false beverage containers into the system by the sellers themselves and not only by the consumers).

## III.C Method of Securing System against Misuse

As the deposit beverage container, at the moment of sale, becomes a security, it is therefore necessary to discuss rate and method of securing against the system misuse (imitation of identification marks etc.). Generally, the higher is the deposit, the higher must be the rate of securing of the system against misuse. At this moment, nevertheless, the question is how high the deposit must be to incite to efforts to misuse the system. The guidance can be the price of production of the beverage container with false identification marks or the costs of sealing the original identification marks with the false ones.

With regard to the fact that the production costs of a PET bottle amount, for some types of bottles, only to about 1 CZK/PET bottle[9], then any deposit higher than this limit represents an occasion of profit and therefore a risk of misuse of the system. From the stated facts it is clear that the deposit in an amount of the production costs reduces the probability of misuse of the system. At the same time, however, it decreases the motivating character of the deposits for consumers. On this ground, a decision on the deposit amount is a decision between the rate of securing of the system against misuse and the preservation of the motivating character of the deposits. The importance of this decision is evident in the process of calculation of system security costs.

If we summarize the idea stated in the latter paragraphs, then admittedly the higher deposit increases the **expected** rate of return of the beverage containers, but at the same time it increases the risk of misuse and accordingly the costs of securing of the whole system.

What is the character of securing of the deposit system in Sweden? The beverage containers which are part of the deposit system bear identification of the deposit amount and further the EAN code (see following pictures).

**Picture 2 Securing of deposit system in Sweden**


deposit in an amount of 50 öre for cans

EAN code

*(technical information on identification marks, their position, size, printing technology or use of colours can be found on the pages of the company Returpack)*

It is very complicated to set the amount of the costs of securing of the deposit system, and therefore it is necessary to search for other possibilities how to estimate the cost amount. One of possibilities is e.g. to determine the costs of the deposit system for 1 bottle in Germany for which a high rate of security is typical and the costs in Sweden for which, on the contrary, a low rate of security (reasons will be analysed below) is typical. The costs of 1 bottle within the deposit system in Germany are estimated at 5.3 cents, whilst in Sweden at 4 cents for a PET bottle (clear, 50 ml)[10]. Thus the difference makes 1.3 cents a bottle, which could be represented by the costs of system security (with

[9] Inquiry at Non-Alcoholic Beverage Producers Association and Mineral Water Producers Association, Alpla s.r.o., CCHB ČR s.r.o.
[10] RolandBerger (2008).

1.6 mld. pieces of PET bottles in the Czech Republic, the security costs would thus amount to 520 mil. CZK).

Control of identification elements in Sweden is carried out either technically (as part of repurchase within reverse vending machines), or visually (in case of manual repurchase of the beverage containers). Whatever technical identification of the beverage container reduces the risk of misuse of the deposit system (but even then misuse cannot be fully excluded!)[11]. Whereas in case of the reverse vending machines every beverage container is identified through an appliance for detection of the container placed in the machine and thus the risk of misuse is minimized, in case of the manual repurchase and the visual control of identification marks only, this risk grows.

Why has Sweden got, according to a statement of Returpack representatives, only little experience with misuse of the system? The reason is the fact that Sweden is geographically surrounded either by countries which have the deposit system, and accordingly there is no motivation to transport the beverage containers across the borders for the sake of gaining the deposit, or enclosed by sea. Thus any effort to misuse the system, with a low deposit amount, runs across the higher costs of misuse of the system (transport costs and production costs of imitation)[12].

In analysing this hypothesis, a completely different situation, nevertheless, can be expected under conditions of the Czech Republic which is surrounded (excluding Germany) by the countries which have not implemented the deposits on the one-way beverage containers. With a low production price of the beverage container (in case of a PET bottle it amounts to about 1.50 – 2 CZK) and an anticipated deposit in an amount of 3 CZK, efforts to misuse the deposit system can be expected, which has to correlate to considerations of the system security.

## III.D Deposit Amount Determination

Another key step in setting the deposit system is the determination of the deposit amount. Which factors has to be taken into consideration in this process? The deposit fulfils two basic functions in the system: 1) motivation, where we suppose an increasing return rate in case of a higher deposit (from available studies however it is not evident what amount of the deposit is "already" motivating and what is not "yet"); 2) it is the most important source of financing of the whole system. Generally it can be said that the higher is the deposit, the higher is the motivating function of the deposits and, at the same time, the lower will be the system revenues from the non-collected deposits.

What does the motivating function of the deposits under conditions of the Czech Republic consist in? In the first place, the deposit has to motivate the consumers to return the empty beverage containers into the trade network. Therewith one aspect is connected which is typical for countries like the Czech Republic which operate a functional system of sorted collection. The deposit has to be as

[11] The study RolandBerger states in this connection: *„Use of the reverse vending machines creates an anonymous environment the quality of which significantly declines at the level creating a fraudulent environment in proportion to the manual, personal collection"*.

[12] This hypothesis is defended by the study RolandBerger as well in justifying the necessity of high costs for security in Germany.

"strong" as to overcome the habitual patterns of consumer behaviour when the consumer depreciates the beverage container and throws it into tanks for sorted waste collection. In this sense "strong" does not mean "high" because it is not possible to define objectively the deposit "amount" which will overcome the difference between the more comfortable sorted waste and the less comfortable return of the empty beverage containers into the trade network (for approximately 50 % of population a sufficient motivation is the deposit of 2 CZK whereas for 30 % of population even the deposit of 5 CZK is not sufficient[13]).

### *III.D.1 Problems of "Higher" Deposits*

It has been said already that there is no objectively defined deposit amount which would compel the consumer to return the empty beverage containers into the trade network. Therefore we consider such a deposit amount which the consumer notices in paying for the beverage and when he realizes that by returning into the trade network the beverage price decreases. The higher is the portion of the deposit in the whole beverage price, the more the consumer will be motivated to return the beverage container actually.

Nevertheless, the higher deposit paradoxically brings lots of problems as well which are not evident at first sight, but which have to be very closely discussed as far as effectiveness of the whole system is concerned. In the first place it is necessary to realize that the deposit beverage container becomes a security, i.e. the risk of its **misuse (falsification)** grows. In case when the deposit is higher than the costs of fitting of the beverage container outside the system with the identification marks of the system (printing of indication of the deposit amount and the bar code[14]), the motivation of the subjects that do not pay the administrative fees in the system to its misuse grows.

With the growing risk of misuse of the system grows the demand for its securing against this illegal behaviour as well whereas this securing begins already with the persons who come across the deposit beverage containers still before their depreciation (it particularly relates to manual collection of the beverage containers when these containers are transported in the original form). Further the securing is also concerned with collection tanks or buildings where the non-depreciated deposit containers are stored before their depreciation.

As the study Perchards (2008; p. 30) states, the higher deposits bring dome other problems as well:

1. The higher deposits generate also the higher revenues in the deposit system – in other words, the system is financed by the consumers who do not return the empty beverage container into the trade network ("penalty" for an environmentally undesirable behaviour); this fact seems to be justifiable in case of the accessible shopping network which enables the repurchase of the beverage containers (however this cannot be secured in case of the voluntary repurchase of the beverage containers particularly in local shops and over-the-counter sale).

[13] Markent: Systém sběru použitých obalů, July 2008.
[14] Under conditions of the Czech Republic these costs reach 1 CZK for a beverage container (information of beverage importers).

2. The higher deposit increases the beverage price especially in the case when the consumer is not motivated to return the empty beverage containers into the trade network (this particularly relates to a certain segment of consumers – young one-member households and young people[15]); the higher beverage price increases motivation to search for cheaper substitutes – e.g. across the border in a country which has not implemented the deposits yet (this can be expected under conditions of the Czech Republic as well).
3. The higher deposit and the related higher costs motivate producers to change the type of the beverage container and to change the final products; some sellers (especially those smaller) will be motivated to buy the beverages across the borders so as to get rid of manipulation with the deposits and to be able to offer cheaper beverages to the consumers. This experience was typical both for Sweden and for Denmark.

### *III.D.2 Deposit Determination Procedures*

To determine the deposit amount for the one-way beverage containers there is a possibility to use several procedures. Within this study we will discuss 4 possible procedures altogether whereas, for assessment of costs and benefits of the deposit system, it will be based on the variant proposal.

In the first place there is a possibility to start from the deposit amounts in Sweden and to convert them with the help of the exchange rate (1 SEK = 2.486 CZK)[16]. In this case the deposit amount for the Czech Republic would be as follows:

**Table 2 Deposit amount for the CR recalculated on the basis of exchange rate**

| | Sweden | CR |
|---|---|---|
| cans | 0.5 SEK | 1.25 CZK |
| PET bottle ≤ 1l | 1 SEK | 2.50 CZK |
| PET bottle > 1l | 2 SEK | 5 CZK |

source: own

Another possibility is to recalculate the deposit amount according to the average household incomes. According to these criteria the deposit amount for the Czech Republic would be as follows:

**Table 3 Deposit amount for the CR recalculated according to average household incomes**

| | Sweden | CR |
|---|---|---|
| cans | 0.5 SEK | 0.65 CZK |
| PET bottle ≤ 1l | 1 SEK | 1.30 CZK |
| PET bottle > 1l | 2 SEK | 2.60 CZK |

source: own

[15] It follows from the statement of a representative of the company Returpack.
[16] According to the current exchange rate valid on 10th July 2008 (www.cnb.cz).

Besides these possibilities, the deposit amount may be determined according to the deposit amount for the refillable beverage containers. In this case the deposit would be set in an amount of 3 CZK. However, the question is for what type of the beverage container this deposit would be defined and whether the volume of the beverage container would be taken into consideration as it is the case in the Swedish model[17]. In case that the deposit for the smaller beverage containers would be set (as it is the case in Sweden) at the proportionally lower level, the demands on securing of the system would be admittedly decreased, but at the same time the motivating character of the deposits too[18]. And on the contrary. Any deposit higher than 3 CZK could result in higher costs of securing of the system.

The last possibility to fix the deposit amount is just the compromise between the production price of the beverage container (event. the caused costs of securing of the system) and the motivating ability of the deposits. From this point of view the deposit should not be higher than the costs of printing of the false identification and the bar code of the beverage container outside the system and at the same time low enough to preserve the motivating character of the deposits.

For the sake of modelling in the framework of this study we consider several variants of the presupposed deposit amount for the one-way beverage containers:

**Table 4 Presupposed deposit amount**

| | Variant 1 | Variant 2 | Variant 3 | Variant 4 |
|---|---|---|---|---|
| cans | 1.22 CZK | 2 CZK | 1 CZK | 0.50 CZK |
| PET bottle ≤ 1l | 2.44 CZK | 3 CZK | 2 CZK | 1 CZK |
| PET bottle > 1l | 4.88 CZK | 4 CZK | 3 CZK | 2 CZK |

source: own

## III.E Number of Beverage Containers on the Czech Market

In estimating the number of the beverage containers on the market in the Czech Republic (PET bottles and cans) which would become part of the deposit system we consider the data provided by Non-Alcoholic Beverage Producers Association, Association of Breweries and Malt-Houses and APC EKO-KOM, a.s. for the year 2007. From the viewpoint of setting of the deposit system in the Czech Republic, the information on the number of the beverage containers in the system is quite essential. It enables to estimate not only the part of revenues from the non-collected deposits with the expected return rate of the beverage containers, but also the demands of the retail sale on the reverse vending machines and the logistics of the whole system from the retail sale through the intermediate stores into the central facility for counting and processing of the repurchased beverage containers. On this ground, due attention was paid to obtaining of this information and the resulting number was

[17] The reason why the Swedish system uses different deposit amounts for different beverage containers (the higher deposits for the beverage containers of the higher volume) is that the deposit reflects the deposit on the refillable beverage containers. This deposit usually reflects the value of the refillable beverage container, and therefore it is higher for the larger volumes (Perchards, 2008).

[18] This risk arises mainly in case of the small PET bottles with the volume smaller than 1l which are typical for the consumption "on the way" and under conditions of the Czech Republic in case of cans.

compared with the available information of producers and with the data of APC EKO-KOM, a.s. from the beverage producers.

The key information for calculation of the number of the beverage containers on the market is consumption of the beverages according to the type (flavoured and non-flavoured packed waters; other non-alcoholic beverages like energetic beverages, juices, nectars, ice teas, ice coffee etc. and beer) on the ground of which the number of the beverage containers was calculated with knowledge of the portion of distribution in PET bottles and cans. All the necessary parts of information are included in the following table.

**Table 5 Consumption of beverages by sort**

| | consumption (in mil. l) | in PET bottles | | in cans |
|---|---|---|---|---|
| | | totally | thereof ≤ 1 l | totally |
| packed water non-flavoured | 886 | 95 % | 3 % | ~ 0 % |
| packed water flavoured (soft drinks etc.) | 1,299 | 92 % | 5 % | 0,5 % |
| other non-alcoholic beverages | 338 | 50 %* | -- | 3 % |
| beer** | 75 | 4 % | 100 % | 96 % |

* rest in beverage cartons

** only in one-way beverage containers (72 mil. l in cans and 3 mil. l in PET)

source: Non-Alcoholic Beverage Producers Association, Association of Breweries and Malt-Houses and APC EKO-KOM, a.s.

For another estimation[19] of the number of the beverage containers it is necessary to know the average volume of the beverage container for the individual types of the beverages. The average volume of the bottle ≤ 1l is about 0.5l (characteristic package is a bottle of 1.5 litre), the average volume of the bottle > 1l is at average about 1.75l in case of the flavoured beverages (characteristic package either 1.5l or 2l) and about 1.5l in case of the packed water (characteristic package 1.5 litre). The average can for the non-alcoholic beverages has a volume of 0.3 litre and for beer 0.4 litre. A PET bottle for beer has a volume of 0.65 litre. PET bottles for other beverages (excluding water and soft drinks) have various volumes (approximately a half is below one litre and a half above one litre) and at average they have a volume of about 1l.

On the basis of the partial steps stated, numbers of the beverage containers shown in the following table were calculated. These data will be used for the analysis of the deposit system for the one-way beverage containers in the Czech Republic subject to possible differences of the stated number in the individual years with a standard deviation of 10 % pursuant to seasonal effects. The seasonal fluctuations (particularly in summer months) can represent up to 25 % from the yearly

[19] Own estimation used based on empirical inquiry.

average (see table 7). Information on the seasonal fluctuations in beverage sales is important for estimation of capacity of the reverse vending machines and processing lines.

**Table 6 Quantity of beverage containers**

| | PET ≤ 1l in mil. p. | PET > 1l in mil. p. | Totally in mil. p. | Cans in mil. p. |
|---|---|---|---|---|
| non-flavoured waters | 53 | 543 | **596** | -- |
| flavoured waters (soft drinks etc.) | 130 | 672 | **802** | 22 |
| other non-alcoholic beverages | 85 | 85 | **170** | 34 |
| beer | 5 | -- | **5** | 180 |
| **TOTAL** | **273** | **1,300** | **1,573** | **236** |

source: own calculation

Accordingly, on the basis of available data we estimate that in the year 2007 altogether 1,573 mil. PET bottles and 236 mil. cans were on the market. This estimation corresponds, with accuracy of 3 %, to the quantity of the beverage containers (PET) which are part of the system APC EKO-KOM, a.s. (if we consider the empirically established average weight of a PET bottle in an amount of 25 g and the average weight of a PET bottle > 1l in an amount of 40 g).

The seasonal fluctuations of the quantity of the beverage PET containers placed on the market by the beverage producers in the Czech Republic in the years 2004 – 2007 are evident from the following table:

**Table 7 Seasonal fluctuations of quantity of beverage PET containers**

| Year | Quarter | PET (in tonnes) |
|---|---|---|
| 2004 | 1Q | 12,086 |
| | 2Q | 16,004 |
| | 3Q | 15,524 |
| | 4Q | 12,998 |
| 2005 | 1Q | 11,320 |
| | 2Q | 16,170 |
| | 3Q | 14,424 |
| | 4Q | 11,924 |
| 2006 | 1Q | 11,297 |
| | 2Q | 16,170 |
| | 3Q | 16,547 |
| | 4Q | 12,948 |
| 2007 | 1Q | 11,825 |

| | | |
|---|---|---|
| | 2Q | 17,269 |
| | 3Q | 14,786 |
| | 4Q | 12,608 |

source: EKO-KOM, a.s.

From the data on quantity of the beverage containers placed by the beverage producers on the market during the year we can estimate the development of consumption of the beverages within one year and accordingly the demands on their repurchase. As it will be clear from the following chapter dealing with estimation of the number of the reverse vending machines, not only the seasonal fluctuations within one year, but also the shopping hours within one day should be considered before purchase of the reverse vending machines.

For interest's sake let's mention the alternative data on the quantity of the beverage containers on the market which come from AC Nielsen and GfK. The statistic of GfK investigates the number of the beverages which households buy for consumption at home. The investigation methodology is based on the fact that about 1,500 households keep a consumption diary on how many beverages they consumed during the year (2007). From this investigation come the following results about domestic consumption of the beverages in the Czech households:

**Table 8 Quantity of beverages bought by households for domestic consumption**

| PET | | | | cans |
|---|---|---|---|---|
| 0 – 499 ml | 500 – 1,499 ml | 1,500 + ml | TOTAL | |
| 26,945,992 | 85,202,728 | 974,510,226 | 1,086,658,936 | 37,092,918 |

source: GfK (2008)

From this table comes one very interesting piece of information on the consumer habits of the Czech households which is also important with regard to implementation of the deposit system for the one-way beverage containers. If we compare the data on the number of the beverage cans sold (data from EKO-KOM, a.s.) with the data of GfK on the domestic consumption then we find out that for the domestic consumption the Czech households buy approximately $^1/_5$ of all cans on the market. The remaining quantity serves the consumption "on the way".

These consumer habits are clearly different between the Czech and Swedish households for which the beverage cans serve particularly the domestic consumption (to which corresponds also the higher return rate for cans). Thus a hypothesis can be raised that with regard to the different consumer habits of the Czech households **a lower effectiveness of the deposits in relation to the return rate of cans** under conditions of the Czech Republic compared to Sweden can be expected in case of the deposit imposition.

In case of the domestic consumption of the PET bottles it is evident as well that approximately $^2/_3$ of the beverage containers serve the domestic consumption and the rest is consumed "on the way"

(exactly these beverage containers are the subject of littering). The effect of the deposits on the return rate in this case will be higher than in case of cans.

Another source of information on the quantity of the beverage containers is AC Nielsen. This statistic is based on the sales inquiry in the chosen sample of about 500 shops and the rest is calculated. According to this statistic the number of the beverage containers (only PET) was as follows[20]:

**Table 9 Number of beverage PET containers**

| PET (mil. l) | | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| 0.33 | 0.5 | 0.7 | 1 | 1.5 | 2 | 3 | 5 | |
| 43 | 110 | 23 | 22 | 601 | 356 | 0 | 1 | 1,155 |

source: AC Nielsen

It is evident that these data are significantly different from the data of Non-Alcoholic Beverage Producers Association. The reason consists in the data collection methodology. Whereas in case of AC Nielsen only a selective sample of sellers is concerned, in case of the data of Non-Alcoholic Beverage Producers Association the voluntary reports of all producers on production and sales of the beverages to a common agency collecting these data are concerned. Accordingly the more complex data are dealt with, and therefore in the framework of this study we will build just on the data of Non-Alcoholic Beverage Producers Association.

## III.F Demands on Reverse Vending Machines

Estimation of the number of the reverse vending machines represents an important part of the costs and benefits analysis of the deposit system for the one-way beverage containers in the CR. Within different analyses it is very often based on the presumption that the higher is the number of the reverse vending machines, the higher system costs have to be counted with. However, in fact, this does not need to be the case because it is necessary to respect the opportunity costs of the shop which does not have any reverse vending machine and which carries out the repurchase of the beverage containers manually with visual control of the protective elements of the system or manually with use of a bar code reader. This analysis will be part of the solution as well.

This reality, nevertheless, does not change anything on the fact that it is necessary to pay due attention to estimation of the number of the reverse vending machines in the system. If we should build on the Swedish deposit model, we know that the system uses approximately 6,000 reverse vending machines whereas a part of the system are about 13,000 subjects (note: Sweden has 9 mil. inhabitants). At the same time we know that in contrast to the Czech market the Swedish food market is highly concentrated (a small number of supermarkets has a great share – approximately 90 % – in the national market). Breweries are simultaneously producers of the packed waters and non-alcoholic

[20] After conversion from the number of hectolitres, the number of cans can be estimated approximately at 29 mil. pieces.

beverages which are, within the direct distribution, sold directly to the retail sale. As it is stated in the study Perchards (2008) too, the deposit system in Sweden requires a relatively small number of the market participants, which results in lowering of the administrative costs, simpler minimization of free-riding and securing of a good network of the reverse vending appliances.

In estimating the number of the reverse vending machines under conditions of the Czech market it is necessary to take these factors into consideration. The items of source information for estimation of the number of the reverse vending machines are also:

- capacity of the reverse vending machines (number of the beverage containers in a minute)
- time spent by the consumer by the machine
- average number of the returned bottles by every consumer
- visit rate of hyper- and supermarkets, discounts and self-service shops in 1 day and during the day (taking rush hours into consideration)
- emptying of the receiver

The technical specifications on the capacity of the reverse vending machines and their price were obtained from the directed questionnaire inquiry with representatives of the company TOMRA-ORWAK which belongs to the most important producers of the reverse vending machines on the market[21]. However, these data were subsequently compared with results of a field inquiry which the task group carried out in July 2008 in selected shopping units (the subject of the inquiry was the machine T-710 from the company TOMRA which collects the refillable beverage containers). It followed from this inquiry that the real capacity of the machines in operation does not correspond to the theoretical parameters provided by the producer, and therefore the data from the field inquiry were used in subsequent estimation.

It results from the field inquiry that the average time spent by the consumer by the reverse vending machine is 36 s (coming, inserting of one bottle and subsequent issue of a record on the number of the beverage containers – 10 s, every subsequent inserting of the beverage container into the machine is 2-3 s) and the average number of the returned beverage containers is 12 pieces[22]. It follows therefrom that the machine is in real operation able to collect maximally 20 beverage containers a minute (and not note than 40 beverage containers indicated by the producer) and 1,200 beverage containers an hour providing however that the consumers approach the machine at the moment when the previous consumer leaves (nevertheless, in real operation, this is an unrealizable condition).

[21] Information from the competitive firms on the market about the price was not obtained till the closing date of this study. Accordingly, available are only technical parameters of the competitive products which relate to the offer of the company TOMRA.

[22] Interesting thing is that if within 1 minute only 1 consumer uses the reverse vending machine, he returns up to 21 beverage containers, however, in case of 2 consumers, everyone would manage to return only 9 beverage containers within 1 minute.

Now we will consider the average sales of the beverages in individual shopping units a day on the ground of which it is possible to estimate the number of the returned beverage containers during the day (as it follows from experiences of the shops in the Czech Republic, capacities of the reverse vending machines are designed just according to the number of the sold pieces and to the experiences with returning of the refillable beverage containers) – hypermarket 10,000 – 15,000 beverages, supermarket 1,500 – 3,000 beverages, discount 1,000 – 2,500 beverages, self-service shop 50 – 500 beverages and over-the-counter sale 50 – 200 beverages. As an example we choose the hypermarket.

The average sales in the hypermarket are 12,500 beverages a day and the same number can be expected to be returned in the hypermarket (though during rush hours, but also before Christmas and in summer the sales are several times higher). As the capacity of the reverse vending machines has to be designed just for the rush hours (almost 2 times higher demands) in such a way that comfort of the consumer is not decreased, accordingly the number of the machines has to be adjusted to this fact. The average opening time of the hypermarket (excluding the hypermarket Tesco with 24 hours operation) is 12 hours. In the rush hours, the demands on the repurchase are approximately 2,100 beverage containers, which would correspond to 2 machines under optimum conditions. With regard to delays, irregular approach of the consumers to the reverse vending machines and with regard to the fact that approximately 200 pressed PET bottles get in the receiver (it corresponds to about 17 consumers), the optimum number of the machines under real conditions, in effort to prevent queuing, would reach 4 pieces. This estimation corresponds also to the current experiences of hypermarkets with the machines for the refillable beverage containers[23].

In the same way we would proceed in case of supermarkets (2 reverse vending machines), discounts (2 reverse vending machines) and self-service shops (no event. 1 reverse vending machine) as well.

For estimation of the costs of the collection machines it is necessary to know first the input technical and economical data of the reverse vending machines. As information source we used the data of one of the most important producers of the reverse vending machines in Europe – the company TOMRA[24].

<u>data on reverse vending machines</u>

- ***machine purchase*** (price of the smallest machines fit for small shops – UNO is 178 thousand CZK, price of the largest machines used in hypermarkets and supermarkets including press T83 Hcp is 765 thousand CZK)

[23] Of course the hypermarket can decide to put into operation even fewer (or even more) machines. In such a case only the model parameter is changed. However, as it will be evident from the last chapter, the number of machines has no substantial influence on effectiveness of the deposit system.

[24] The technical parameters of the machines from the company TOMRA correspond to the parameters of the machines which are provided by other producers on the European market. However, as we did not succeed in establishing the price of the reverse vending machines from the competitive firms, we use data from the company TOMRA for the model solution.

- ***manipulation area*** (1 square meter for a small machine whereas the technical parameters indicated by the producers of the reverse vending machines note approximately 0.45 square meter in case of the smallest machines, which is however only the area for placing of the machine and not for manipulation with it, 6 square meters for a large machine plus 3 square meters of manipulation area)
- ***power consumption*** (40 W in sleep mode and 200 W in operation)
- ***case*** for storing the beverage containers from the machine (34 SEK a carton box)
- ***labour force*** taking care of the machine (time spent with emptying of the full receivers, time for cleaning the machine as a preventive care etc.) (average wages of the storekeeper 92.81 CZK/hour)
- ***machine service*** (for a small machine 2 times a year by 4 hours – 450 CZK/hour + transport on the average 200 km by 10 CZK and for a large machine 4 times a year by 4 hours with the same prices; 5 % of the value of the appliance a year – established by empirical inquiry)
- ***storage space*** for the beverage containers from the machine prior to their transport into a processing line (0.1 m for a box for half week – collection 2 times a weak)
- ***fulfilment*** of all fire-fighting, hygienic and technical regulations for ***storage*** of the beverage containers[25]

For emptying of the machine the worker uses standardized cases (carton boxes) which are placed in advance on a given place in the store. Material which is obtained from the machine is the deformed (pressed) beverage container which is not sorted by colours. In case of the small machines it does not come to deformation of the beverage containers which are put into the case intended for transport into the processing line.

<u>manual collection</u>

- storage space for the collected beverage containers (in sealed bags) (storage in a small shop without machine – construction adjustments and securing 50,000 CZK)

[25] In the model we will not consider the demands on fulfilment of the hygienic and other regulations though if follows from the opinion of the chief hygienist of the SR MUDr. Ivan Rovný, Ph.D. from 14th November 2002 that in process of preparations of the deposit system under conditions of the Slovak Republic it is necessary to take these regulations into consideration. As he states: "*the room for collection of the deposit containers has to satisfy the given purpose in terms of capacity, it has to be equipped with running drinking water, soap and paper tissues*". And further in case of demands of the storing area: "*In consequence of expected implementation of the collection of the PET bottles it is necessary to consider a substantial increase of the area of the storing room in shopping stores*". As it is not possible, without knowledge of the concrete adjustment of the system, to estimate how big the demands on harmonizing of the system with the hygienic standards would be, we will not consider these costs in our model.

- bags for storage of the beverage containers (70 to 80 litre bag with the mass of 100 – 120 g is worth of approximately 2.50 – 4 CZK whereas it contains 50 non-deformed PET bottles + the bag sealing (plastic seal) at the rate of 1 CZK has to be taken into consideration)
- time spent by the seller in repurchase of the beverage containers (time which cannot be applied to selling activity – i.e. opportunity costs) (the average wages in the retail sale 92.81 CZK/hour)
- identification of the beverage container
    - costs of acquisition of the bar code reader (the bar code serves as the identification mark of the beverage container which is part of the deposit system) acquisition costs 17,000 CZK (with the memory of 3,000 positions)
    - costs of acquisition of the computer and ADSL connection (on connection to the system it is possible to enter the EAN code and wait for the answer from the central office whether the beverage container is part of the system or not – this process is, however, quite long and user unfriendly as even several minutes long delays can occur) (connection to the data network 6,000 CZK; we do not include the till and computer costs)
- fulfilment of all fire-fighting, hygienic and technical regulations for storage of the beverage containers (see above)

For the purpose of the model we have chosen 6 variants which follow our assumptions on equipment of the trade network by the reverse vending machines (in all variants + depreciations). The first variant of the manual repurchase without the reader does not include the till and computer costs and is typical for the over-the-counter sales. We estimate the investment in construction adjustments at 50,000 CZK. The second variant counts again with the over-the-counter sale and manual repurchase, but this time with use of the reader (for shops with a higher frequency of the beverage purchase). We again count with construction adjustments in an amount of 50,000 CZK and further with the acquisition of the reader in an amount of 17,000 CZK. The third variant (model Jednota) is an automated repurchase with a small machine without a press and without connection to the till network. A model for small self-service shops is concerned. In this case we consider the investment in construction adjustments in an amount of 60,000 CZK and the acquisition of the machine for 178,000 CZK. The fourth variant (model Albert) reckons with an automated repurchase with help of two small machines without a press with connection to the network. We presuppose the investment in construction adjustments in an amount of 75,000 CZK, investment in the machines in an amount of 356,000 CZK and investment in IT in an amount of 12,000 CZK. The fifth variant is an automated repurchase with help of a large machine with a press with connection to the network where we consider the investment in construction adjustments in an amount of 60,000 CZK, investment in the machines in an amount of 765,048 CZK and investment in IT in an amount of 6,000 CZK. The last variant is a variant with two large machines with a press and connection to the network which is actually the doubled previous variant with construction adjustments in an amount of 75,000 CZK. The model outputs in terms of the repurchase costs are stated in the following table.

**Table 10 Operational repurchase costs**

| Repurchase method | Operational costs of 1 bottle/can |
|---|---|
| Manual repurchase without use of reader | 1.64 CZK/bottle |
| Manual repurchase with use of reader | 1.53 CZK/bottle |
| Automated repurchase, one machine without press | 1.30 CZK/bottle |
| Automated repurchase, two machines without press | 1.21 CZK/bottle |
| Automated repurchase, one machine with press | 0.77 CZK/bottle |
| Automated repurchase, two machines with press | 0.81 CZK/bottle |

source: own

Sometimes a possibility is considered to use, for the repurchase of the one-way beverage containers, the current machines for the repurchase of the refillable beverage containers. This alternative is theoretically possible (after previous adjustment of the machine), but practically excluded. The trade network dimensions the capacity of the current machines according to its experiences with the repurchase of the refillable beverage containers. The excessive capacities of the reverse vending machines involve wasting of the costs for business, and therefore the sellers are motivated to dimension the capacity exactly corresponding to their needs. Any other demands, therefore, would have to be solved by the acquisition of additional machines.

# IV. LOGISTICS OR TRANSPORT OF BEVERAGE CONTAINERS FROM SELLERS TO PROCESSING LINE

## IV.A Logistics in Sweden

As soon as the beverage container passes the reverse vending machine, it is deformed and stored in the receiver which is regularly changed (or emptied) by a worker of the shop. After storage there follows transport to the line in Norrköping where the beverage containers are sorted and counted in case that they come from the manual collection. The transport of the beverage containers from the shopping points till the year 2008 was guaranteed by the producer (event. importer) that subsequently claimed the settlement of the transport costs from the system operator (fee for collection and transport of the beverage containers which was accounted separately for the pressed containers and separately for the uncounted and unpressed containers).

For the purpose of transport of products into shops the producers (event. importers) leased services of the transport companies which within so-called reverse logistics brought together the empty beverage containers coming from the reverse vending machines or the manual repurchase from the trade network. Such a practice did not result in savings from use of the transport capacities on the way back because a paid transport service of an external subject is concerned.

The dominant distributor of the beverages into shops was the company Carlsberg which used the direct distribution (beer and Coca-Cola). This form of distribution, however, on the ground of low

effectiveness, was gradually transformed into other forms of distribution, which exercised influence on effectiveness of transport within the deposit system in Sweden as well.

At the present time, in connection with the growing quantity of the one-way PET bottles and cans, rises the pressure on reassessment of the way of transport of the beverage containers to the line in Norrköping – from transport guaranteed by the producer event. importer to transport secured by the company Returpack itself. The main reasons of the gradual withdrawal from the direct distribution can be seen not only in the growing transport demands, but also in the change of the way of distribution of the beverages especially by the breweries and at the same time in the effort to make the transport system more effective through choice of different vessels for transport of the repurchased beverage containers (withdrawal from the carton boxes to the larger cases in which the beverage containers will be discharged).

Therefore, as from the year 2009, the company Returpack plans to transport the deposit beverage containers from the shop by its own means. The acquisition of the transport technology and the equipment of the shop with new technology are certainly connected with it (withdrawal from the carton boxes to the wired cases with higher volume where the beverage containers can only be discharged). The planned frequency of transport from the shops is 1-7 times a week. Just on this ground it is necessary to consider the amount of the transport costs typical for the conditions of the Czech Republic.

The original transport system was typical for the Swedish logistic system which, however, is quite different from the system which is typical for the Czech Republic. In the Czech Republic, until recently, the distribution "in circle" was in operation where a product (event. different sorts of products) is distributed from the logistic centre to several shops on a previously fixed route. This means that a car is always transporting something and it cannot be assumed that it could carry the returned beverage containers on the way back. In Sweden, but also in Norway the products are distributed from the logistic centre into a certain shop, and therefore it is possible to take away the beverage containers on the way back and to transport them to the line in Norrköping.

For the logistic system of the returned beverage containers within the Czech Republic, creation of an independent transport system can be expected (organized by the deposit system operator). From this point of view it is necessary to answer the following questions:

- how many lines will be operated in the Czech Republic
- how many intermediate stores will be operated
- how many cars will transport the waste
- transport costs

## IV.B Theoretical Aspects of Distribution

One of the principal tasks of the distribution logistics is planning of the transport routes. The effective distribution logistics can have an influence on reducing of the operational costs. We distinguish the **length** of the distribution chains (= number of the distribution stages between the producer and the

consumer) and the **extent** of the distribution chains (= number of participants that take part in the distribution in a given stage). The distribution can be divided into the **direct** and **indirect** one. In the direct distribution only one distribution stage is used, in the indirect distribution several stages are used.[26]

In practice several variants of the distribution and trade chains (Pernica, 2005; p. 413 – 431) can be distinguished on the ground of which it is possible to explain the difference between the distribution in the Czech Republic and in Sweden:

a) **storage deliveries into the retail sale shops** – there can be three forms. The first one is the classical form with participation of the wholesale (so-called **delivery wholesale**) where the first member, under our conditions, used to be one wholesale whereas in Western European countries often more wholesales were the first member, the second member tends to be a storage of the retail sale firms, further the form with participation of the **producer's distribution storage** and last but not least the form where the producer, importer or warehouse uses the services of an external logistic partner – **logistic service provider**;
b) **direct deliveries from the production to the retail sale shops** (this form is common for 30-40 % of the grocery assortment);
c) **direct sales to the consumers from the wholesale stores** of the type cash and carry;
d) **mail order business**;
e) **direct deliveries of goods from the production to the consumers.**

For the Czech Republic in the nineties owing to privatization of the retail sale, the sale of goods to the consumers from the wholesale store of the type *cash and carry* was typical whereas in case of Western European countries this form of distribution was slowly loosing importance. Under conditions of the Czech Republic the importance of the classical storage delivery to the retail sale shops began gradually to grow when the goods moved from the producer into the wholesale store and subsequently in form of a "circle" (gradual distribution of goods) to the retail sale network. From here only the goods are handed over to the final consumer. Recently, the importance of the distribution by means of the direct deliveries in form of *cross-docking* is growing in the Czech Republic when the goods from the producer are transported into the so-called distribution centre from where the goods are transported into a certain retail sale shop. This kind of distribution, nevertheless, completely destroys the intentions about use of the transport capacity of the carriers for the return of the repurchased beverage containers.

As Pernica (2005; p. 1441) states, for 10 largest trade companies in the Czech Republic it applies that:

- all the trade companies, one excluding, use the logistic centres

[26] Pernica, P. (2005).

- if a company uses more than 1 centre, the most frequent is allocation of the retail sale network supplied from multi product line centres according to the territorial approach
- most logistic centres are a combination of the classical pallet store (with pallet truck technology) and the cross-dock centre; cross-docking is very extended – it is operated by 90 % of trade companies, altogether with fast movement items, event. in reloading between individual centres carried out because of using the vehicles to full capacity
- logistic centres participate just in a small extent in the reverse logistics – only by 15 % of the chains, the centres sort the returning containers and hand them over to the firms specialized in their liquidation. The centres receive back commonly only the means of transport and the returnable containers.

Interesting thing is (ibidem) that 90 % of the dry goods product line, 40 % of chilled and frozen goods, 40 % of fruits and vegetables, 45 % of beverages and 30 % of non-groceries come through the company's logistic centre itself. And what is the reverse logistics? With the reverse logistics we mean: "*organization and realization of the reverse flows from the consumption point to the revaluation or liquidation point*" (*Pernica, 2005; p. 555*). The same author draws attention to the fact that: "*in comparison with the flow towards the consumer, it (the reverse flow of the returned goods by the logistic chain to the producer – author's note) can reach as much as the ninefold of the logistic costs*" (Pernica, 2005; p. 554).

From the stated distribution conditions within the Czech Republic it follows that the optimization of the transport system of the deposit one-way beverage containers would require that the sorting, accounting and recycling line would be located in the area of the logistic centre. In any other case the transport costs would increase, which again would make the system more expensive[27].

## IV.C Logistics of Deposit System under the Czech Conditions

Under conditions of the Czech Republic following transport costs can be considered (data according to Česmad):

- transport costs = 27 – 50 CZK/km for a lorry (Avia up to 8 tonnes approximately 18 CZK/km) + manipulation fee in an amount of 250 – 300 CZK/hour
- in densely populated areas lump sum 450 CZK/hour (delivery) or up to 900 CZK/hour (lorry)
- differentiation according to use of roads with or without toll: roads with toll 47 CZK/km and roads without toll 42 CZK/km

Expensiveness of the system in the Czech Republic will among others depend on the number of lines which will recount and process the deposit beverage containers. The jumping board for defining the

[27] On the contrary – in case of Sweden the logistic centres are situated near the line in Norrköping, which made it possible to realize savings of the transport costs.

necessary number of lines under conditions of the Czech Republic are experiences from Sweden which state the following system parameters:

- 3 lorries an hour approach the line, i.e. 45 lorries a day altogether
- on 1 lorry 192 cartons can be loaded whereas the capacity of 1 carton is 200 bottles, i.e. 1 lorry can carry 38,400 bottles
- production of PET and UBC on the line amounts, in case of the line in Norrköping, to 18,000 tonnes of PET and 13,700 tonnes of UBC; with regard to the fact that the yearly production of PET in the CR represents 56,754 tonnes and with assumption of 80 % recycling this results in a need of 45,403 tonnes of the line capacity, i.e. under conditions of the Czech Republic more than 2 lines (not considering UBC) or 1 line with an extended capacity

Besides the line it is necessary to consider also the number of intermediate stores where the beverage containers will be transported. If we presuppose that approximately in every district will be 1 intermediate store, then 84 intermediate stores are concerned. A van with the planned payload of 80 % (if the shop has more beverage containers) will go to the shop, from the intermediate store the lorry goes fully loaded (at 100 %) already. In modelling we start from the assumption that the hypermarkets and discounts will be cleared 7 times a week, the supermarkets event. self-service shops twice a week and over-the-counter sales with manual repurchase once a week. For calculation of the transport costs we consider the average number of services for one ride, the surface density of the shops, the average geographical distance between the shops, the distance moved in the collection area, the average geographical distance from the intermediate store to the collection area, the loading time in one shop, the time on the way at the average speed of 40 km/hour, the obligatory stops and other variables entering the model. The average transport costs according to the repurchase character are stated in the following table.

**Table 11 Average transport costs**

| Repurchase character | Costs |
|---|---|
| Average transport costs of one container to the centre from large machines | 0.17 CZK |
| Average transport costs of one container to the centre from small machines | 0.35 CZK |
| Average transport costs of one container to the centre from manual repurchase | 0.45 CZK |
| Overall transport costs for large machines for one container | 0.33 CZK |
| Overall transport costs for small machines for one container | 0.75 CZK |
| Overall transport costs for manual repurchase for one container | 0.66 CZK |

source: own

Intermediate store (platform, hall and guard)

- we will consider 84 depots (the cheapest variant of the deposit system)
- average geographical distance of intermediate store to centre 91.5 km
- distance moved from intermediate store to centre 119.7 km
- bag collection transported by vans – mostly in development
- average wages of administrative worker in transport is 210.94 CZK/hour (number of administrative workers for 1 intermediate store = 1 and storekeeper = 2)
- yearly lease of intermediate store = 200 CZK/$m^2$/month
- intermediate store area 179 $m^2$
- yearly lease of intermediate store 430,050 CZK

# V. PROCESSING ON THE LINE IN NORRKÖPING

The equipment of the line in Norrköping includes machinery which, in case of the beverage containers from the machines, sorts PET according to colours in such a way that the maximum cleanness of the output raw material is secured for further processing within the close loop. Moreover, the white PET bottles are more valuable as the secondary raw material on the market compared to the coloured PET bottles. They are suitable for bottle-to-bottle production. The coloured PET bottles are separately pressed to the minimum volume and packed into bales.

Recycling of the coloured PET bottles is secured by the recycling line in the area of the line in Norrköping (that means that they do not need to be transported anywhere and the transport costs are saved). The flacks are subsequently transported to the facilities of PET bottle producers that produce the basis for production of new bottles. Recycling of cans is secured by another plant which pays Returpack for the value of the material.

Within the model we will consider the following parameters: 5 administrative workers of the centre, 16 storekeepers and 4 workers operating the petimeter. The price of the technological equipment of the centre 100 mil. CZK (without petimeter), the price of buildings, areas, roads and infrastructure 125 mil. CZK. Potentially, current capacities of some facility can be used, but in this case it would be necessary to consider the reconstruction costs and the equipment itself whereas particularly the reconstruction costs can be higher than the construction costs of a new line. A handicap of such attempts is also the specific location of the line on the territory of the Czech Republic which minimizes the transport costs, and therefore the system costs as well.

# VI. TRADE

## VI.A Trade Network and Distribution in Sweden

As it has already been stated in the chapter IV, the structure of the beverage production, the dislocation of the trade network and the distribution nature play a quite essential role in implementation of the deposits under conditions of the Czech Republic. For Sweden, a concentrated network of the retail sale network is typical which makes the process of implementation and operation of the deposit system for the one-way beverage containers easier. Put in numbers: only small number of supermarkets represents 90 % of the national market. Moreover, for Sweden the direct distribution is typical where it comes to so-called vertical integration of sale – trade chains buy directly from the producers, which eliminates the need for wholesale. Such an environment with relatively few producers and retail sale shops represents, in the deposit system, lower demands on complexity and costs of system operation (Perchards, 2008; p. 32).

One of the factors which have to be taken into consideration with regard to impact of the deposits on the trade network are the demands on investments of the trade units. It is evident that the larger trade units (particularly hyper- and supermarkets) are better equipped, in terms of capital and staff, for realization of larger investment actions and have better access to credits. Any investment claims on the trade network can therefore have irregular impacts on the hyper- and supermarkets (event. discounts) and the smaller shopping points like self-service shops or over-the-counter sales, which can result in further concentration of the trade network.

At the present time, in comparison with Sweden, a competitive environment with the lower concentration rate is typical for the Czech Republic (though the concentration rate is increasing). On the other hand, the ongoing process of concentration is, according to Czech Confederation of Commerce and Tourism, accompanied by the fact that the proportion of small and large shops in the overall trade volume is approximately 50:50. The shops with the shopping area smaller than 400 $m^2$ (98 %) clearly prevail in the total number of the retail sale shops. Exactly the fragmentation of the shopping units can pose problems in effort to implement the deposit system.

It further follows from the data provided by the company INCOMA Research that the consumers mostly look for the hypermarkets (38 %) as the shopping points the proportion of which, however, stagnates in the recent 5 years. Surprising is the gradual decrease of proportion of the hypermarkets on the market (16 %) and on the contrary the increase of proportion of the discount (25 %). The smaller self-service shops keep their market share in an amount of 14 %. These consumer habits are typical for the Czech Republic.

## VI.B Trade Network in the Czech Republic

In case of monitoring the impact of the deposits on trade in the Czech Republic we will consider the data on the trade network in the years 2006 and 2007 which are part of the document “Trade in the Czech Republic in the Year 2006” and the trade annual report of the company Incoma Research. The quantitative data will be supplied by the results of an unofficial inquiry of the representatives of the

trade network which was carried out by Czech Confederation of Commerce and Tourism by request of the project operator in the year 2008.

According to the statistics of the retail sale network of the Czech Statistical Office were **142,379** retail sale shops in the Czech Republic in the year 2002[28]. According to the qualified estimation of Czech Confederation of Commerce and Tourism, 50 % of this number were shops which deal with sale of groceries and beverages (or approximately 70,000 retail sale shops). In the deposit system for the one-way beverage containers, these shops would face a decision whether to take part in the system and collect the beverage containers from the consumer or not to take part in this system on different grounds. In case the shops would make a decision to take part in the repurchase of the one-way beverage containers, they have to consider the way in which the repurchase will be realized – whether by means of the reverse vending machines or with use of the reading device (so-called bar code reader), event. only manually with visual control of the control elements.

In order to be able to estimate the deposit system costs for the retail sale network, we will try to estimate how many shops from the stated number will acquire the reverse vending machine or the reading device. In estimating the number of the reverse vending machines we will use the experience of the Swedish shops (e.g. for which shops the acquisition of the reverse vending machines is typical).

Data on development of the number of the shopping units of the chains are evident from the following table.

**Table 12 Number of shopping units**

| | 2004 | | 2005 | | 2006 | | 2007* |
|---|---|---|---|---|---|---|---|
| format/month | 6 | 12 | 6 | 12 | 6 | 12 | 12 |
| **discount** | 379 | 427 | 447 | 468 | 481 | 513 | 560 |
| **hypermarket** | 148 | 161 | 167 | 192 | 198 | 213 | 235 |
| **supermarket** | 861 | 845 | 850 | 855 | 849 | 857 | 865 |
| **TOTAL** | **1388** | **1433** | **1464** | **1515** | **1528** | **1583** | **1660** |

* development on condition of linear increase of number of shops (calculated)

source: ***mag*** CONSULTING, s.r.o.

[28] source: Czech Statistical Office (publication code 9107-05)

Definition of the shopping units is stated in the following table:

**Table 13 Definition of shopping units**

| | shopping area ($m^2$) | product lines | number of sold bottles a day |
|---|---|---|---|
| larger hypermarket | > 5,000 | extensive groceries and non-groceries | 10,000 – 15,000 |
| smaller hypermarket | 2,501 – 5,000 | extensive groceries and non-groceries | |
| larger supermarket | 1,001 – 2,500 | extensive groceries | 1,500 – 3,000 |
| smaller supermarket | 401 – 1,000 | extensive groceries | |
| discount | generally 401 – 1,000 | groceries (limited number of products) | 1,000 – 2,500 |
| self-service shops | < 400 | extensive groceries | 50 – 500 |
| over-the-counter sales | < 50 | extensive groceries | 50 – 200 |

source: INCOMA Research + expert estimation of number of sold bottles

In estimating the number of the reverse vending machines for one shop we consider the experiences of the shops in the Czech Republic in case of the repurchase of the refillable deposit beverage containers and the experiences of the Swedish shops. If we suppose the reverse vending machine which is able to repurchase PET bottles and cans at the same time, then the following equipment of the shops with the reverse vending machines can be expected:

- hypermarket with 4 reverse vending machines
- supermarket with 2 reverse vending machines
- discount with 2 reverse vending machines

From these data it follows the minimum need of **3,790 pieces** of the reverse vending machines for hypermarkets, supermarkets and discounts. Besides the stated shops like hypermarket, supermarket and discount, it is also necessary to consider the shops of so-called Czech voluntary and franchise chains. Among 17 largest Czech voluntary and franchise chains with 4,840 shops there are 13 chains offering groceries whereas the number of their shops amounts to 3,872[29]. In case of this type of shops we will consider different variants which will depend on a concrete decision of operators of these shops as to whether they acquire the reverse vending machine or not.

The same applies to the case of the self-service shops the number of which, according to the estimation of Czech Confederation of Commerce and Tourism, amounts to approximately 2,000. In these shops the operators will make a decision among 3 variants as well: 1) repurchase yes, by means of reverse vending machine; 2) repurchase yes, manually; 3) repurchase no.

The costs arising for the shops in connection with the deposit system administration are partially settled by the system operator, namely through so-called manipulation fees. A part of the costs,

[29] source: INCOMA Research

nevertheless, will have to be settled by the sellers from their own sources whereas the resulting proportion will depend on fixing of the amount of the manipulation fee. As it follows from a dialogue with a representative of the company Returpack, the manipulation fee enables to settle the costs connected with the deposit system particularly to large shops. In case of small shops like self-service shops and over-the-counter sales, however, this is problematic.

In the middle of the year 2008 the amounts of the manipulation fees were as follows[30]:

- Manipulation fees for containers/bottles received through machines are:
  - Can 0.15 SEK (net)
  - PET ≤ 1 0.40 SEK (net)
  - PET > 1 0.50 SEK (net)

- Manipulation fees for containers received manually are:
  - Can 0 SEK (cans are not received manually any more)
  - PET ≤ 1 0.40 SEK (net)
  - PET >1 0.40 SEK (net)

Returpack gathers information on the collected deposits from the shops once a week (in the same way the so-called manipulation fees are paid out too[31]). The following table shows the total costs of the trade network by the different return rate. In modelling we use the knowledge of the number of the one-way beverage containers on the market and of the number of the shops. Our model is based on the condition that 9 % of the whole number of 70,000 shops will participate in the system. 12,740 shops out of the remaining number of the shops repurchase the containers and return them indirectly.

[30] source: Returpack: www.returpack.se/filer/file/Manadsrapport.pdf
[31] so-called handling compensation charges

**Table 14 Total costs of trade network by different return rate**

| Shop type | Pieces of containers a day for shopping unit during season | Auto-mation type | Total costs of trade network by different return rate | | |
|---|---|---|---|---|---|
| | | | 80 % | 85 % | 90 % |
| Hypermarket | 9,491 | 2x2 large machine | 515,291,381 CZK | 541,570,334 CZK | 567,849,284 CZK |
| Supermarket | 1,074 | 2x1 small machine | 310,310,221 CZK | 326,731,173 CZK | 343,152,124 CZK |
| Discount | 2,544 | 2x1 large machine | 314,530,594 CZK | 330,579,171 CZK | 346,627,748 CZK |
| Self service shop in voluntary chain | 278 | 1 small machine | 17,570,977 CZK | 18,371,503 CZK | 19,172,029 CZK |
| Self service shop / independent shop | 158 | 1 small machine | 6,227,181 CZK | 6,462,630 CZK | 6,698,079 CZK |
| Manual repurchase with reader (20 % of shops) | 1,587 | | 456,366,047 CZK | 484,241,923 CZK | 512,117,799 CZK |
| Manual repurchase without reader (80 % of shops) | 99 | | 136,621,927 CZK | 144,059,517 CZK | 151,497,108 CZK |
| **TOTAL** | | | **1,756,918,329 CZK** | **1,852,016,251 CZK** | **1,947,114,173 CZK** |

source: own

# VII. PRODUCERS AND IMPORTERS

The deposit system will quite certainly exercise influence on behaviour of the producers and importers on the market. The model confirmed that the deposit system for selected beverage containers is much more expensive pro producers than the system of the sorted collection of all types of the beverage containers. This fact can make the producers change to production of the beverage containers without the deposit (see the example of Germany – increase of the beverage cartons). Some types of the beverage containers are not usually part of the deposit system, though they are used as a package for the beverages which are included in the deposit system (Perchards, 2008).

As well as in other cases of decision of the producers and importers, even in case of participation in the deposit system the producers, at the moment the system costs become known (the administrative fee and demands on the identification of the beverage containers), will compare the costs of participation in the deposit system with the costs of participation in the sorted collection system. In such a case, examples of the producers changing to the beverage containers which pursuant to their characteristics do not fall within the deposit obligation cannot be excluded (Perchards, 2008). In this connection again it is necessary to stress that the simple change of production of the beverage

containers in line with the change to the deposit system is possible only in case of the large producers with a strong market position and not of the small producers of local importance. For these producers, this change is much more difficult.

# VIII. DEPOSITS AND SORTED WASTE COLLECTION IN THE CZECH REPUBLIC

The area of the sorted collection of reusable components of the municipal waste is the area of considerations of the consequences of implementation of the deposits in the Czech Republic for which it is not possible to use the experiences from Sweden. The deposit system for the one-way beverage containers (aluminium cans) has been operated in Sweden since the year 1984 and in the year 1994 it was extended to the one-way PET bottles as well. In the year 1994, the obligation of so-called producer's responsibility became part of the environmental legislative (as a consequence of the government regulation) whereas this obligation first referred to containers and newsprint and only subsequently it was extended to tyres, car wrecks, electro-waste, building waste etc. In consequence of this obligation the producers committed themselves to creation of the system of sorted collection of the packing waste and its subsequent recycling with the aim to fulfil the defined purposes of material utilization. The operator of this system became the company REPA which, in the year 2007, was transformed into the company FTI (Förpacknings- och Tidningsinsamlingen). An interesting trait of the sorted collection in Sweden is the fact that the obligation to include the waste sorting in the plan of the waste management came in force only in the year 2004.

Thus the deposit system in Sweden preceded the creation of the sorted collection system – the sorted collection is a mere supplement of the deposit system. The operators of the system REPA state that the sorted plastic collection, despite of existence of the deposit system, involves approximately 10 % of PET bottles. In case of the PET bottles ≤ 1 l which are not returned in the trade network (in the year 2007 it was 28 % of these PET bottles) 5-6 % of them end in the sorted collection tanks and the rest becomes part of the littering or of the mixed municipal waste. Just this fact that the collection tanks for the sorted collection (but also the baskets in public area) contain the deposit beverage containers increased the littering around these tanks because particularly the underprivileged citizens "poke" these collection tanks with the aim to obtain the valuable deposit beverage containers. The solution of this problem is introduced in the box with the note No. 2.

At the present time, in Sweden, the sorted collection for 950,000 tonnes of containers and 570,000 tonnes of newsprint is created whereas the recycling amounts to 54 % of all containers (source: EC, DG Environment). Part of today's discussion about the deposit imposition is also the question where are the limits of the sorted waste collection in terms of the utilization rate of the usable components of the municipal waste. From the successful operation of the sorted collection in Germany before the deposit imposition it follows that the limits of voluntary sorting amount approximately to

80 % recycling rate[32]. The results of material utilization of the container waste in Sweden and the Czech Republic are evident from the following table:

**Table 15 Material utilization of container waste in Sweden and the Czech Republic**

| | Sweden | | CR |
|---|---|---|---|
| | Utilization aim | Result 2005 according to EC | Result 2006 according to ME |
| paper | 70 % | 72.2 % | 90.8 % |
| metals | 70 % | 63.7 % | 47.1 % |
| plastics | 70 % * | 29.9 % | 44.3 % ** |
| glass | 70 % | 95.3 % | 70.5 % |
| total | | 54.4 % | 63.4 % |

* aim involves material recycling in an amount of 30 %

** beverage PET 60 % (2007)

source: EC DG Environment 2005, ME 2006

The main reason of the lower rate of material recycling of plastic in Sweden compared to the Czech Republic consists in the low level of sorting of the domestic refuse and in the related conceptual orientation towards burning of plastic in the incinerators of the municipal waste. For comparison of the sorted collection in Sweden and the Czech Republic, the degree of equipment with collection tanks and the average distance of the collection tank from a citizen can be stated furthermore. Whereas in the capital city of Sweden – Stockholm citizens have at their disposal 250 collection points (5,800 collection points within whole Sweden), in the capital city of the Czech Republic – Prague citizens have at their disposal 11,000 collection points. This fact is also reflected in the average distance of the collection tank from a citizen which in Sweden amounts to 400 m whereas in the Czech Republic it is approximately 118 m.

In Sweden, it is possible to observe one specific trait of the parallel operating systems – the deposits and the sorted collection. Cans which are thrown by the consumers into the sorted collection tanks are counted as those returned in the deposit system. I.e. the return rate of cans in the deposit system includes also the cans which were sorted by the consumers within the current sorted collection system, which artificially overestimates the effectiveness of the deposit system.

The difference of the Czech Republic as compared with Sweden is the fact that the potential deposit system would be, on the contrary, a supplement of the sorted collection system, however, with specific impacts which have to be analysed and which Sweden was not obliged to solve. The key impacts on the sorted collection we will deal with within this study are:

- influence on system revenues

[32] The dual system of the sorted collection of usable components of the municipal waste in Germany led, even prior to implementation of the deposit system, to 80 % recycling of the one-way beverage containers (RolandBerger, 2008).

- influence on organization of the system and its costs
- influence on fees from clients of the system (persons putting containers into circulation)
- influence on fulfilment of recycling quotas defined in the law on containers
- influence on system of the municipal waste management
- influence on public budgets

## VIII.A Influence on System Revenues

The subjects putting containers or packed products on the market or into circulation are obliged to secure the return and utilization of packing waste whereas they can do so by means of so-called joint discharge by virtue of a contract with an authorized packing company (APC). For discharge of obligation these subjects pay fees to APC whereas the revenue serves the securing of sorted collection in municipalities. The fees are derived from the mass of containers placed on the market. In case of implementation of the deposits on the one-way beverage containers, these subjects would stop paying the fee to APC, even despite of the fact that a part of beverage containers produced by them, in spite of the deposit system, would remain in the sorted collection. A part of the costs of sorted collection of the packing waste would not be covered by appropriate revenues from liable persons.

With regard to the fact that the total number of the non-returnable plastic beverage containers (non-alcoholic beverages – carbonated and non-carbonated waters, juices, soft drinks and other non-alcoholic beverages; alcoholic beverages – wine, spirits; beer) amounted in the year 2007 to 56,754 tonnes altogether, the unsettled fees would amount approximately to 240 mil. CZK. In case of the beverage cans (2,773 tonnes in the year 2007) the unsettled fees would amount approximately to 4 mil. CZK. The total amount of the unsettled fees would also amount approximately to 244 mil. CZK, which represents about one fifth of the revenues of APC.

## VIII.B Influence on Organization of System and Its Costs

As it has been stated above, even within the deposit system it cannot be expected that the rate of return of the deposit containers into the trade network would approach 100 %. Always it is necessary to reckon with alternative possibilities as to how to dispose of the empty beverage container. In the systems where the sorted collection of municipal waste according to individual materials (particularly plastics) is under operation, it can be expected that the beverage container will be disposed of within this system, event. it will become part of mixed municipal waste, littering or illegal ways of waste management (e.g. burning in domestic fireplaces).

In such a case, nevertheless, financing of the sorted plastic collection on the part of municipalities (event. APC) would run across the lack of means which this activity should be paid from. The difference between the revenues and the costs of securing of the sorted plastic collection is the more important, the lower is the deposit effectiveness or the lower is the rate of return of the deposit containers in the trade network. Such conditions can be expected particularly in the first years of operation of the deposit system when the return rate amounts approximately to 50 % (see e.g.

Norway)[33]. Though in the next years the quantity of the deposit PET containers decreases in the sorted plastic collection, the reduction of fees from the producers and importers for the joint discharge occurs already in the first year of operation of the deposits, on the ground of which APC is forced to search for other financial sources of the sorted plastic collection. The experiences from Germany also show evidence of the fact that this phenomenon is an accompanying characteristic of parallel operation of the deposits and the sorted collection.

As the study Perchards (2008) suggests, a possible solution could be that the transport firm separately sorts the deposit beverage containers for which it subsequently claims the settlement from the operator of the deposit system. Such a solution, however, has not been applied anywhere.

An important consequence of the loss of a part of the collected commodity (PET) is the loss of savings from extent which are realized by APC in connection with spreading of the sorted plastic collection. Though along with decrease of the sorted plastic collection, a decrease of the variable costs can be expected, the fixed costs (administration etc.) will have to be secured at the lower performance of services and at the lower revenues from fees.

## VIII.C Influence on Fees from System Clients

An accompanying effect of the deposits on the one-way beverage containers is also the probable increase of the fees for discharge of obligation of return for other persons putting containers or packed products on the market or into circulation. The decrease of revenues of APC, the costs of the sorted collection of the deposit beverage containers and the decrease of savings from extent will result in need to increase the fees even for persons that do not put the beverage containers on the market or into circulation. From the current amount of the fees paid by the persons that put the containers on the market or into circulation and from the quantity of the containers we estimate that the increase of the fees would amount to 34 % under ideal circumstances when willingness of citizens to sort the waste in unchanged quality will be preserved and the waste management firms will decrease their profits in due proportion to the decreased quantity of waste.

## VIII.D Influence on Fulfilment of Recycling Quotas

According to § 12 of the law No. 477/2001 Coll. on containers, the person putting containers or packed products on the market or into circulation is obliged to secure that the packing waste is utilized in the extent stipulated by this law (see the following table).

[33] The costs of sorted plastic collection in the first year of operation of the deposits with 50 % effectiveness, with the plastic collection costs in an amount of 6,500 – 9,000 CZK/t, can be estimated at 185 – 255 mil. CZK.

**Table 16 Compulsory rate of utilization of packing waste**

| | CR | |
|---|---|---|
| | **target (31. 12. 2007)** | **reality joint discharge (2007)** |
| paper and cardboard | 63 % | 96 % |
| metals | 36 % | 54 % |
| plastics | 25 % | 52 % |
| glass | 66 % | 68 % |
| wood | 6 % | 26 % |

source: ME

It can be expected that imposition of the deposits on the one-way beverage containers (particularly PET bottles) would be reflected in the rate of utilization of the packing waste (particularly plastics and metals). However, the question is how large the change of the rate of utilization will be, in which direction and what variables will play the most important role in this change. Withdrawal of the one-way beverage containers from obligation of the return will result in a smaller quantity of the plastic containers placed on the market. With regard to the fact that approximately 52 % of the sorted plastics are represented by PET, then at the same time a decrease in the quantity of the sorted plastics can be expected as well. As the experiences from Germany indicate, a decrease in the sorted collection of mixed plastics can be expected too. As the consumers perceive the sorted plastic collection particularly in connection with the sorting of the PET bottles, diversion of the flow of the deposit PET bottles into the trade network can reduce willingness of the consumers to sort the mixed plastics.

In which way also will the rate of utilization of the plastic containers be changed in consequence of the deposit imposition? If we start from the assumption that even after the deposit imposition the consumers will throw 20 % of the PET bottles into sorted collection tanks and at the same time one third of the consumer will stop sorting plastics, then the rate of utilization of plastics would decrease at 38 %. In case of a higher deposit efficiency (only 10 % of the PET bottles will be part of the sorted collection) and a higher discipline of the consumers (only every fifth consumer will stop sorting the mixed plastics), the rate of utilization would decrease at 40 %. In case of a still higher deposit efficiency (only 5 % of the PET bottles end in the sorted collection tanks) and unchanged behaviour of the consumers as far as the mixed plastics are concerned (they will continue to sort these plastics regardless of the fact that they will return the PET bottles into the trade network), the rate of utilization would decrease at 46 %.

However simple this consideration may appear, its implications can be important. In the first place it is evident that the more consumers will be convinced that sorting of the mixed plastics is meaningful, though they will lose the symbol of plastic sorting – the PET bottles, the lower the impact on the current rate of utilization of the packing waste will be. This fact will demand substantial

financial means for information campaigns (the Swedish REPA spends 3 mil. EUR a year for advertising and information campaigns the target of which is also the support of the sorted collection of the mixed plastics).

At the same time, paradoxically, the lower the deposit efficiency (or the more PET bottles enter the sorted collection) with unchanged behaviour of the consumers in case of the mixed plastics will be, the higher will be the rate of utilization of the packing waste. Thus the deposit system and the sorted collection system would be "competitive" in demand for the PET bottles so that both systems could fulfil the politically defined targets.

Inability of the sorted collection system to reach the legally stipulated recycling targets would cause a need for searching for new ways how to reach these targets so that the persons putting the containers and packed products on the market or into circulation would not act contrary to law. A solution would be to include the recycling of the deposit PET in the whole recycling of the plastic packing waste (in Sweden, nevertheless, the efficiency of both systems is evaluated separately). Last but not least, distinctively more intensive information campaigns are necessary which support the sorted collection of the mixed plastics.

## VIII.E Influence on Municipal Waste Management System

As it has already been stated in the chapter II., one of the political targets of the deposit implementation is also the increase of the waste recycling which is connected with the decrease of the waste quantity deposited on dumps. Influence of the deposits on the quantity of the mixed municipal waste (MMW) deposited on dumps can have two forms:

- ↓ MMW in consequence of returning of the PET bottles and cans in the trade network (or the waste which, before the deposit implementation, was left uselessly in the mixed municipal waste)
- ↑ MMW in consequence of unwillingness of the consumers to sort the mixed plastics because the symbol of plastic sorting (PET bottles) becomes part of another management regime

Let us analyse now these two effects of the deposit imposition in detail. First we will deal with the hypothesis on the decrease of production of MMW[34] in case of the deposit imposition for the one-way PET bottles and cans **[I]**. The enter data for the years 2005 – 2007 are indicated in the following table:

[34] For the sake of analysis we will consider the data on the overall production of the mixed municipal waste or on the overall production of the municipal waste with deduction of the waste which was materially utilized, also with deduction of 20 %.

**Table 17 Share of beverage cans and PET in MMW**

| | MMW (t) | Beverage cans (t) | Beverage PET (t) | TOTAL (cans + PET) (t) |
|---|---|---|---|---|
| 2005 | 3 520 000 | 3 776* | 24 564 | 28 340 |
| 2006 | 3 200 000 | 3 776* | 25 610 | 29 386 |

* assumed mass of 236 mil. pieces of cans with average mass of 16g

source: own calculation based on data from CENIA, ME, EKO-KOM

If we consider the simplifying assumption that the deposits on the one-way beverage containers divert 100 % of the beverage cans and 100 % of the beverage PET bottles from the mixed domestic waste, then the quantity of the mixed municipal waste would decrease, in the year 2006, approximately by 0.9 % (almost 30 thousand tonnes of waste). However, as it has been stated, the second effect **[II]** of the deposits in the area of municipal waste management is the decrease of the sorted collection of the mixed plastics which will be thrown by the consumers into the mixed domestic waste. The enter data for analysis of this effect are in the following table:

**Table 18 Quantity of sorted plastic and quantity of mixed plastic**

| | Quantity of sorted waste in system EKO-KOM – plastics (t) | Quantity of mixed plastics (48 %) |
|---|---|---|
| 2005 | 48,687 | 23,370 |
| 2006 | 59,600 | 28,608 |

source: EKO-KOM (2008)

Again, if we consider the simplifying assumption that all the consumers sorting the mixed plastics will stop sorting these plastics and begin to dispose of them in the framework of the mixed domestic waste, then the quantity of the mixed domestic waste deposited on dumps will increase. The consequence of both stated effects of the deposits **[I]** and **[II]** would be the decrease of the quantity of the mixed municipal waste in the year 2005 by 4.970 tonnes and in the year 2006 by 778 tonnes. The real effect on the decrease of the quantity of the mixed municipal waste is also quite negligible.

If we make the stated assumptions more real and consider the return rate of the PET bottles and cans in the extent of the current return rate in Sweden and at the same time we presuppose that only 20 % of the consumers will stop sorting the mixed plastics, then the quantity of the mixed municipal waste decreases by 17,998 tonnes in the year 2005 and by 17,787 tonnes in the year 2006, also approximately by 0.5 %. If we consider the average price for depositing the waste on dumps in the year 2007 which amounted to 927 CZK/tonne, then the savings of municipalities would amount to almost 17 mil. CZK for depositing the mixed domestic waste on dumps (savings of the costs for transport itself are not included).

What will be the effect of the deposits on material utilization of the municipal waste? If we consider the stated assumptions of the latter example, then for the year 2006 (for which there are also the data in terms of methods of municipal waste management) the rate of material utilization would increase by 0.6 %.

## VIII.F Influence on Public Budgets

The one-way beverage containers (mostly PET) are currently a part of the sorted collection of the reusable parts of the municipal waste which is organized by municipalities with support of an authorized packing company and also of the collection of the mixed municipal waste. Through the deposit imposition a change of organization of the whole system of the municipal waste management can be expected, but also a change in the area of the municipal budgeting. To make the influence of the deposits clear, we will try to indicate the expected changes in financing the municipal system of the municipal waste management by individual revenue and cost items.

### *VIII.F.1 Municipal Costs*

Particularly mixed municipal waste, bulky waste, baskets in public area, sorted collection, dangerous waste, waste collection yards, promotion, illegal waste dumps and others belong to the analysed cost items. The most important cost item of the municipal budget for the waste management are the costs of collection, transport and disposal of the mixed municipal waste which represent 60 % of the overall municipal costs. As it has already been stated in the previous chapter, through imposition of the deposits on the one-way beverage containers it is possible to expect the decrease of the municipal costs of the mixed municipal waste by **approximately 17 mil. CZK**. This amount, nevertheless, relates only to the disposal of the waste deposited on dumps. Other savings can be expected in case of the lower demands on the transport of the municipal waste and the collection tanks.

The second most important cost item are the sorted collection costs (approximately 11.5 % of the total costs). In consequence of the deposits particularly the decrease of the sorted plastic collection can be expected, namely both the PET bottles which will become part of the parallel system and the mixed plastic as part of the consumers will stop sorting the mixed plastics. This fact, on the one hand, will be demonstrated in savings of the transport costs of PET and mixed plastics, but, on the other hand, in the decrease of the revenues from PET sales and the decrease of the revenues from the producers for securing of utilization of the packing waste (remuneration to APC).

The transport costs of PET with the volume of approximately 35 kt and the unit price of 7,560 CZK/t amount approximately to 265 mil. CZK (if we deduct the depreciations in an amount of approximately one third of the costs, then the effective saveable costs amount to about 175 mil. CZK). These savings come from the fact that PET will not be transported within the current system of the sorted waste collection. PET sales on the market follow the actual price amount for the coloured and white PET. If we consider the approximate prices from the end of the year 2007, then the price of the coloured PET amounted to 5,000 CZK/t and the white PET 9,000 CZK/t. The following distribution of plastics in the sorted collection results from the field inquiries of APC EKO-KOM, a.s.:

**Table 19 Distribution of plastics in sorted collection**

| PET white | PET coloured | foils | PVC packing | other packing | foils non-packing | PVC non-packing | other plastics | admixtures |
|---|---|---|---|---|---|---|---|---|
| 22.3 - 35.9 % | 32.6 - 42.4 % | 2.3 - 6.7 % | 0.3 - 0.6 % | 7.4 - 16.3 % | 2.1- 9.2 % | 0.6 - 2.6 % | 2.6 - 5.4 % | 2.5 - 7.5 % |

source: APC EKO-KOM, a.s.

If we consider the 65 % distribution of the coloured PET and 35 % of the white PET in the sorted beverage PET containers, then the revenues from the unrealized sales would amount to 224 mil. CZK. Accordingly, the total amount of the loss in consequence of withdrawal of the PET bottles expressed as a difference of the savings and the losses reaches about 49 mil. CZK.

Another item of the public budget which will be influenced by the deposit implementation are the costs of baskets in public area as well. The purpose of the deposits on the one-way beverage containers is also an effort to exclude the deposit beverage containers from scrapping in the collection tanks in public area and, accordingly, to save the municipal costs. As it follows from the Swedish experiences, the deposit beverage containers disappear in fact from the baskets in public area, nevertheless their quantity is not as much important as to influence the costs of handling these baskets in a substantial way. Furthermore, one of the undesirable consequences of the deposits is reflected in the costs – the poking of the baskets in public area by underprivileged citizens and subsequently the problem of littering around the collection tanks.

At the same time, it is necessary, in this connection, to mention the substitutional effects of the deposits stated in the introduction of this study – the replacement especially of the deposit beverage containers by the substitutional beverage containers which become part of littering. The evaluation of these effects is very complicated because the final effect will be the result of an interaction of the consumer and production decisions. However, as the study Prognos (2008) states, the deposit beverage containers in the freely scattered waste (littering) were substituted by the glass cullet and beverage cartons. The structure of the beverage containers making up the content of the baskets in public area can have an impact on the costs. As this waste is mostly deposited on dumps and the price of dumping depends on the waste mass, then the replacement of the PET bottles and cans in littering by the glass cullet can have negative effects on the price.

Last but not least, changes in the costs of cleaning of communications can be expected too, but as it follows from pronouncements of the representatives of the transport companies in the Czech Republic, these costs are not so important as far as the total amount of the costs is concerned (for municipalities they represent approximately 5 %) and in addition to it, the very withdrawal of the beverage containers from the road cleaning has no influence on the costs of the cleaning "process", but only on the costs of handling the waste obtained in this way. In case of the expected substitutional effects, the positive influence of the deposits on mass reduction of the waste from the road cleaning

can be compensated by an increase of quantity of the glass cullet and beverage cartons[35]. With the problem of cleaning of communications the problem of littering is very closely connected as well which, nevertheless, will be the subject of a special chapter.

### *VIII.F.2 Municipal Revenues and Costs*

The key municipal revenues from which the municipal system of the waste management is financed are particularly the payments from the inhabitants (77 % of all revenues) and further also the payments from trade, profits from sales of the secondary raw materials and remuneration from APC EKO-KOM, a.s. It can be expected that in consequence of the deposit imposition the structure and importance of individual revenues in the municipal budget will change. Diversion of the flow, in terms of the market price, of the most important component of the sorted collection of the reusable components of the municipal waste will result in the decrease of the revenues from sales of the secondary raw materials and remuneration from APC EKO-KOM, a.s.

On the basis of the above stated analysis of the costs and savings of municipalities resulting from the deposit imposition it is evident that it will come to the savings of approximately 17 million CZK in the area of the mixed waste costs and to the loss of approximately 49 million CZK in the area of the sorted waste costs. From the viewpoint of the municipalities, the deposit imposition causes the total loss of the public budgets in an amount of approximately 32 million CZK. Thus the deposit imposition, from the viewpoint of the public budgets of the municipalities, is more or less neutral.

# IX. INFLUENCE OF DEPOSITS ON CONSUMERS

There will be a double influence of the deposits on the consumers. On the one hand, the consumer will be obliged to change his behaviour, accept new conditions and accommodate himself to them and, on the other hand, the deposits will relate to the consumer through the change of prices of certain types of beverages or of all groceries. The company Markent carried out a broad inquiry within the Czech society which was aimed at the influence of the deposits on the consumer's behaviour and at his attitude towards the deposits. In this chapter we will introduce some results from the final report of this inquiry[36].

Through the deposit imposition there will be a longer distance for the consumers to transport the containers. In case of the sorted collection they have the collection tanks at their disposal in such distances which most consumers regard as an acceptable distance to be willing to do sorting[37]. However, in the framework of the deposits, they will be forced to return the containers in the shops which are at average 2 times more remote.

[35] Study Prognos (2008) states that the deposit imposition for the one-way beverage containers has no economical effects on cleaning of communications and its statement is, among others, based on the opinion of the office BASt NRW (Bundesanstalt für Straßenwesen in Nordrhein-Westfalen) which in the years 2002 – 2005 noticed no effects of the deposits on the waste quantity and the costs of cleaning of public communications, roads and lay-bys.

[36] Markent, July 2008.

[37] Markent, July 2008.

In connection with the increased transport distance and the higher demands on the volume of storage and transport, the increase of the transport costs of the consumers into the shops can be expected as well. A part of the consumers states that in consequence of the deposits they will start using their car to do shopping.

The consumers regard as meaningful to return the glass and PET bottles for repeated filling. They though do not regard as meaningful to return the beverage cans, tins and PET bottles. From the realized inquiries it also follows that with the deposit imposition for the PET bottles the consumers imagine the repeated filling of the containers with the appropriate beverages (up to ½ respondents).

From the detailed inquiry of the consumer behaviour of the company Markent it follows that 31 % of the respondents think that they certainly do not manage to keep the PET bottles at home in an undamaged condition before returning them into the shop, 46 % rather do not manage to, only 3 % are convinced that they manage to keep the PET bottles in an undamaged condition (19 % rather manage to).

Again, 23 % of the respondents fully agree with the statement that they have no place at home where to store the waste, 43 % rather agree, 12 % do not agree and 21 % rather do not agree. For the same percentages storing the waste in the household represents a high hygienic risk.

Within the above stated questionnaire survey the respondents had to assess verity of some statements the aim of which was to establish the change in sorting the waste and the reaction of households to the imposed deposits.

*Because of returning of some containers in the shops people will stop sorting the rest of waste – 48 % agreed with the statement.*

*If the deposits on the PET bottles will be imposed, they will stop sorting plastics – 42 % agreed with the statement.*

*After the deposit imposition for the PET bottles they will sort no waste any more – 35 % agreed with the statement.*

*For 82 % of the respondents the preferred type of container is the container collected in the sorting tank.*

In case of the deposit imposition a dramatic decrease of the quantity of the sorted plastics can thus be expected, but also of other waste. The real percentages of the decrease will probably be lower, but even despite of it these decreases can be regarded as important because they will probably appear in a considerable increase of the proportion of the municipal waste deposited on dumps as well. On the basis of the inquiry it can be expected that the consequence of the deposits, if they will not be accompanied by any other important interferences with behaviour of citizens, will be the decrease of the participation of the consumers in sorting the plastic waste by up to one half and of the overall waste sorting regardless of material by up to one third. That would mean, with the dumping price of 927 CZK per tonne, an increase of the total costs of the waste management of households by about 30 to 50 CZK a year.

As it has already been mentioned at the beginning of the chapter, with the deposit imposition an increase of the beverage prices can be expected too. The willingness of people to return the deposits is low and its dependence on the deposit amount is not high too much. The limit which motivates at least one half of the consumers to return the containers is the deposit of at least 3.5 CZK for the large PET and at least 2.7 CZK for the small PET bottle, to reach the return rate of 80 %, nevertheless, the deposit of at least 5 CZK a bottle is necessary. Unfortunately, the deposit system costs depend on the return rate as well. In its calculation the revenues of the shops and of the system from the non-returned deposits (the deposits received on the containers which were not returned by the consumer) are regarded as the cost compensation as the consumer loss from the non-obtained deposit is regarded as a sort of penalty or an application of the polluter pays principle. Under this condition the impact on an average household which returns the bottles will be quite considerable within the limits of 418 to 1,500 CZK a year. Unfortunately, the more consumers will return the bottles, the higher the financial impact will be. The lower limit of the impacts on households thus corresponds to the low total return rate of 80 % and the high deposits exceeding 4 CZK whereas the upper limit of the impacts corresponds to the return rate of 90 % with the low deposits. It can accordingly be expected that the real impact on the consumer will rather amount to about one half of the range stated.

In case that the repurchase of the beverage containers will be a completely voluntary decision of the seller, i.e. the seller has no obligation to receive the beverage containers from the consumer, the number of places where the consumers can return the beverage containers decreases. From the inquiries performed it is evident that, for the households, the deposits are something which interferes with their familiar patterns of behaviour. In case of voluntariness of the repurchase of the deposit bottles on the part of the seller, a considerably lower return rate of containers and at the same time a stronger reaction of the consumers particularly in the area of substitutional purchases can be expected.

From the economic point of view a negative financial impact on an average household can be expected within the range of 500 to 1,500 CZK a year brought about by the increase of the waste management service prices, the beverage prices and the grocery prices. The distribution of this impact among the individual causes is hard to be done in advance with regard to the fact that both the range and the individual way of burden on the consumer depend very much on the really attained return rate of the containers and on the way of organizing and distributing the system costs among the sellers and producers.

Furthermore, the consequence of the deposit imposition will be a substantial change of behaviour of the consumer himself with which he will respond to the decrease of his comfort. On the one hand, a change of shopping behaviour will be concerned, particularly replacement of the deposit packages by the non-deposit ones in the average consumption basket, and, on the other hand, a substantial decrease of the willingness of the consumer to take part in sorting the municipal waste.

# X. ENVIRONMENTAL EFFECTS AND LITTERING

## X.A Environmental Effects

The deposit system should by a measure having a positive impact on environment. According to the supporters of the deposit system, the PET bottles would be removed from the municipal waste and accordingly its burned or stored quantity would be reduced. These positive impacts, nevertheless, would be surpassed by other negative effects.

The deposit system leads up to increase of the transport demands, the consequence of which is the growth of emissions. Namely both on the part of demand, i.e. consumers that would be often forced to use a car for returning the bottles during shopping, and on the part of supply where the firms would be obliged to secure the transport of the PET bottles into the counting or processing centre. From the inquiry of the company Markent it follows that some people who go shopping on foot today will use a car for shopping after the deposit imposition. With the growing number of the returned bottles, the transport demands will grow and subsequently the gas emissions discharged into the atmosphere.

Use of the machines, but also the manual readers would lead up to the increase of energy demand. With regard to their quantity, the increase of the power consumption in every firm in possession of this equipment will be apparent.

In case of the manual collection, a situation could occur when the firms would be forced to wash the bottles before their storing so that they could not stink in the shop until the transport into the counting centre and the hygienic conditions would not be infringed. Thus more energy would be consumed and simultaneously sewage water would be produced.

## X.B Littering

As it has already been stated at the beginning of this text, littering or free throwing of the waste in public areas is one of the key arguments for the deposit system implementation. Even an assumption has been pronounced that in consequence of the deposits littering would be partially removed, which could lead up to the decrease of the public area cleaning costs. Probability of the previous statement will be discussed at the end of this chapter.

In connection with the considerations on the deposit imposition, two studies dealing with littering have been started in the Czech Republic. The first one which has just been finished was submitted by ME[38] and the second one which is being processed (partial conclusions are known) is solved by the firm ETC Consulting Group, s.r.o. (below only ETC)[39]. The purpose of both studies is to establish the rate and composition of littering in the Czech Republic. As it can be seen from the following tables, the studies come to different results.

[38] SPF Group v. o. s. (2007).
[39] ETC Consulting Group, s. r. o.: Study monitoring littering in the CR.

**Table 20 Outcomes of study of ME**

| Total average of freely scattered waste divided by materials | | |
|---|---|---|
| Components | Mass (%) | Volume (%) |
| Plastics | 41.44 | 75.75 |
| Paper | 6.46 | 6.02 |
| Glass | 14.8 | 2.17 |
| Metals | 6.11 | 5.7 |
| Others | 31.17 | 10.36 |

source: ME: Analysis of freely scattered waste in the CR

The study of ME came to the conclusion that the plastics occupy the largest part of littering both in terms of mass (41.44 %) and in terms of volume (75.75 %).

**Table 21 Outcomes of study of ETC**

| Percentage distribution of individual components in terms of frequency | |
|---|---|
| Components | % |
| Cigarettes | 56.6 |
| Hygienic Utensils | 0.8 |
| Metals | 4.1 |
| Paper | 4.4 |
| Plastics | 7.3 |
| Miscellaneous | 2.5 |
| Glass | 10.0 |
| Tetra Pack | 0.1 |
| Chewing Gums | 11.1 |
| Biological Waste | 3.11 |

source: ETC Consulting Group, s.r.o.: Study monitoring littering in the CR

Compared to the previous study, the ETC study states that the largest portion, as far as the quantity of the freely scattered waste is concern, are cigarettes (56.6 %) and chewing gums (11.1 %). According to this study, plastics participate in littering by 7.3 %.

The results of these two studies differ in case of determination of the portion of the PET bottles in littering as well. The ME study indicates that their portion in terms of mass is 44.02 % and in terms of volume 77.41 %. In partial results of the ETC study it is stated that the PET bottles in terms of frequency represent 0.7 %, in terms of mass 8.8 % and in terms of volume 27.8 % of the freely scattered waste.

The difference of the results of these studies is caused by the differences in methodologies used. The aim of both studies is admittedly the determination of the rate of littering in the CR, but either wants to reach the results with the help of different indicators. The **choice of an indicator** is the main reason of the different results. The ME study chose mass and volume as the indicator whereas the ETC study chose frequency (the number of pieces of the freely scattered waste) as the main indicator. The individual indicators tend to overestimate or underestimate the different groups of waste. Therefore, in interpretation of the results it is always necessary to mention the indicator which was chosen.

The question is which indicator is correct and should be used? Most foreign studies today use the number of pieces of the freely scattered waste as the indicator, namely on that account that it is considered as the best image of the decreased aesthetical value of the landscape or the environment.

Another reason for the different results can be the temporal **inquiry realization** when the ME study was performed only in November and the ETC study both in autumn and the spring. Thus the first study does not take into consideration the possibility of the seasonal fluctuations. With regard to the fact that the autumn is often rainy, the mass indicator can be overestimated in the absorbent waste. On the other hand, owing to rain, the absorbent waste can be quicker absorbed, and therefore the underestimation can occur.

With the temporal realization of the ME study, the **choice of the representative sample** is also connected which should correctly include all the places where the occurrence of the scattered waste is possible. The November inquiry caused that the places with a higher elevation above sea level had to be omitted where snow had already fallen at that time. Further, the study concentrated on the highly frequented places only. The ETC study attended to places with a lower frequency of occurrence too.

The last factor, but also a very important one, which caused the different results was the definition of the **minimum size** in the ME study owing to which **cigarette stubs and chewing gums were not included in the inquiry** which are regarded by the ETC study, after inquiry realization, as a substantial problem of littering.

In comparison of the results of the Czech studies with the foreign ones, the task group came to the conclusion that the results rather agree with the ETC study. An example is the following table.

**Table 22 Outcomes of Viennese study**

| Percentage distribution of individual components in terms of frequency | |
|---|---|
| Components | % |
| Cigarettes | 58.3 |
| Paper, Carton | 8.8 |
| Biological Waste | 9.8 |
| Plastics | 11.6 |
| Glass | 7.3 |
| Metals | 3.9 |
| Miscellaneous | 0.5 |

source: ARA AG, MA 48: Die Studie der Wirtschaftsuniversität Wien (Viennese study)

The table shows the results of the Viennese study which came to very similar conclusions as the ETC study (the study itself analysed littering in the European context, and therefore it also included analyses carried out in the CR). The evidence of it is particularly the proportion of cigarettes in littering which in both studies makes up almost 60 %. The reason for the same conclusions is the choice of a very similar methodology.[40]

Therefore the question remains which results, regarding methodology, are less distorted and should be considered in assessment of the influence of the deposits on littering? The different results of the studies lead up to the different impacts of the deposit system. The higher is the proportion of the PET bottles or cans in littering, the larger will be the influence of the deposits on the partial removal of the freely scattered waste and vice versa.

### *X.B.1 Influence of Deposits on Littering*

It is assumed that after the deposit imposition the consumers will be motivated to return the bottles into the shops so that they would avoid the additional costs in form of the unpaid deposits, and therefore, through the removal of the bottles from public area, the quantity of the freely scattered waste will be reduced.

As it has already been stated in the chapter III.B Return of Beverage Containers from Consumers, important is the concrete form of § 9 of the law No. 477/2001 Coll. on containers which obliges the persons putting the deposit product on the market to collect this product. In considering the Swedish model, a situation would arise when littering would almost not be affected by the deposit imposition at all. The sellers here are not legally obliged to collect the deposit bottles from the consumers, and subsequently it comes to the situation that there is no point in searching for a shop for the consumer where he could return the deposit bottle, and therefore he prefers to litter it in surroundings. If the § 9 were cancelled, the same conditions as in Sweden would be reached.

[40] The Viennese study chose frequency as the main parameter. And similarly like the study ETC, it reckoned with the small waste (cigarette stubs, chewing gums etc.).

If the paragraph continued to be valid in the same wording or if it were only changed (as well as in Germany), the influence of the deposits on littering could be negligible. A consequence of the deposits could be a partial removal of littering, but at the same time it would cause the substitutional effect within the composition of the freely scattered waste.

The PET bottles would be partially removed from public area through the motivating function of the deposits. The consumers would be motivated to return the empty bottles back into the shops and subsequently it would not come to their littering so often. However, it cannot be supposed that 100 % of the PET bottles and cans would be returned.

If the consumers acted only on the basis of comparison of the costs of leaving the waste on the spot with the costs of their proper disposal, no one-way beverage containers would get into the collection tanks or back into the shops. In the consumer's behaviour the opinion is important that he does something right and if the additional costs of the proper disposal are not too high, he prefers the proper disposal.

In case of littering, the psychological and social aspects play the key role. In different situations the different littering types have different motivations. The study of the University Basel distinguishes several types of people. The first one is **I'm just not bothered**. It is typical for all the age groups, people consider littering as something which simply happens. The second type is **I don't want to be seen like a geek** where particularly younger pupils are concerned who, if they are alone, do not litter, but within a group they do not want to look like eager beavers and thus they litter as well. They will want to stop littering only if the others start behaving in such a way. The third type is **Blame it on the bins**. It is typical for a large segment of young people who are aware of the problem of littering which is caused by the lack of the collection tanks.[41] Thus littering is a problem of particularly young people. For these groups, the deposits will probably not be the substantial motivating function, littering is a life style for them, one of the occasions how to show off. The deposit will not be so much important for them so as to prevent them from littering the waste. From existing psychological and social aspects it follows that the freely scattered one-way beverage containers will not be removed ever. No measure is able to eliminate this phenomenon completely.

Another motive for littering the waste, for some consumers, is the already scattered waste. Some consumers can lose their scruples in this situation and throw off the waste on the dirty spot as well. More often, nevertheless, a passive behaviour is concerned when the waste is left on the spot than an active behaviour when the waste is consciously littered. Often behaviour of other people has a bearing on the consumer.

The supporters of the deposit systems often assume that the underprivileged individuals would start collecting the littered PET bottles and thus they would be disposed of. The problem however is that the bottles would have to remain in an unchanged condition and undamaged and this is, with regard to the natural conditions (wind, snow, rain) and the consumer habits to squeeze the bottles, improbable.

[41] MGU (2004): p. 42 - 43.

Thus, theoretically, littering could partially be disposed of in an amount of the proportion in which the PET bottles and cans together are present in the freely scattered waste, but from the practical viewpoint, such a disposal will not happen (regarding the sociological and psychological aspects). The study carried out in Cologne states that "through the deposits littering can be disposed of in a maximum amount of 20 %".[42]

Form the inquiry carried out by the company Markent it follows that people will be willing to return the large bottles, but the small bottles which are used for consumption on the way will continue to be thrown into a basket. Further, the respondents think that, even after the deposit imposition, there will be those who will not return the bottles. Over 80 % agree with the statement that the deposit imposition for the containers will result in the situation that some people will poke the litterbins in a larger extent. If follows therefrom that people expect that, even after the deposit imposition, the PET bottles will be thrown into the collection tanks.

The main consequence of the deposit system imposition will not be the partial removal of littering, but particularly the change in its composition. The deposit container will become undesirable for some consumers even despite of its advantages (low weight, storability). The consumer will start searching for a non-deposit beverage container. With the change of preferences, the littered waste in public area will change its composition as well. Probable is the substitution of the littered PET bottles with the beverage cartons, glass bottles or other types of the beverage containers. In consequence of substitution even the partial removal of littering may not happen, the quantity of the littered waste would remain the same, only the composition would be different.

### *X.B.2 Littering Solution*

In conclusion of the littering studies a recommendation of how to solve this problem is often formulated. Prevention of littering is particularly important so that the costs of its disposal would be as low as possible. Therefore, creation of information and educational programmes, campaigns, advertisements or different notices on the internet is often recommended.

Other measures which motivate the consumers to put the waste where it belongs are the economical incentives. They could be the deposits on the PET bottles, the deposits on the refillable containers, the penalty imposition etc. Thus littering would be included in the costs of the polluters.

One of other possibilities of the partial removal of littering in the future is implementation of the biologically dissoluble plastics. E.g. at the present time, the biologically dissoluble plastic portable bags have been placed on the market.

Thus the deposit imposition for the PET bottles and cans is not the only solution of the problem. In contrast to the campaigns and educational programmes it is only a partial solution of the problem. With regard to the cost demands of the system it would be better to chose a more complete and less expensive measure. The evidence is the statement of the study RolandBerger: "The operation of the deposit system for the one-way beverage containers, besides the effective dual system, reduces the

[42] Cologne (2002): p. 54.

waste littered in public area caused by the beverage containers only in a certain amount and the programmes for reducing this waste are always necessary anyway."

### *X.B.3 Public Area Cleaning Costs*

Cleaning of public area is secured by its administrators, i.e. the appropriate city and municipal authorities, infrastructure administrators (Road and Motorway Directorate, Czech Railways, bus companies, Prague Public Transportation Co., …), administrators of the special objects and delimitated parts of nature conservation (administrators of water plants, protected landscape areas, national parks, national cultural monuments, river basins). Within these organizations a survey was carried out in the period from 20th June to 7th August 2008 with the help of the telephone and email questioning and subsequently an analysis of the costs of cleaning of the environment from the freely scattered waste.

In sixteen cases out of sixty the contact with the appropriate worker who takes care of the waste management agenda was not established. Other eleven authorities stated that they did not keep the records of the freely scattered waste management or did not have any freely scattered waste at all, event. they did not consider this a problem which would have to be solved. The data were successfully gathered from 28 offices and organizations. Even those, nevertheless, did not manage to exactly define the littering removal costs as it was filed together with other municipal waste.

Only two representatives of the city authorities responded to a question "what part of littering is made up by the beverage containers?". A representative of the Municipality of Olomouc stated: "I estimate the percentage of the PET containers at 1 %". A representative of the City District Prague 10 stated: "PET containers represent 0.1 % by estimation". If follows that the PET bottles represent only a small portion in cleaning of public area. The major part of the sweepings includes the inert waste, e.g. old road spreading. Accordingly, the cleaning will have to be done even in case of a potential reduction of littering through the deposits because the PET bottles represent only an inconsiderable part of whole dirt which has to be cleaned from public area.

The public area cleaning costs would thus remain the same for the cleaning firms. Admittedly, the quantity of the littered waste would be reduced in a certain extent, but it would not affect the necessity to clean public area of other scattered waste, old road spreading and e.g. leaves. The fact that the composition of the littered waste is not important for cleaning of public area was confirmed by the representatives of the cleaning firms who were questioned.

The study Prognos states as well that "the deposit system imposition has no economical influence on cleaning of public area". The reduction of littering through the deposits is so inconsiderable that the cleaning has to be carried out with the same frequency as before the deposit imposition.

# XI. MODEL EVALUATION

The final chapter deals with evaluation of the model results. The main purpose of the model was to establish the whole system costs by the different rate of recycling, to determine the share of the shops and producers in these costs, to establish the cost balance by the different deposit amounts and finally to identify the minimum and maximum variant, event. the variant that we consider a real one. Last but not least, the key parameters will be evaluated which take the biggest part in the deposit system costs. Just in this regard we will formulate several very interesting results.

In the first place let us have a look at the whole system costs by the different return rate of the beverage containers and for the different shops. It is evident from the results that the costs are covered in 71 % by the shops and in 29 % by the producers. The overall results will be stated in the following table.

**Table 23 Total costs by different return rate**

| Shop type | Total costs by different return rate | | |
|---|---|---|---|
| | 80 % | 85 % | 90 % |
| Hypermarket | 944 085 279 CZK | 991 912 475 CZK | 1 039 739 672 CZK |
| Supermarket | 669 697 234 CZK | 706 391 801 CZK | 743 086 367 CZK |
| Discount | 696 768 857 CZK | 733 352 281 CZK | 769 935 704 CZK |
| Self service shop in voluntary chain | 26 123 424 CZK | 27 383 485 CZK | 28 643 546 CZK |
| Self service shop / independent shop | 8 656 489 CZK | 9 027 096 CZK | 9 397 702 CZK |
| Manual repurchase with reader (20 % of shops) | 694 848 108 CZK | 734 651 728 CZK | 774 455 349 CZK |
| Manual repurchase without reader (80 % of shops) | 196 793 082 CZK | 207 212 609 CZK | 217 632 135 CZK |
| Containers repurchased, but returned outside system (own transport) | 2 740 000 CZK | 12 740 000 CZK | 12 740 000 CZK |
| **TOTAL** | **3,249,712,473 CZK** | **3,422,671,474 CZK** | **3,595,630,475 CZK** |

source: own

In the following table the expected system revenues are stated – the revenues from the sales of PET and cans and the revenues from the non-collected deposits. The enter data of the model are the current redemption prices of aluminium, iron, coloured PET and white PET:

- redemption price of aluminium 15 CZK/kg

- redemption price of iron 1 CZK/kg
- redemption price of coloured PET 3,000 CZK/t
- redemption price of white PET 9,000 CZK/t

**Table 24 Expected system revenues**

| Revenue type | Revenues by different return rate | | |
|---|---|---|---|
| | 80 % | 85 % | 90 % |
| Sales of PET | 218 880 000 CZK | 101 745 000 CZK | 107 730 000 CZK |
| Sales of cans | 19 635 200 CZK | 20 862 400 CZK | 22 089 600 CZK |
| Revenues from non-collected deposits (4.88/2,44/1.22 CZK) | 1 459 608 000 CZK | 1 094 706 000 CZK | 729 804 000 CZK |
| Revenues from non-collected deposits (4/3/2 CZK) | 1 298 200 000 CZK | 973 650 000 CZK | 649 100 000 CZK |
| Revenues from non-collected deposits (3/2/1CZK) | 936 400 000 CZK | 702 300 000 CZK | 468 200 000 CZK |
| Revenues from non-collected deposits (2/1/0.5 CZK) | 598 200 000 CZK | 448 650 000 CZK | 299 100 000 CZK |

source: own

The following table includes the balance of the cost demands of the deposit system under conditions of the Czech Republic. From this table it will be evident under which conditions it is possible to reach the minimum costs and which variant, on the contrary, is connected with the highest costs.

**Table 25 Balance of cost demands of deposit system**

| Revenue type | Balance (loss) of deposit system | | |
|---|---|---|---|
| | 80 % | 85 % | 90 % |
| Revenues from non-collected deposits (4.88/2,44/1.22 CZK) | 1 551 589 273 CZK | 2 205 358 074 CZK | 2 736 006 875 CZK |
| Revenues from non-collected deposits (4/3/2 CZK) | 1 712 997 273 CZK | 2 326 414 074 CZK | 2 816 710 875 CZK |
| Revenues from non-collected deposits (3/2/1CZK) | 2 074 797 273 CZK | 2 597 764 074 CZK | 2 997 610 875 CZK |
| Revenues from non-collected deposits (2/1/0.5 CZK) | 2 412 997 273 CZK | 2 851 414 074 CZK | 3 166 710 875 CZK |

source: own

In connection with this table it is necessary to stress that the results with the concrete parameters which simulate the cheapest variant are concerned. These parameters include:

- number of machines 4,025 p.
- number of shops engaged 6,300
- rate of automation of self-service shops 4 %
- rate of engagement of shops in system 9 %
- number of intermediate stores 84
- number of sorting and counting centres 1

The results of the model, of course, are significantly changed with the choice of different parameters. We stress again: **the results stated in the table represent the cheapest variant of the balance of the revenues and costs of the deposit system in the Czech Republic!**

It is appropriate to note that these parameters of the cheapest solution represent not only a significant worsening of the citizen's comfort compared to the previous conditions, but also a significantly lower comfort in comparison with the Swedish solution itself. The precondition of the low costs is less than a half of the shops engaged in the repurchase compared to smaller Sweden (in fact only every eleventh shop will repurchase the bottles) and also a substantially lower utilization of automation (use of the machines is in fact presupposed only in the shops which are part of the networks of the international trade chains).

Within the model we tried to estimate the limit of profitability of the deposit system compared to the current waste sorting system. The results show for which return rate the deposit system is still profitable in comparison with the present conditions. The higher return rate increases already the costs above the framework of the current system. At the same time, we tried to establish by how much the producers' costs within the deposit system will be increased compared to the current conditions as well as the costs of recycling of one tonne of the waste in comparison with the present state. The results of these considerations are in the following table (the limit of profitability means in this case that if the deposit system reaches the return rate higher than the limit of profitability, then the costs of recycling reached through it will be, from the consumer's viewpoint, higher than the current costs of the sorted waste collection):

**Table 26 Limits of system profitability compared to current waste sorting system**

| Revenue type | Limit of profitability compared to present state | Producer's costs of containers compared to present state | Costs of recycling of 1 tonne compared to present state |
|---|---|---|---|
| Revenues from non-collected deposits (4.88/2,44/1.22 CZK) | 66 % | 1136 % | 757 % |
| Revenues from non-collected deposits (4/3/2 CZK) | 63 % | 1169 % | 780 % |
| Revenues from non-collected deposits (3/2/1CZK) | 55 % | 1244 % | 830 % |
| Revenues from non-collected deposits (2/1/0.5 CZK) | 43 % | 1315 % | 876 % |

source: own

It is clear from this table that the deposit system represents an expensive system in case of its comparison with the system of the sorted collection of reusable components of the municipal waste, namely both from the viewpoint of the producers and from the viewpoint of the waste management system. Which parameters of the deposit system are the most important for the overall balance of this system? As important we will consider the parameters the importance of which exceeds 2 % (the importance is assessed as the percentage change of the total costs in consequence of the 10 % change of a parameter). These parameters include:

- return rate of the beverage containers into the trade network (78.20 % of importance: with every increase of the return rate by 1 %, the costs are increased at least by 100 mil. CZK a year)

- annual consumption of the PET bottles (11.3 % of importance)
- number of the machines (7.3 % of importance)
- rate of automation of the independent and alliance self-service shops (6.9 % of importance, the costs grow by 87,000 CZK a year for one machine)
- costs of transportation by a lorry (CZK/km) (6.7 % of importance)
- % of the shops selling the beverages included in the system (4.4 % of importance, the costs grow at least by 37,000 CZK a year for every engaged shop)
- effective price of 1 square meter of the shopping area (4.1 % of importance)
- price of the transport carton box with capacity of 200 bottles (3.4 % of importance)

It is evident from the stated parameters that the most important factors are mainly the annual consumption of the PET bottles, the number of the machines and the return rate. Paradoxically, the number of the intermediate stores in the system and the number of the processing lines constructed do not play an important role. The change of these parameters has only a minimum influence on the overall balance. More lines or more intermediate stores result admittedly in an increase of the investment costs of construction of buildings, but at the same time the transport costs are decreased (see importance of the costs of transportation by a lorry).

The number of the machines does not play such an important role too as it could seem at first sight. As it has been stated in the previous tables, the operation of the machine, on the contrary, decreases the costs of 1 container. Thus, admittedly, the number of the machines in the system influences the total costs, but the importance of this parameter cannot be overestimated.

# XI. CONCLUSION

The study, according to the requirements of the submitter, analyses the costs and effects of the deposit system of the beverage containers and draws on the Swedish model. During the study the most important characteristics of the system are analysed – voluntariness and non-voluntariness of the system, determination of the deposit amount, demands on the machine equipment, question of distribution. The result of the study is a model which is able to present the total costs of the system by different rates of recycling and other changes of the defined parameters. This model is based on the conditions which were defined at the beginning of the study.

The task group of the project is aware of the strong additional effects too which relate to implementation of the deposit system of the beverage containers. Particularly the consumer behaviour and reactions of trade and often dubious environmental benefits are concerned.

According to the realized inquiries of the consumer behaviour, a strong substitutional effect will work, which means that up to 70 % of the consumers will prefer, in case of implementation of the deposit containers, the products in the non-deposit containers. Dramatic reactions can occur in the overall waste sorting as well. Not only the proportion of the sorted plastics will be generally reduced,

but also, in reaction to the imposed deposits on the PET bottles which are the basic symbol of sorting for the consumer, a dramatic decrease in sorting of other waste can occur and the whole sorting system can collapse.

A strong reaction of trade to the implemented system of the deposit containers, replacement of the beverages in the deposit beverage containers by the substitutes – non-deposit containers (e.g. nectars in the beverage carton etc.) are expected.

The positive environmental impacts of the implemented system can be lightly disputed as well because the increase of the transport costs, growing power consumption and increase of littering around the waste baskets and collection tanks are evident.

The whole system of the deposit beverage containers can be, in final consequence, little functional along with incidence of other negative effects. In fact, the costs of domestic waste recycling will be at least doubled, with the recycling increase by about 3 %.

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