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Real Price of Deposit

Analysis of the introduction of the deposit-refund system for single-use beverage packaging in the Slovak Republic

November 2018

Economic analysis **4**

Note

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Non-technical summary

Although PET and aluminium represent less than 2 % of weight of all municipal waste, the issue of the mandatory deposit-refund system for single-use packaging has been opened on a regular basis in Slovakia. As they are not biodegradable, they disturb the ecosystem in the long term, they can float on the water surface, and reduce the aesthetic value of territories, the public perceive them very sensitively. The objective of the study is to estimate the real price of deposit including the investment costs and annual costs of operation, operation of machines, employees, transport, etc.

According to IEP estimates, about one billion pieces of single-use PET beverage packaging and roughly 345 million beverage cans are placed on the Slovak market annually. About 62 % of PET bottles are collected through the separate collection.

The deposit-refund system is an instrument that can increase the quantity of collected PET bottles to more than 90 % and it also contributes to the reduction of the quantity of litter lying around in the nature. However, in comparison with the separate collection it is a relatively expensive system. Its introduction would also mean the weakening and rise in price of separate collection because the most lucrative raw materials would be excluded from it. At present, the mandatory deposit-refund system for PET and other beverage packaging is in operation in eight EU countries.

The study works with the model of deposit-refund system for single-use beverage PET packaging and cans, which is inspired by successful Scandinavian systems. If the producer fails to reach at least the prescribed 90% return rate or decides to not use deposits and to not participate in the system, they will have to pay a relatively high environmental tax for each packaging. All retailers will have to sell beverages with the deposit; however, not all of them will collect them. Take-back and deposit refund will be obligatory for retailers with sales area exceeding 400 m^2. We expect that smaller shops will also join the system due to the competitive advantage. The whole system will be financed by producers through the administrative fee per one bottle/can. The deposit-refund system also assumes the establishment of the so-called Central System created by associations of producers with the Ministry's supervision, which will coordinate activities, finance the system and act as a clearing centre for the stakeholders.

The introduction of the deposit-refund system in Slovakia would require investment costs amounting to about EUR 80 mil., of which the costs of purchase, installation and service of reverse vending machines will amount to EUR 61.8 mil.. The rest will cover the costs of system security, manual collection and costs of the establishment of the Central System, whose competences will include the counting, sorting and collecting of bottles from entire Slovakia.

The system should generate annual revenues of EUR 28 mil. and the operating costs should amount to about EUR 33.3 mil. The costs of the Central System should amount to almost EUR 20 mil., of which the biggest item is costs of transportation (EUR 14.2 mil.). Beverage packaging will have to be collected from shops, transported to interim storage facilities and from there, consolidated packaging will be transported to the counting centre and sorting plant in Žilina. The retail costs will amount to EUR 13.6 mil. The Central System will compensate these costs to retailers through the so-called handling fees. On the side of revenues, EUR 15.3 mil. will flow from uncollected deposits, EUR 9 mil. from the sold PET material, and almost EUR 4 mil. from aluminium cans sold for recycling.

The total negative balance of EUR 5.1 mil. will be paid by producers through the administrative fees. Today, the producers pay approximately 0.4 cents for a PET bottle, in the mandatory deposit-refund system it will be 1.5 cents. As aluminium's value is several times higher than the value of PET, revenues from the secondary aluminium will be sufficient so that can producers will pay no administrative fee. Our estimates

are in compliance with the standard amounts of fees in the countries with the deposit-refund system in operation. The total producers' costs of packaging collection will rise from current annual costs amounting to EUR 3.6 mil. to EUR 13.2 mil. – including the settlement of the negative operating balance as well as investment costs depreciations.

The total operating costs of the system are sensitive in particular to the rate of return of PET and cans. The operation itself does not depend so much on the rate of collection automation or on the supplier of reverse vending machines; it rather depends on the rate of return of packaging. The more bottles are returned by the consumers, the lower revenues from non-refunded deposits remain in the system. The deficit must be settled by producers as a higher administrative fee. The price of operation also depends on the prices of PET and aluminium material. Higher prices for material mean higher revenues from the sale of material, thus reducing the total operating costs. The rate of automation has an essential influence on the amount of investment costs. With a higher number of bottles returned through reverse vending machines, the costs of machines naturally rise. The selection of machine supplier also affects the amount of investment costs. In the study, we worked with two offers with a difference of 6 %, where with the more expensive offer the rate of automation would drop by 2 percentage points and reverse vending machines would not be advantageous for any small shops. So we recommend that all machines are procured and paid by the Central System because it has a better negotiation ability and better knowledge of the market.

The introduction of the mandatory deposit-refund system will have only a minimum impact on the total rate of recycling of municipal waste. As PET and aluminium beverage packaging is light and creates only a negligible share in the total municipal waste, the rate of recycling of municipal waste would rise with a 90 % return rate of PET and cans by only 0.5 percentage points. We should rather see benefits in the volume of averted littering and landfill waste, all that only for PET bottles in the amount of 0.9 million cubic metres, which can be visualised as Námestie slobody (Freedom Square) in Bratislava filled with PET bottles to a height of 22 metres.

The mandatory deposit-refund system for PET bottles and cans will also have other indirect and social costs and benefits. The biggest benefits include the reduction of the quantity of litter lying around, a positive influence on employment, and environmental benefits resulting from a lower quantity of discharged emissions and energy and material savings. Moreover, it will lead to many other, only hardly identifiable indirect benefits, such as an increase in the aesthetic value of territories or a lower burden for ecosystems. On the other hand, by excluding PET bottles and cans from the separate collection the system of separate collection will lose valuable raw materials, which will increase the price of the system. As the consumers will have to store and bring bottles and cans back to shops, their comfort will be reduced.

The analysis examines the possibilities and costs of the introduction of the deposit-refund system for PET bottles and cans in Slovakia. The first chapter defines the problem, the second chapter presents advantages and disadvantages of the mandatory deposit-refund system, and the third chapter its application in Europe. The fourth chapter representing the core of the analysis presents how the mandatory deposit-refund system could be operated in Slovakia, and direct financial costs and benefits of the deposit-refund system are quantified for this example. The last part describes and, if possible, quantifies other indirect or socio-economic benefits and costs.

1 Accumulating waste from single-use beverage packaging

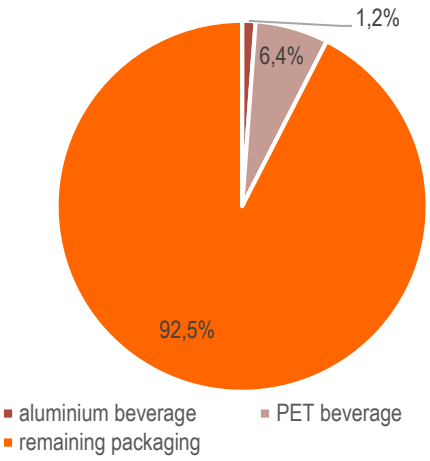
From the moment of production, almost any packaging is condemned to become waste. Customers purchase products because of the content. The packaging is only the means through which the goods are supplied to customers in intact condition. After the use of the product, packaging at best becomes part of municipal waste. Worse, they end up in public areas, in the forests or seas.

The surge of packaging waste has become a global problem. According to the Eurostat data, only in the EU almost 85 million tons of packaging waste are produced annually and the quantity continually grows. A large part can be recovered also thanks to incineration; however, thousands of tons still end on landfills or in the wild. From there, they get to rivers, which take them to seas and oceans. The Great Pacific garbage patch is estimated to be twice as large as France and it essentially affects life in the ocean (Milman, 2018).

Although pollution of seas is caused mostly by waste from Asia and Africa, the problem of littering, i.e. litter lying around is also present in our country (UN Environment, 2018). Recently, the public has noticed the case of the river Bodva, but the water reservoir Ružín is the best known example in the long term. Every year, hundreds of cubic metres of waste are extracted from it, which represents costs amounting to tens of thousands of euros (TASR, 2016).

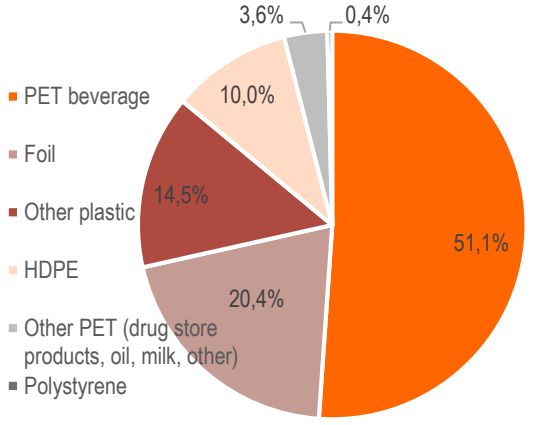
Beverage packaging represents a great part of street pollution. They create almost 8 % of the total weight of all packages placed on the market. However, the packages themselves create only one fourth and beverage PET and aluminium less than 2 % of the total weight of all municipal waste including small construction waste. Their share in the weight of waste is not big, on the other hand, due to their size and physical properties they are much more visible than other packaging, and the public perceives them more sensitively. Their disadvantage is that despite low weight they have big volume and float on the surface. Moreover, they are not biodegradable and disturb the ecosystem and aesthetic value of territories in the long term.

Chart 1: The share of cans and PET beverage packaging in the total weight of packaging on the market



Source: IEP's estimate based on Envipak data

Chart 2: The share of materials in the total weight of recycled plastics



Source: IEP's estimate based on Envipak data

Today, Slovakia is able to collect only about 60 per cent of single-use PET bottles. For cans, there is no similar statistics; and aluminium is even more lucrative material than PET. This share can be increased by increasing the efficiency of separate collection including the increase in the fees for landfilling, by introducing environmental taxes on packaging or by introducing deposit-refund systems. In particular because of their great number, easy recycling and secondary use, as well as a significant share in littering, PET bottles and cans are ideal candidates to increase the rate of recycling.

Box 1: How much beverages in PET bottles are drank annually?

It is not clear how many PET bottles are placed on the Slovak market annually. The foreign as well as Slovak research agencies and associations dealing with the problem (such as Nielsen, Canadea, SLICPEN or AVNM), estimate their number to be within the range of 530-830 millions pieces. According to the reports of producers within the system of extended responsibility, it is about 774 millions pieces. On the opposite side, conservationists such as Mikuláš Huba estimate 1.5 billions pieces (Huba, 2018).

According to the estimate of the IEP, more than 34 thousand tons of PET bottles are placed on the market in Slovakia annually, which means almost one billion pieces. According to these estimates, the reports of producers are underestimated by almost 30 % and the real rate of separation of PET bottles is about 62 %. Our estimate is based on the data on municipal waste for 2016 and waste analyses. Within the separate collection about 21.6 thousand tons of PET material are collected. Roughly 10 thousand tons are in mixed waste and additional 2.5 thousand tons are in the waste from street cleaning. Litter lying around in the nature and water courses in tens to hundreds tons of PET bottles is to be added. Thus, the total quantity of PET material reported should not be lower than 34 thousand tons, i.e. almost one billion pieces per year.

Education and raising awareness of responsible waste handling is the key to a high rate of separation. This is a long term process. If we want to reach a significant improvement in the rate of separation and recycling in the short or medium term, in addition to environmental education also other measures have to be taken.

The achievement of a 90 % rate of separation of plastic bottles proposed by the European Commission is possible in practice only by introducing the mandatory deposit-refund system for PET bottles (European Comission, 2018). With this system, when buying a beverage in the PET bottle or can, the customer pays a deposit in addition to the product price. The shop will pay the deposit back only after the beverage packaging is returned; subsequently it is recycled.

Box 2: Proposal for a Directive on the reduction of the impact of certain plastics on the environment

At the end of May 2018, the European Commission published the Proposal for a Directive of the European Parliament and of the Council on the reduction of the impact of certain plastic products on the environment whose objective is to prevent the environmental impact (European Comission, 2018). the main proposed measures include:

- **ban on selected plastic products** such as cotton bud sticks, plastic kitchenware and plates, straws,
- **consumption reduction targets** for food containers and beverage cups,
- **the duties of producers** to cover a part of costs of waste management and environmental clean-up, as well as to raise awareness of harmfulness of food containers, packaging, beverage cups, tobacco products with filters, wet wipes, balloons or lightweight plastic carrier bags,
- **collection targets** including the target of 90 % collection for single-use plastic beverage packaging by 2025,
- **marking requirements** with the instructions how to dispose of waste from selected products, such as wet wipes, balloons or sanitary towels,
- **measures raising awareness** about the negative impact of littering as well as about the available re-use and waste management options for the plastic products.

2 Advantages and disadvantages of the deposit-refund system for beverage packaging

The academic literature comparing the total costs and benefits of the deposit-refund system is ambiguous and the results to a great extent depend on the particular conditions. According to Davies (2017), the total social benefits are three to six times higher than the costs of introduction of the deposit scheme, in particular thanks to lower littering. In Israel, according to Lavee (2010), the total benefits should exceed the costs by 35 % and there should be considerable positive influences for municipalities due to lower costs.

On the contrary, authors in certain countries are sceptic. According to Deprez (2016), the costs of the deposit-refund system in the Netherlands exceed the benefits by more than 10 %. Vigsø (2004) in Denmark estimated that total social costs of the deposit-refund system are higher than benefits even after taking into account the environmental benefits. If cans are excluded from the system and energy recovered along with the other municipal waste, social cost savings amounting to EUR 6.7 to 8.1 mil. annually would be achieved. According to Dewees and Hare (1998), the scheme is more expensive than separate collection even when taking into account other costs than waste collection or its disposal.

Despite the ambiguity of studies, the system is popular in many countries of the world. According to Dewees and Hare (1998) it is for example in Canada due to the costs hidden from the consumer at least in case that the consumer returns the packaging. Another reason can be that the public feels that the deposit-refund system is justified with any costs because the beverages concerned do not fill essential needs.

The biggest advantage of the mandatory deposit-refund system for beverage packaging is its provable performance, when the rate of return often reaches more than 90 %, which no other waste collection scheme matches (Reloop - CM Consulting Inc., 2016). Less waste from selected raw materials ends up in landfills or lying around in the nature as the amount of the deposit gives consumers reason for returning the bottle (Dace, et al., 2013).

Unlike higher landfilling fees, the deposit-refund system does not motivate to illegal waste management and can be an optimum measure if the deposit amount equals to the marginal social cost of packaging disposal (Palmer & Walls, 1997). Indeed, the influence on littering reduction in certain countries was doubted, for example according to Deprez (2016), the deposit-refund system for single-use beverage packaging in Germany has not considerably reduced the quantity of litter thrown away on the streets, but the total impact is different in each country and depends on how common the littering is and on the share of beverage packaging in the littering.

Moreover, the introduction of the mandatory deposit-refund system considerably reduces the quantity of the litter lying around, thus, it reduces also the costs of cleaning (Eunomia, 2012; Hogg, et al., 2017). It also increases the revenues from the secondary raw material as the collected PET has a positive market value in contrast to many other waste. Additionally, the material collected is cleaner, which increases its market price. Hogg et al. (2011) also expect a positive influence of system introduction on employment.

The mandatory deposit-refund system is the only system which can exactly monitor, how many products were placed on the market, and how many were collected, thus minimising stowaways in the system. In the countries, where no deposit-refund system is in operation, the rate of recycling is only estimated with a deviation of 10 to 20 percentage points (Zero Waste Scotland, 2017). Moreover, the system penalises the polluter – the citizen, if they fail to return the bottle, and the producer that places the products on the market by funding the system and ensuring its function (Eunomia, 2010).

According to Kuczenski – Geyer (2009), who monitored the environmental impacts of PET recycling on the example of the mandatory deposit-refund system in California, in comparison to primary PET, recycling can reduce the use of primary energy by 54 % and emissions of greenhouse gases by 23 %. The total impact on CO_2 emissions is usually evaluated as positive but according to certain authors it is relatively low in comparison with the necessary costs of the scheme (Deprez, 2016). It is because the scheme requires additional costs of transport which causes additional emissions of CO_2.

The main disadvantage of the deposit-refund system is the expensiveness of the system as the revenues from uncollected deposits and raw material sold are not sufficient to cover the costs of its operation (Europen, 2009). This is another reason why in the EU, the system has been implemented only by eight countries. It is necessary to consider whether increased expenses would not bring a bigger effect with the strengthening of the current system. In addition to significant investment costs of mainly reverse vending machines and sorting line, the system also requires non-negligible annual operating costs. The system of packaging marking preventing from the collection of deposits for bottles from abroad will also represent additional costs.

Some critics point out that the deposit-refund system undermines the system of separate collection already in operation as it disturbs the habits of citizens to throw plastics into yellow vessels (Europen, 2009). At the same time, by excluding aluminium and PET, the system of separate collection will lose a considerable source of revenues because they are among the most valuable materials. It will overprice separate collection for the other producers, which can mean pressure on price increase.

In addition to the financial costs, it will also bring indirect costs in the limitation of free beverage market between Slovakia and other countries of the EU as the Slovak bottles will have to bear specific labelling (Europen, 2009). Last but not least, the deposit-refund system brings along the reduced comfort of consumers who will have to go to the closest shop repurchasing bottles; it will not be enough to throw the bottle into a container near their house (Deprez, 2016).

The mandatory deposit-refund system does not solve waste management as a whole; it focuses only on one part of waste from packaging (Eunomia, 2010). The deposit-refund system for PET or aluminium beverage packaging will not increase in any way the use of recyclable alternatives and the producers using hardly recyclable packaging materials will remain untouched by the measure.

Box 3: Research for the real rate of separation and recycling

Today, it is relatively difficult to specify the exact rates of sorting and recycling for individual waste components. According to the reports sent by producers to the producer responsibility organisations (PRO), the rate of separation of plastic packaging and non-packaging in the municipal waste in Slovakia in 2016 was only 26 % and the rate of recycling 53 %. According to the estimates of IEP from data on municipal waste it is only 22 % for both indicators. Neither this may be the real rate of separation or recycling of plastic packaging.

The official rate of recycling of packaging and non-packaging is based on the reports of producers to PRO and is distorted by the following facts:

- **the reports may be underestimated** by as much as 30 % (more in Box 1),
- **recycled packaging and non-packaging do not come only from municipal waste but also from industrial waste**. If the quantity of materials collected from municipal waste is not sufficient to reach the targets of waste recycling and recovery, PRO can supplement the uncollected quantities from municipal waste with industrial waste from packaging in order to achieve the prescribed target,

- **on the contrary, the total quantity of packaging placed on the market is not increased by the industrial packaging**. PRO can increase the data on recycled packaging by industrial packaging but this does not apply to the data on the total quantity of packaging placed on the market.

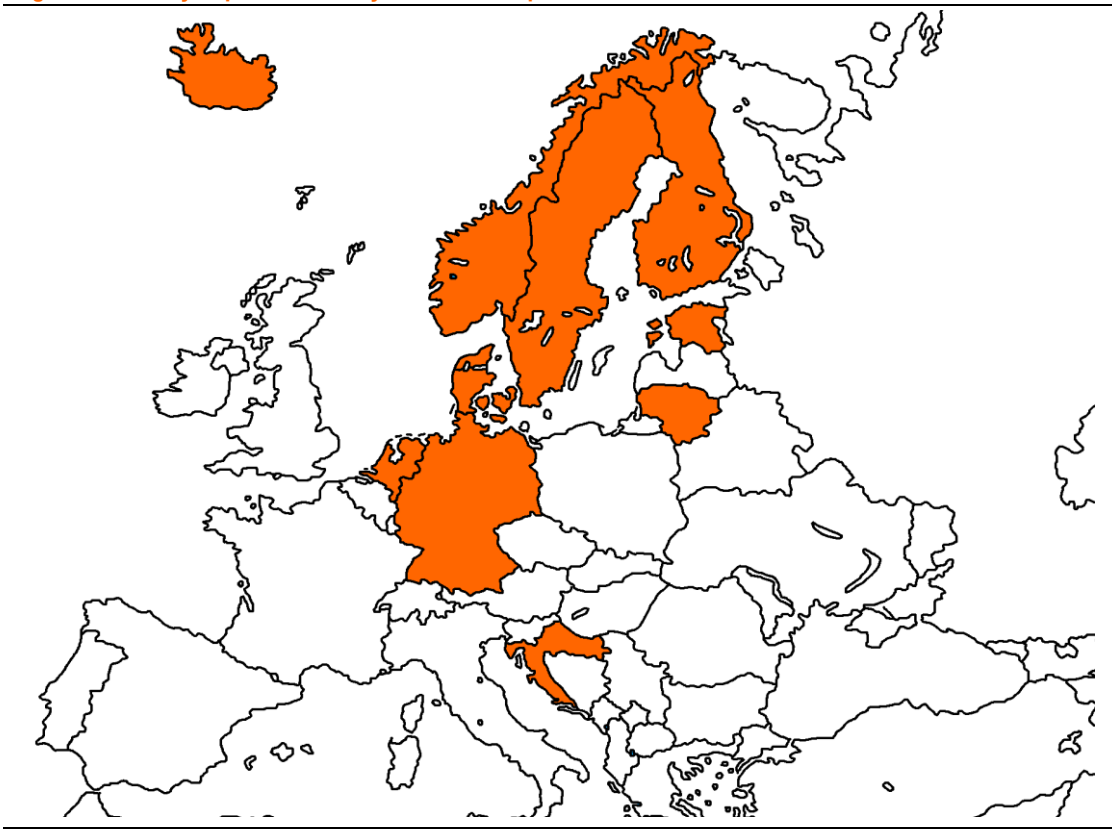
Therefore, a more accurate estimate is provided by the analysis of municipal waste. The analysis is based on the official figures concerning the waste sorted as well as on the estimated share of the materials in the mixed municipal waste. According to this methodology, we separate and recycle about 22 % of plastics from municipal waste. However, the data serve to monitor only the selected materials, we cannot assess the general rate of separation in Slovakia because the municipal waste also contains the waste that does not belong to sorted components and it is not included in the mixed waste (voluminous waste, small construction waste, waste from street cleaning etc.). More accurate estimates of rates of separation could be obtained based on regular analyses of municipal waste and strict control of producers' reports.

3 Mandatory deposit-refund systems in Europe

Mandatory deposit-refund systems for beverage packaging are currently in operation in eight countries of the EU (Sweden, Denmark, Finland, Estonia, Germany, Netherlands, Lithuania, and Croatia) and in two other countries of the EEA (Norway and Iceland). Scotland also plans to introduce the deposit-refund system for beverage packaging and several countries have worked out an analysis of possible introduction of this system. Moreover, the system is in operation in ten States of the USA, in Canada, Israel and partly in Australia and some islands in the Pacific Ocean.

The first States to introduce the deposit-refund system were Iceland and Sweden in 1989, Lithuania was the last one in 2014. All the systems in Europe have the deposit-refund system for PET bottles and also cans; the amount of deposit ranges from about 7 cents in Croatia to 40 cents in Finland[1].

Fig. 1: Mandatory deposit-refund systems in Europe



Source: IEP

The systems in operation in individual countries often differ from each other to a great extent, either as regards materials, which they include, or because the scheme involves reusable packaging. Their common objective is to capture almost all PET bottles placed on the market. Almost all systems can collect over 85 % of all PET placed on the market.

For hygienic reasons, most countries exclude packaging with milk and fruit juices from the deposit-refund system. Due to large differentiation, alcohol also is often excluded from the system, except for beer. Finland represents an exception; any alcohol packaging is subject to the deposit-refund system. The system usually does not include very small (less than 0.1 litres) and very big (over 3 litres) beverage packaging. Small

[1] The summary of the systems is provided in the comparing table in Annex 2.

producers are also granted exceptions. Environmental tax is an alternative of how to burden the packaging that can be included in the deposit-refund system only with difficulties.

Not all the systems are directly mandatory for producers. The environmental tax is an instrument indirectly motivating the producers to include their packaging into the deposit-refund system. For example, in Finland the producers are obliged to pay the environmental tax in the amount of EUR 0.51/litre unless they are involved in the system. In Norway, ecological tax also exists but it is focused on achieving a 95 % rate of return. In the other countries, the participation in the system represents a statutory duty.

There is no system operating without the participation of retail. The retail is not a polluter (like the producer placing the packaging on the market and the citizen who does not return the packaging), therefore, individual schemes pay to the retail a handling fee covering the costs connected with collection. Collection takes place in particular through reverse vending machines, whose purchase is not always reimbursed. In Norway, it is included in the handling fee, in Sweden one machine per shop is reimbursed, in Finland there is no way of compensation. In Lithuania, the central system leases the machines.

All the systems are characterised by the existence of the so-called “central system”. It is an organisation coordinating the activities of individual actors. Its powers differ depending on the country, for example, in the Scandinavian countries it is also the accounting unit, in Germany it does not balance the deposits and has no records of actually returned bottles. The central system is created by producers, often also the retail, the local Ministry of Environment usually acts in audit bodies.

Box 4: Current deposit-refund system in Slovakia

The deposit-refund system for reusable beverage packaging is in operation in Slovakia today. It is voluntary for producers and mandatory for sellers. Thus, the producer can decide whether the product will be included in the deposit-refund system, on the contrary, if the seller sells the bottle, they must also collect it. The common costs of collection as well as the costs of machine purchase are thus fully borne by retailers. On the contrary, the producer is involved in collection only if it is economically advantageous for them. The deposit-refund system concerns more or less only beer bottles and breweries bear only single costs of recording bottle or crate identification in machines. The costs amount to tens of thousands of Euros. The rate of return of beer bottles subject to deposits is estimated to be about 98-99 %. In the past, reusable plastic bottles were sold in Slovakia. Today, however, no reusable plastic bottles are on the market in Slovakia and they also retreat from the markets in the countries with the mandatory deposit-refund system.

4 Financial costs of the deposit-refund system for single-use PET bottles and cans in Slovakia

Separate collection has come into existence only recently, and in many countries it was preceded by the deposit-refund system. The deposit-refund system in Slovakia included only reusable (mostly) glass packaging, whereas Sweden and Iceland were the first countries to introduce the mandatory deposit-refund system for single-used beverage packaging at the turn of the 1980s and 1990s.

The question of introducing the deposit-refund system for PET bottles in Slovakia is opened in regular intervals. It is caused by the increasing population's sensitivity to litter lying around, where PET bottles dominate, as well as by the habits of the society concerning the deposit-refund system for glass beverage packaging. The recently notified intention of the EU to increase the return rate of plastic beverage packaging to 90 % again activated the voices for the introduction of the mandatory deposit-refund system.

A well operating system is able to achieve a relatively hight rate of return. However, the costs necessary for such system are questionable, and this one of main arguments of the deposit-refund system opponents. The only complex Slovak study of this area so far was worked out in 2005. It compared the separate collection and deposit-refund system and came to a conclusion that although separate collection achieves a lower environmental efficiency, in every time period it is exceeded by the advantage of its higher economic efficiency, i.e. lower costs (M.E.S.A.10, 2005).

The objective of this chapter is to show, on a theoretical model of mandatory deposit-refund system in Slovakia, the possibilities of its operation and to quantify approximate costs and revenues.

4.1 Basic rules of the system

The basic inspiration for the pricing of the deposit-refund system was the Scandinavian model known as highly effective; most successful deposit-refund systems in Europe are based on it. On the contrary, the German model is considered to be one of the most expensive models, and it cannot exactly prove the rate of return because it includes only a limited flow of data. To estimate the costs, we simulated the following system:

- **PET bottles and cans will be included in the deposit-refund system.** Essentially each system includes cans, they are able to share the same infrastructure with plastic bottles without greater limitations. Thanks to the high price of aluminium they can often fund themselves, for example, in Norway the revenues from the sold raw material and uncollected deposits are enough to fund the entire system. Plastic bottles with milk, oil and fruit juices are excluded from the system. Thus, our model takes into account roughly one billion single-use PET bottles and 345 million beverage cans placed on the Slovak market annually.

- **If a producer decides to not join the deposit-refund system, they shall pay an environmental tax of 24 cents for a beverage packaging.** Several countries use environmental taxes that must be paid by producers if they do not participate in the deposit-refund system and/or if they do not fulfil the prescribed target. In our system, we expect the voluntary participation of producers in the system, and at the same time, the environmental tax amounting to 24 cents/beverage packaging, if the producer decides to not join the deposit-refund system. At the same time, producers must achieve the target of at least 90 % return rate of packaging. If they fail to observe it, the producers will have to pay the environmental tax for each bottle under the target quantity.

- **The whole system will be coordinated by the so-called Central System (CS).** It coordinates activities, finances the system and acts as a clearing centre for the stakeholders. It is one organisation created by producers, ideally by several associations that associate them in order to prevent preferential treatment of larger producers or producers that will join the system later. For example, in Estonia the central system is owned by the associations representing retail - 25 %, importers - 25 %, soft drink producers - 25 %, and breweries - 25 %. The CS will be supervised by the Ministry of Environment of the Slovak Republic, with which the CS will be obliged to share data.

- **The amount of deposit will be determined by the Central System.** Regardless of whether the bottle will be purchased in a shop collecting or not collecting bottles, the customer will pay deposit for each purchased bottle in the system - thus, deposits for bottles will be paid to all shops but not all shops will collect. In theory, producers may determine the deposit amount themselves so that they reach the prescribed target as efficiently as possible. In our model, we take into account the unified amount of **deposit for a PET bottle of 12 cents and for a can of 10 cents (more about the determination of the deposit in Annex 1)**. As a great part of littering consists of bottles smaller than one litre, we recommend not burdening them by a lower deposit. OECD also recommends that deposit amounts are not differentiated (OECD, 2015).

- **The mandatory deposit-refund system for bottles will take place in retail shops with the sales space exceeding 400 m².** The other shops[2] will be able to join the system voluntarily. We assume that a considerable part of shops with the sales space smaller than 400 m2 will also join the system. They will be motivated by a competitive advantage (customers will prefer shops where they will be able to return the bottles) and by full reimbursement of costs connected with collection in the form of handling fee.

- **Most bottles and cans will be collected by reverse vending machines, in small shops also manually.** The reverse vending machine can identify bottles in several ways and in theory, the machine can receive them by reading the label, shape or hardened surface of the bottle. However, the system needs security in order to prevent speculations with the import of foreign bottles with the objective to collect deposits. Therefore it is necessary to equip the bottles with a unique EAN code specific for the bottles placed in the territory of the Slovak Republic. This will bring additional costs of security.

- **The Central System will be in charge of the procurement of the infrastructure necessary for collection.** It has a much better negotiating ability as well as better knowledge of market operation as a whole. It can use machines within shops as well as other ways of collection (e.g. a solution out of the shop), it can combine several suppliers or use long-term lease like in Lithuania. Last but not least, the retail is not a polluter so there is no philosophical reason for bearing such load by it.

- **The system will be financed by producers through the administrative fee per one bottle/can.** The total amount paid by the producer will depend on the quantity of bottles placed on the market. Moreover, the producers usually pay to the Central System the so-called **membership** (once, when joining the system) and **registration fee** (for the control and approval of each new beverage packaging; in the Scandinavian countries this means about 200-250 EUR/new product). Thus, the producers of PET bottles and cans will fulfil their duties resulting from the extended responsibility of producers, in the mandatory deposit-refund system. They will not have to pay the fees for the bottles to the PRO like they have been doing so far, they will pay the fees within the Central System of the mandatory deposit-refund system.

[2] In theory, also fuel filling stations and HORECA (hotels, restaurants, and catering) can join if they are interested in it.

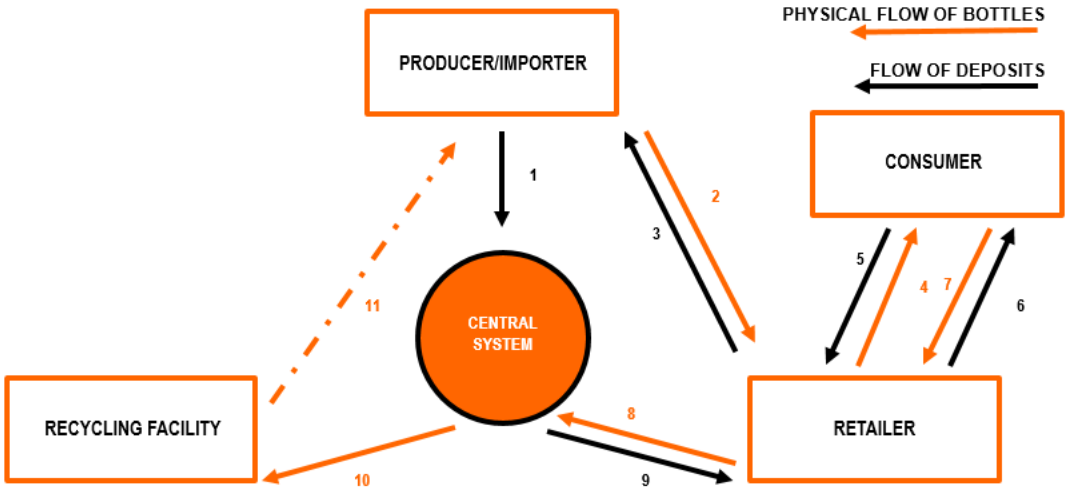
- **The system does not allow for the provision of advantage to reusable bottles.** The inclusion of reusable packaging would overprice the system with a disputable influence on the preferences of producers and manufacturers. The additional costs of the measure would not only probably eliminate the positive impacts of reusable packaging but also the effect of increased usage of such packaging would be disputable (Fitzsimons, et al., 2005). Everywhere in Europe and in the countries with the traditional support of reusable beverage packaging the trend of their retreat prevails (Reloop, 2016).

- **The current deposit-refund system of reusable glass bottles will remain unchanged** as it has its own infrastructure and corresponding results. Of course, in the future the question remains, what should be done with the other beverage packaging, either in glass or other materials (e.g. Tetra Pak, HDPE). There are schemes abroad with a much wider portfolio of beverage packaging; Finland even included in the deposit-refund system also glass bottles with wine or spirits.

4.2 The story of the bottle

To better understand how the deposit-refund system operates, it is suitable to describe the physical flow of bottles (or cans) and deposits in the system, as well as the flows of costs, revenues and information.

Fig. 2: Diagram of physical flow of bottles and flow of deposits



Source: IEP

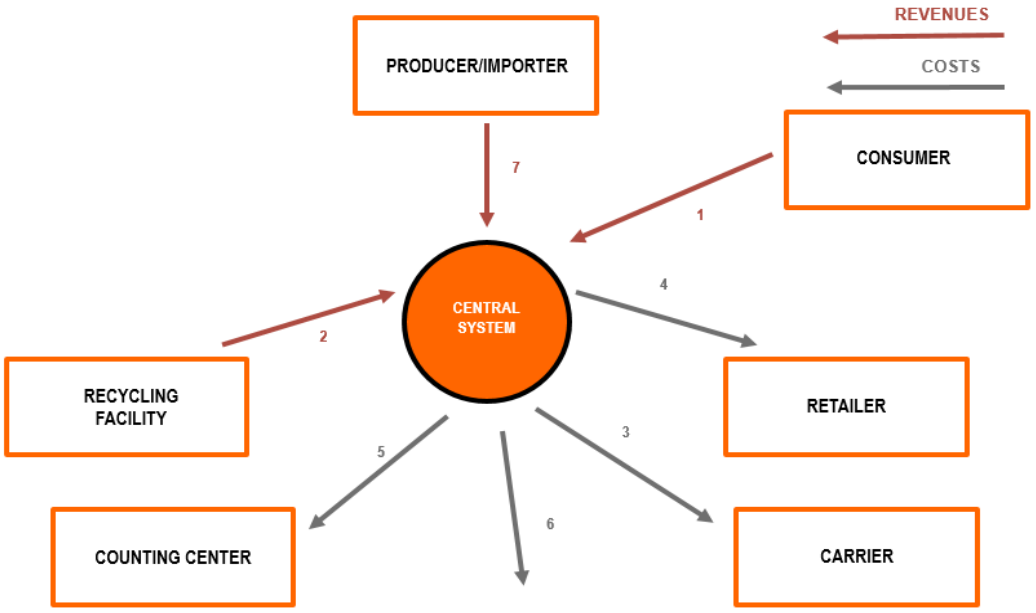
The producer or the importer places on the market the beverage bottle and registers it in the central system, where they pay a deposit for it (1A). They sell the bottle and send it to the retailer (2A), who pays the deposit for it (3A). At that moment all the deposits paid to the central system are returned to the producer.

The retailer sells the bottle to the consumer (4A), who pays the deposit for it, which returns to the retailer the deposits that were paid previously to the producer (5A). The consumer consumes the beverage and has a dilemma whether they should return the bottle or dispose it in other way. The amount of the deposit motivates them to return the bottle and get back the paid deposit.

The bottle returns back to the retailer whose figures are negative because they had to pay the deposit (6A) and take over the empty bottle (7A). However, the retailer sends the bottle to the central system (8A), which will pay to the retailer the deposits paid to the consumer (9A). At that moment all the deposits paid to the consumer are returned to the retailer. The central system sells the empty bottles to the recycling facility (10A). In practice, however, the bottle can go directly from the retailer to the recycling facility and the central system will only account it. The recycling facility will process the bottles and a part of the material will get back to the producer in the form of a new bottle (11A).

This will be directly reflected in the scheme of the flow of revenues and costs. At that moment, the central system has revenues: from the uncollected deposits (1B) and from the material sold to the recycling facility (2B). It has also costs: of the transport of bottles (3B), the handling fees to the retailer covering the costs resulting from the participation in the system (4B), of the counting centre and sorting plant, which interconnects manual collection and collection in reverse vending machines (5B), and other common expenses (6B). The difference between the system revenues and costs is negative. The difference is settled by the producers through the so-called administrative fee (7B).

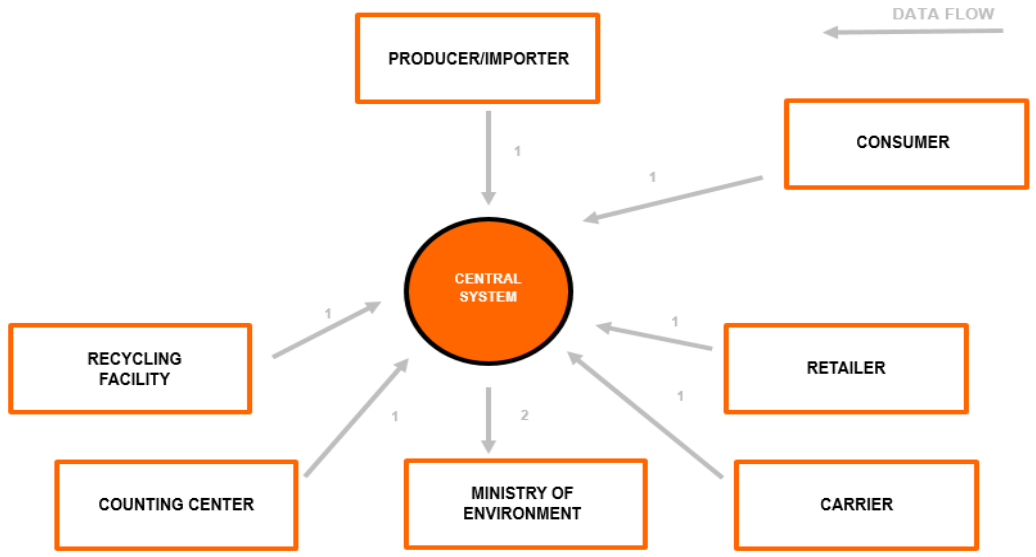
Fig. 3: Flow of revenues and costs



Source: IEP

Data flow also takes place between individual actors and the central system. All the entities send data to the central system (1C), which shares them subsequently with the Ministry of Environment (2C).

Fig. 4: Data flow



Source: IEP

4.3 Calculation of direct financial costs and revenues

The direct financial costs and revenues are estimated based on the zero scenario prepared on the basis of foreign literature and on practice and domestic data. The key parameters are provided in Table 1. Further assumptions are analysed in the calculation of individual costs. The complete methodology is provided in the technical annex.

Table 1: Zero scenario input parameters

Parameter	Value	Source
Rate of return	90 %	Arbitrarily set based on the rate of the systems already introduced
Deposit amount	12 cents for PET bottles and 10 cents for aluminium cans	Logarithmic function based on the reloop data, see more in Annex 1
Rate of involvement of small organised shops (with the sales space less than 200 m²)	100 %	IEP based on the data on saleability
Rate of involvement of unorganised shops	50 %	IEP based on the date on saleability
Number of shops with a reverse vending machine	2,017 (hypermarkets, supermarkets, discount shops and large organised shops will be fully automated, 26 % of small organised shops and 0 % of unorganised shops will have a reverse vending machine)	IEP based on the data on saleability and capacity of reverse vending machines
Environmental tax	24 cents per bottle but it also expects that the producers will not pay it because they will fulfil their objective of 90 % collection	Arbitrarily set to double the deposit
Average weight of beverage packaging	PET 35 grams and can 16 grams	The average value of several sources (Eunomia, Recoop, LIMO Špec, IEEP, and Dace, et al., 2013)
The quantity of beverage packaging placed on the market annually	989 mil. PET bottles and 345 mil. beverage cans[3]	IEP based on the data on waste, see more in Box 1
Market shares of shops	36 % hypermarkets, 24 % supermarkets, 25 % discount shops and large organised shops, and 15 % small and unorganised shops.	IEP on the basis of INCOMA Research and GfK estimates

Source: IEP

We estimate that the introduction of such system will require single investment costs amounting to EUR 80.2 mil. and the operating balance of the system will be EUR -5.2 mil. per year. Both the investment cost and the negative balance of revenues and costs will be financed by the producers placing beverage packaging on the market through administrative fees. They have paid about EUR 3.6 mil. per year to the producer responsibility organisations so far, whereas to the central system they will pay annually about EUR 13.2 mil. – including the reimbursement of the negative operating balance as well as depreciations of investment costs.

At the same time, the total rate of recycling of municipal waste[4] in Slovakia will increase by 0.5 percentage points, from 23 % to 23.5 %. The rate of recycling of plastic packaging in 2016 reached 48 % based on the data of PRO reports and on the ground of an underestimated quantity of PET beverage packaging placed

[3] We expected that the deposit-refund system would have a negligible or no influence on the quantity of bottles sold. Although the deposit is an extra cost for people, 90 % of consumers will decide to take over the deposit so it should not affect the total demand.
[4] Without small construction waste.

on the market. In comparison with this number, the rate of recycling of all plastic packages would increase by 7 percentage points to 55 %. The rate of recycling of all packages would increase from 64.6 % to 66.5 %, i.e. approximately by 2 percentage points. On the other hand, only for PET bottles, the volume of littering and landfilling saved will amount to 0.9 million cubic metres – i.e. Freedom Square in Bratislava filled with PET bottles to a height of about 22 metres.

Table 2: Mandatory deposit-refund system balance

Fee	Value (EUR)
Investment costs	80,181,011
Operating costs	33,324,913
Revenues	28,272,415
Total balance (the difference between the operating costs and revenues)	**-5,052,498**

Source: IEP

The system will specify the administrative fee according to the real costs. Based on price estimates we expect that the administrative fee will amount to 1.5 euro cents per one PET bottle placed on the market. The revenues from the sale of aluminium should be sufficient to cover all the related costs therefore can producers will not have to pay administrative fees[5]. However, this depends on the actual market prices of both commodities.

The costs also include the settlement of costs incurred by retail due to the participation in the system. The retail would receive compensation through the so-called handling fee in EUR per a returned beverage packaging. Like for the administrative fee, the central system will calculate it according to real costs, however we estimate that for retailers with reverse vending machines it will be 0.9 euro cents per packaging and for a retailer with manual collection 3.1 euro cents per packaging. The fee for manual collection is higher because the investment costs of collection from reverse vending machines will be settled by the central system. This cost as well as the other investment costs are included in the administrative fee as depreciations.

Table 3: Fees within the scheme (per one beverage packaging placed or returned)

Fee	Value (EUR)
Administrative fee per PET bottle	0.015
Administrative fee per can	-0.005[6]
Handling fee for a retailer with a reverse vending machine	0.009
Handling fee for a retailer with manual collection	0.031

Source: IEP

Although the amounts of fees (in particular the handling ones), in particular due to the different approach to the reimbursement of costs of purchase of reverse vending machines, are not fully comparable with the fees abroad, we can state that our estimate is in compliance with the standard amounts of fees in the countries where the deposit-refund system is in operation.

Table 4: Comparison of administrative fees in selected countries (in euro cents)

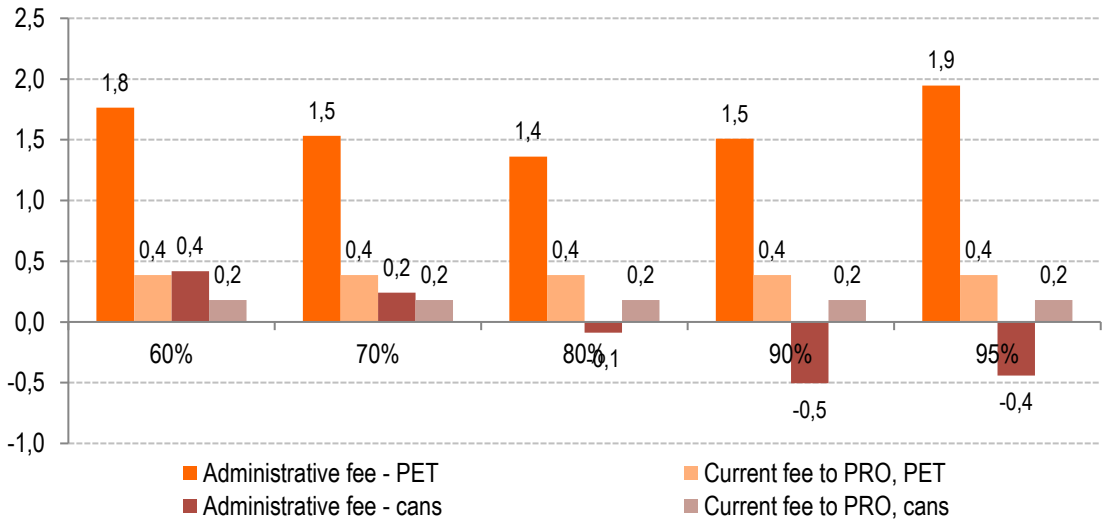
	SVK_IEP	Norway	Sweden	Finland	Denmark
aluminium cans	-0.5	0 to 0.3	0	0.5	1.2 to 5.5
PET bottles	1.5	1.9 to 3.4	2.1 to 5.5	1.7 to 11.5	2.8 to 3.6

Source: IEP, reloop

[5] It must be noted that the system along with PET bottles generates high savings from which also cans draw. If only cans were included in the deposit-refund system, their producers would have to pay an administrative fee amounting to approximately 3.1 cents/can.
[6] In practice, this fee will be most probably equal to zero because it is slightly negative also in other countries (e.g. in Norway) but the central system nowhere pays the excess money back to producers.

The introduction of the mandatory deposit-refund system will essentially increase the costs of the producers placing PET beverage packaging on the market. Today, they pay about 0.4 cents per bottle, in the mandatory deposit-refund system it will be 1.4 to 1.9 cents depending on the rate of return, and with the aimed rate of 90 % it will be 1.5 cents, i.e. about four times more.

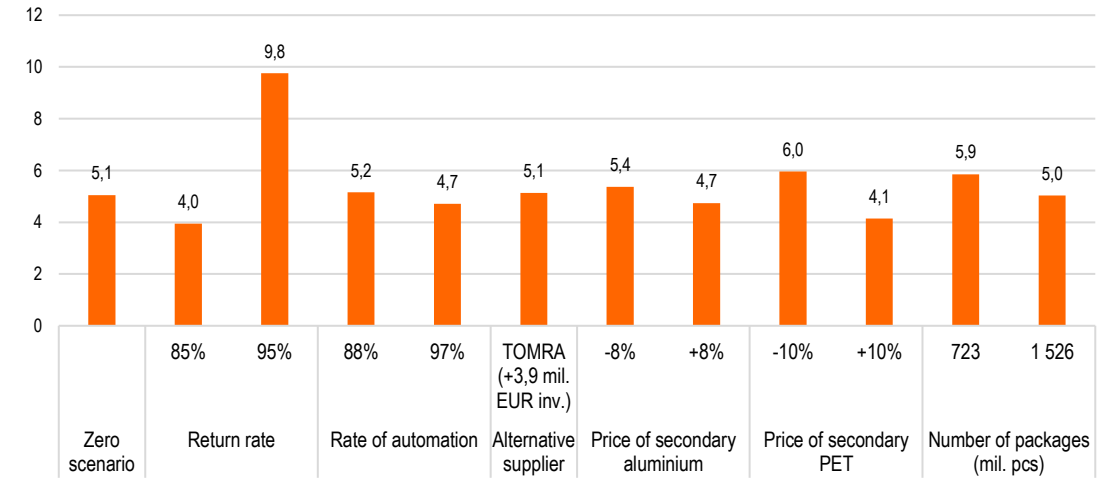
Chart 3: The amount of the paid by producers with various rates of return (in cents/packaging placed)



Source: IEP and NATURPACK

The operation of the system itself does not depend very much on the supplier of the reverse vending machines, it depends more on the rate of return of bottles and on the rate of automation. The rate of automation, i.e. the number of packages returned through the reverse vending machine out of the total number of returned packages, depends on the form of collection selected by the shop. A lower rate of automation means higher costs of manual collection which is inefficient in certain cases. The lower limit of the rate of automation represents the case when small organised shops will collect only manually, on the contrary, the upper limit means fully automated collection in small organised shops. As regards the dependence on the rate of return, the more bottles are returned by consumers, the lower revenues go to the system from the unreturned deposits. As the deposit amount is several times higher than the price of the raw material of which the bottle is produced, a bigger quantity of PET material cannot cover a lower revenue from uncollected deposits. The negative operating balance increases and it must be paid by producers in a higher administrative fee. The operating balance of the system is also affected by the price of the secondary material. Based on the development of stock exchange prices, we tested the influence of an 8% deviation of the aluminium price and 10 % of the PET price, and the balance is more sensitive to the change of the price of secondary PET.

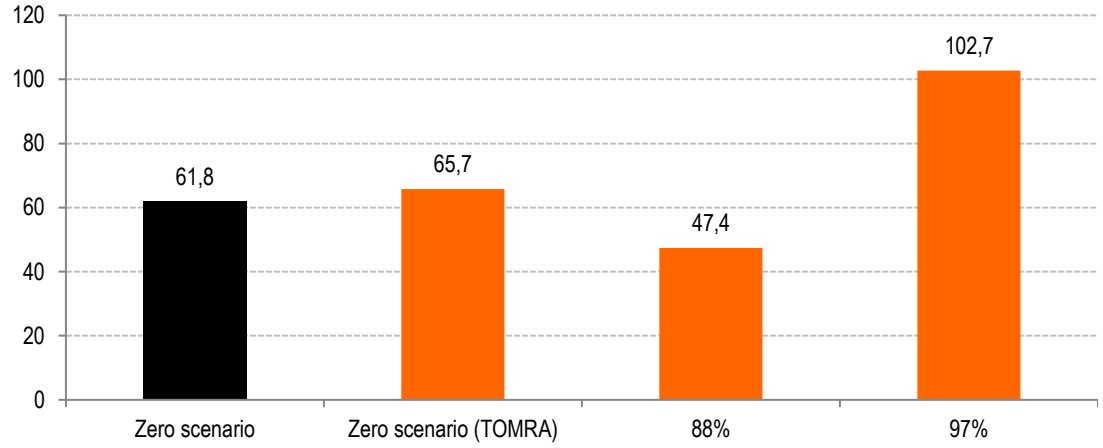
Chart 4: Negative operating balance of the system depending on individual indicators (in mil. EUR)



Source: IEP

In addition to the rate of return, the rate of automation has an essential influence on the amount of investment costs. The smaller is the shop, the less efficient is the operation of a reverse vending machine. If too many shops are automated, the low efficiency will manifest itself in high investment costs.

Chart 5: Investment costs of reverse vending machines depending on the rate of automation (mil. EUR)



Source: IEP

4.3.1 Investment costs

We estimate that the introduction of the mandatory deposit-refund system for beverage PET and metal packaging will require single investment costs amounting to approximately EUR 80.2 mil. All the investment costs are subsequently reflected in the fees paid by producers, which means that after ten years the producers will have settled through the administrative and registration fees the whole investment costs as well as operating costs of the system for that period.

Table 5: Investment costs of the mandatory deposit-refund system

Item	Value (EUR)
Purchase, installation and service of reverse vending machines	61,838,831
Additional costs of manual collection space modification	334,813
Establishment of a central and counting centre	14,585,803
out of it establishment of a counting centre and sorting plant	3,893,416
out of it establishment of the central system	10,692,388
Security (deposit logo, EAN code)	3,421,564
TOTAL	**80,181,011**

Source: IEP

The biggest item will be the **purchase of reverse vending machines** (RVM). According to the price quotation of Norwegian RVM Systems, the investment costs for 10 years amount to EUR 61.8 mil. The price includes purchase, installation, and service of the machines. According to a competitive price quotation from TOMRA, investment costs for the purchase of machines would amount to EUR 65.7 mil., and the rate of automation would drop by two percentage points, and the reverse vending machines would not be economical for any small shops. Higher prices and lower automation can be assigned in particular to the non-conforming capacity of their machines for smaller shops as they offer higher than needed capacity.

It depends on the decision of the Central System, from whom it will purchase the reverse vending machines or whether it will not prefer lease over the direct purchase of machines. In reality, the Central System may also select several suppliers or involve large-capacity "cash&go" machines from Anker Andersen in the system. However, it is not a standard solution therefore in the zero scenario we preferred the offer from RVM Systems. Moreover, we contacted other producers, such as: Wincor Nixdorf, Envipco Holding N.V., Toperczer, Eltronic, and Trautwein. However, we received no price quotations from them.

Reverse vending machines are in Slovakia currently supplied mostly by Tomra. There are about 800 reverse Tomra vending machines on the market today, of which 12 % can be modified so that they would be able to receive both the PET bottles and the cans. Although modification of a reverse vending machine is cheaper than the purchase of a new one, the shop will lose the capacity for receiving glass bottles. Therefore we selected the variant that the whole capacity for receiving PET and metal beverage packaging will come from newly purchased reverse vending machines.

Our model assumes that 100 % of organised shops with the sales space smaller than 200 m^2 will join the scheme voluntarily. For unorganised small shops, we considered a 50 % rate of involvement in the system. The shops without reverse vending machines will collect the beverage packaging manually. The optimum form of purchase in the shop is specified on the basis of the annual sale of packaging per one shop and the recommended volume of sale, from which the reverse vending machine is economical. In case of manual collection, additional costs are necessary to modify the space; their pricing is taken over from the Spanish study worked out by Eunomia (Eunomia, 2012).

The investment costs for the establishment of the **counting centre and sorting plant** are estimated in the amount of EUR 3.9 mil. For economic reasons, the reverse vending machines will collect bottles and cans into one vessel. The beverage packaging from entire Slovakia will be separated, consolidated and compacted in the accounting centre, where the bottles from manual collection will also be counted up. To perform such acts, additional technology will be necessary, such as optical line, counting and sorting machine and magnetic separator. The costs of sorting line were estimated on the basis of data from the Norwegian central system of the deposit-refund system Infinitum.

Central System establishment will require the costs amounting to EUR 10.7 mil. They consist of system planning and design, its implementation, conclusion of contracts, communication, costs of rooms, equipment and the information system that will gather and process all data. The costs were estimated according to the

study of Eunomia for the deposit-refund system for single-use beverage packaging in Scotland. **System security** includes the deposit logo and EAN codes. The costs of security were also taken over from the Scottish study and they are about EUR 3.4 mil.

4.3.2 Operating costs

The total annual operating costs of the system are estimated in the amount of EUR 33.3 mil. Out of that, EUR 13.5 mil. will be the costs of retail and EUR 19.8 mil. the costs of the central system with the biggest item being transportation.

Table 6: Operating expenses of the mandatory deposit-refund system

Item	Value (EUR)
Retail costs	13,564,279
Costs connected with reverse vending machines	9,933,544
Space in the shop and store including the opportunity costs	3,091,622
Bags	4,944,499
Reverse vending machine operation (energy)	180,933
Labour costs	1,716,490
Costs connected with manual collection	3,630,735
Store space	609,059
Labour costs	2,833,668
Logistics equipment (bags, labels and seals)	188,008
Central system costs	19,760,634
Transportation	14,171,668
Administrative costs (employees, rooms, IT)	1,639,875
Counting centre and sorting plant costs	3,949,091
TOTAL	**33,324, 913**

Source: IEP

The costs will be fully reimbursed to retailers in the form of a handling fee for each bottle collected by the retailer. The handling fee represents the share of retail costs for the quantity of collected bottles. They differ depending on whether the retailer collects bottles manually or through the reverse vending machine.

The total costs of the retailers collecting bottles through reverse vending machines represent EUR 9.9 mil. The retailer involved in collection through the reverse vending machine has labour costs concerning the employees who empty and clean the reverse vending machine, the costs of equipment for logistics, as well as the costs of space in the shop and store, which also includes the opportunity costs because a part of the space, which could have been used commercially, must be used for the collection of empty beverage packaging.

The costs of manual collection will amount to EUR 3.6 mil. They include the costs of store space, labour costs and equipment for logistics. The equipment for logistics includes the costs of plastic bags, labels, and security seals necessary for the collection, transportation and identification of bottles, and correct payment of handling fees and deposits, which is based on the estimates of Tomra and RVM Systems, the Spanish study of Eunomia and the Institute for Economic and Ecological Policy (IEEP) (Jílková, et al., 2008). The price of equipment for logistics was provided by the Danish company Trioplast, which also provides such equipment in Norway.

The operating costs of the **central system are estimated to be EUR 19.8 mil**. and they consist of the costs of transportation, administrative costs of CS, and costs of the counting centre and sorting plant.

More than one half of the costs of central system is created by the transportation costs. For their estimate we expect one counting centre and sorting plant in Žilina and 34 interim storage facilities around Slovakia. The carrier will collect empty packaging from individual shops and transport them to the interim storage facility where they will be consolidated in transport containers. The frequency of removal of empty packaging was determined according to the practice of the Norwegian system Infinitum. The carrier will arrive to pick up empty packaging from the shop, if their quantity corresponds to the size of 6.5 euro pallets. We also assume that the carrier will remove packaging from several shops during one drive in order to fill the vehicle to a maximum extent. From the interim storage facility they will be transported to Žilina on a regular basis, where the packaging from manual collection will be counted, sorted and subsequently compacted together with beverage packaging from the reverse vending machines. Then, the packaging will be EXW handed over to the recycling facility, which means that the facility will provide their own transportation.

The determination of transportation costs requires the road distance for the transportation of packaging from shops to interim storage facilities, from the interim storage facilities to the sorting centre and the price of transportation. As we do not have any map of shops and do not know the distance among them, the road distance between the shops and interim storage facilities was estimated by means of the methodology used in the Czech study of IEEP (Jílková, et al., 2008). The methodology is described in detail in the technical annex. The price quotations for transport are from the forwarding companies BM Transport and Lörincz.

The location and the number of interim storage facilities was determined on the basis of the minimum quantity of packaging that will have to be temporarily stored each year according to the experience of the Norwegian central system Infinitum, the number of inhabitants in individual districts and their geographic proximity. We do not take into account investment costs of their construction because we expect that the already existing stores will be used.

In practice, backhauling is often applied to the transportation of empty packaging from shops to interim storage facilities, which means that the truck supplying new goods to the shop uses the emptied space and fills it with empty returned packaging and transports them back to the interim storage facility. Thus, the costs of this part of transportation would consist only from additional fuel costs in comparison with the transportation of an empty truck.

The administrative costs of the central system consist of the administration of IT infrastructure, wage costs and costs of the services necessary for operation. The estimate is from the Scottish study of Eunomia, which is based on the data of the Finnish central system Palpa, with which we also communicated. The Scottish, Finnish and Slovak markets are relatively similar (Hogg, et al., 2015).

The counting centre and sorting plant will have operational labour costs, energy costs and costs of storage rooms. We estimated the investment and operational costs of the centre on the basis of communication with the Norwegian system Infinitum.

4.3.3 Revenues of the system

The total annual revenues of the mandatory deposit-refund system for beverage PET and metal (in Slovak conditions aluminium) packaging will be around EUR 28.3 mil. and they consist of the revenues from uncollected deposits and from the sold raw material provided that consumers will return 90 % of PET bottles and beverage cans.

Table 7: Mandatory deposit-refund system revenues

Item	Value (EUR)
Revenues from unclaimed deposits for PET bottles	11,975,194
Revenues from the sold PET raw material	9,046,194
Revenues from unclaimed deposits for cans	3,281,667
Revenues from the sold raw material of (aluminium) cans	3,969,360
TOTAL	**28,272,415**

Source: IEP

The price used for PET material comes from the recycling facility General Plastic. As the bottles from such collection will be probably cleaner, thus partial costs of cleaning will not be included, based on the communication with the company we expect the price of PET higher by about 10 %. One ton of aluminium was priced based on the recommended price of secondary aluminium from cans according to TOMRA EXW.

5 Indirect and social costs and benefits

The reduction of littering, increase in employment and environmental benefits on the one hand, reduced funding of separate collection and a decrease in the comfort of the population on the other hand – the introduction of the mandatory deposit-refund system for PET bottles and cans will not only affect the producers and the system itself but it will also bring other indirect and social costs and benefits. It must be noted that individual figures cannot be summed up as not all estimates are equally robust.

5.1 Additional benefits of the system

The introduction of the deposit-refund system will have a positive impact on the reduction of littering because the deposit amount will motivate people to return bottles to the shop. At the same time, the introduction of the system should bring the creation of approximately 250-360 jobs and environmental benefits due to increased recycling resulting in lower consumption of materials and energies and lower emissions of CO_2.

Table 8: Indirect revenues of the mandatory deposit-refund system

Item	Lower limit (EUR)	Upper limit (EUR)
The saved costs of littering removal and landfilling of mixed municipal waste	**682,634**	**3,399,741**
Costs of littering cleaning	628,895	2,710,086
national parks and protected landscape areas	0	*51,385*
roads	*44,250*	*147,750*
streets	*556,674*	*2,440,574*
rivers	*27,971*	*70,377*
Costs of landfilling of mixed municipal waste	53,739	689,655
Benefit of increased employment	**3,350,500**	**4,824,720**
Environmental benefits of increased recycling	**3,035,587**	**11,618,986**
Saved energy and material	1,216,432	10,531,949
Saved emissions of CO2 (in tons)	271,965	1,087,038

Source: IEP

The introduction of the mandatory deposit-refund system for single-use beverage PET bottles and cans would bring a benefit in the **reduction of littering** in the amount of EUR 0.68 to 3.4 mil. As today there is no comprehensive estimate of nationwide littering, we can use only partial estimates included in street cleaning, water-course cleaning in the Košice region (Bodrog river-basin, Ružín and Zemplínska Šírava) and the estimate of costs of cleaning of beverage PET and cans from roads. The real benefits of the deposit-refund system in the form of lower littering may be, however, considerably higher, which is suggested by the approximated estimates from the Czech study of IEEP for Slovakia, which represent the basis of the upper level of estimate (Jílková, et al., 2008). The increased rate of return of PET will also mean lower costs of landfilling. Today, a part of PET packaging is also in the mixed municipal waste. Here, we also expect the reduction of quantity, thus, also the reduction of landfilling costs by EUR 53 to 690 thousand.

Following the Scottish study of Eunomia, a positive influence on **employment** can be expected in the amount of 250-360 new permanent wages, which is equal to a single benefit for economy in the amount of EUR 3.4 to 4.8 mil. (Hogg, et al., 2015). The estimate is based on the expert estimate of the Institute of Financial Policy as a weighted added value in common prices per employee.

The increased PET and aluminium recycling will lead to **environmental benefits** in the amount of EUR 3 to 11.6 mil. in the form of saved energy and material, as well as lower emissions of CO_2 equivalents[7] in comparison with the production of the primary raw material. Recycling is especially efficient for aluminium, where up to 90-95 % of energy can be saved and secondary aluminium can be used for the same purpose. On the contrary, the recycled PET does not have the same properties and usage as primary PET. The value of CO_2 equivalent emissions savings comes from Turner, et al. (2015) and it is based on the comparison of emissions in producing the primary and secondary raw material.

It is only a part of positive environmental impacts. Moreover, the introduction of the deposit-refund system will lead to many **indirect environmental benefits that can be hardly quantified**, for example in the form of a higher aesthetic value of cleaner territories where litter was lying around or a lower load on ecosystems due to lower presence of non-biodegradable material in the wild. What is more, we are still not able to express the benefits of reduced plastic littering for population health as the research of health impacts of microplastics is at the beginning.

5.2 Additional costs of the system

The main indirect costs include the reduced revenues in the system of separate collection, and the reduced comfort of the population, which will have to return bottles to shops.

Table 9: Indirect costs of the mandatory deposit-refund system

Item	Lower limit (EUR)	Upper limit (EUR)
Net influence on separate collection	**-4,140,998**	**- 10,707,097**
Lost revenues from the sale of PET raw material in separate collection	-5,720,893	-5,720,893
Lost revenues from the sale of cans in separate collection	-1,825,354	-1,825,354
Lost income from producers' fees for PET	-2,554,420	-2,554,420
Lost income from producers' fees for cans	-606,430	-606,430
Saved costs of separate collection of waste	6,566,099	0
Costs of the reduced comfort of consumers	**- 13,869,301**	**- 21,393,563**
Costs of storage of bottles in the household	- 7,524,261	- 15,048,523
Costs of work for returning the bottles	- 6,343,040	- 6,345,040

Source: IEP

The introduction of the mandatory deposit-refund system for beverage PET and aluminium packaging will lead to the **loss of revenues** of EUR 4.1 to 10.7 mil. **in the current system of separate collection**, which is provided for by the producer responsibility organisations (PRO). On the one hand, the system costs will be reduced because there will be less raw material for collection and sorting (this will increase the capacity of the available structure), on the other hand, valuable raw material will disappear from the vessels and the revenues of PRO from the sale of material and fees paid by producers today for the packaging will decrease. The lower limit of separate collection cost savings is based on the annual costs of collection and quantity of PET, which is today in the yellow vessels. However, it is possible that the real savings will be lower because the frequency of collection will not be reduced equally to the reduction of plastics in the yellow vessels, thus the total loss of separate collection revenues will be bigger. The upper limit was set as a possibility that the costs will not be reduced at all.

As the inhabitants will have to return empty beverage packaging back to shops, the introduction of the deposit-refund system will bring **reduced comfort for inhabitants** with a value of about EUR 13.9 to 21.4 mil., i.e. EUR 2.55 to 3.94 per citizen. We expect that they will connect the returning of packaging with

[7] We took into account the price of CO_2 equivalent of EUR 31.

shopping, thus, the discomfort itself represents the time necessary for returning the beverage packaging as well as the space of the households for temporary storage. IEEP estimates that an average person will return 12 beverage packages. In such case, the costs of the returning of bottles (when time is priced by the average nominal wage in the economy) represent EUR 6.3 mil., i.e. about EUR 1.17 per citizen. The costs of storage (taking into account the average price of lease of flat area) amount to EUR 7.5 to 15 mil., depending on whether the consumers place them next to each other or in one bag. Unit cost, i.e. EUR 1.39 to 2.77 per citizen or EUR 4.06 to 8.13 per household.

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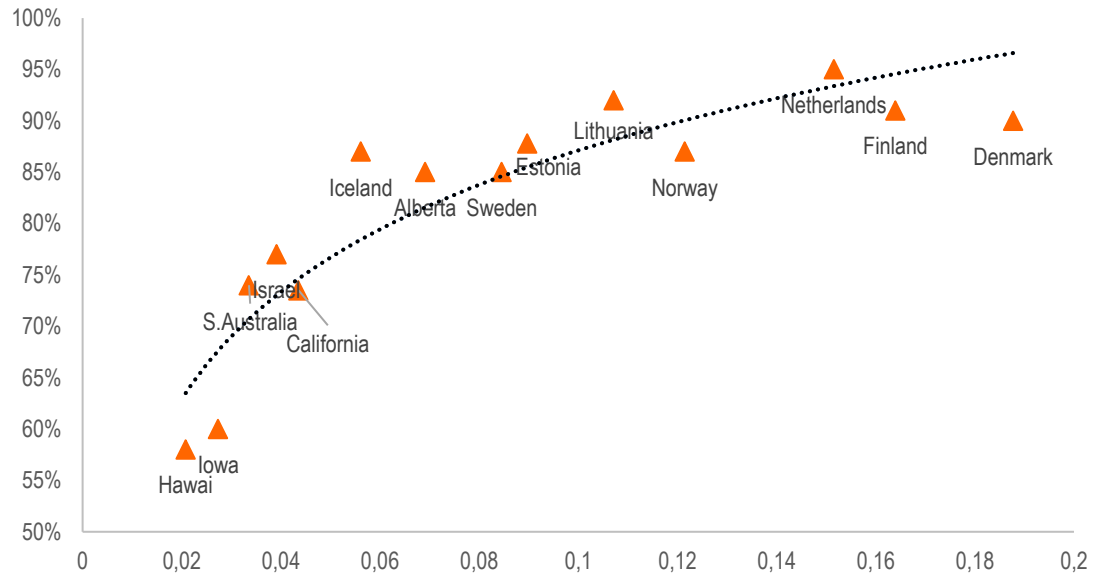
Annexes

Annex 1: Calculation of an optimum deposit amount

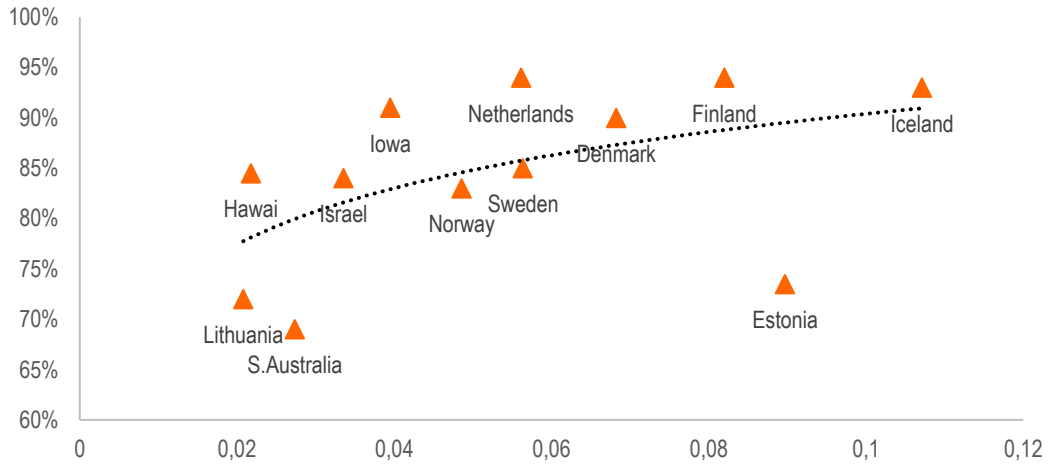
The rate of return depends on the deposit amount. The higher it is, the higher the motivation of people to return the beverage packaging. Therefore, if we set the target of return rate to 90 %, we will not reach it with any deposit amount only with the amount based on the mutual relation of these values in the form of logarithmic function, see (Eunomia, 2012) and (Hogg, et al., 2015). Based on Reloop data (2016) on the amount of deposits and rate of return, which were adapted to price conditions in Slovakia through the purchasing power parity, we came to the result that if we want to achieve a 90 % rate of return, we need a fee amounting to at least 12 cents with PET bottles and with cans 10 cents.

Chart 6: Logarithmic function of the deposit for PET packaging (rate of return vs. deposit in PPP EUR)



Source: IEP pursuant to reloop data

Chart 7: Logarithmic function of the deposit for aluminium (rate of return vs. deposit in PPP EUR)

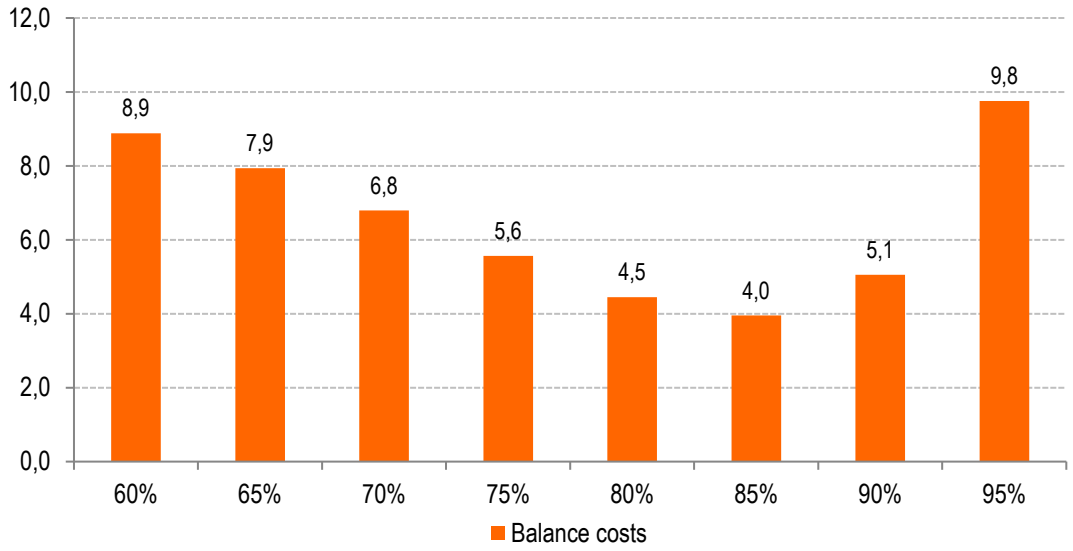


Source: IEP pursuant to reloop data

Annex 2: Test of sensitivity

The rate of return affects both the operating costs and operating revenues. The higher the rate of return, the higher the costs of system operation and revenues from the sale of material. On the other hand, the revenues from uncollected deposits decrease with the rate of return.

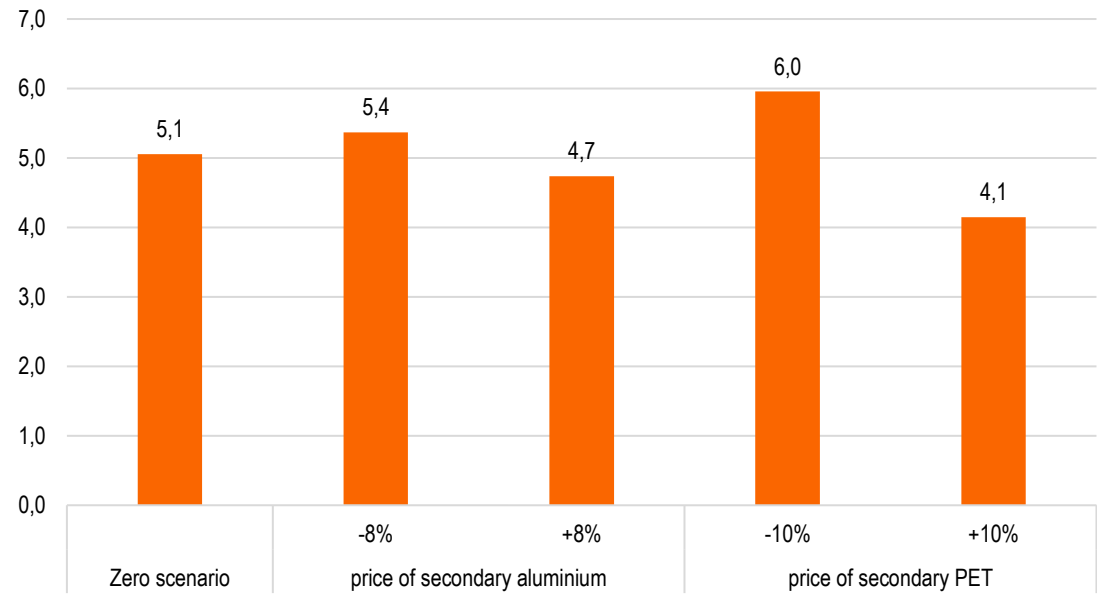
Chart 8: The amount of balance costs for various rates of return (in mil. EUR)



Source: IEP

The prices of secondary PET and aluminium from cans vary within the range of +/- 8 % for aluminium and +/- 10 % for PET. The unstable prices affect the revenues of the system, thus, they affect also total balance costs which can rise or drop by as much as EUR 1 mil.

Chart 9: The amount of balance costs depending on prices of secondary materials (in mil. EUR)



Source: IEP

According to the information available, the number of PET bottles and cans ranges from 723 to 1,526 million per year. The expected number of packages affects all types of costs. In case of a lower number of packaging in comparison with the zero scenario, the deposit-refund system is more expensive in terms of balance costs as well as administrative costs.

Table 10: Analysis of sensitivity to the number of packages placed on the market

Number of packages (mil. pieces)	Balance costs (in mil. EUR)	Investment costs (in mil. EUR)	Administrative fee amount (euro cent/ packaging)	
			PET	can
723	5.8	58.3	2.2	0
1,334	5.1	80.2	1.5	-0.5
1,526	5.0	90.6	1.5	-0.6

Source: IEP

In the zero scenario we consider a 100 % involvement of hypermarkets, supermarkets, discount shops and organised shops, and with a 50 % involvement of unorganised shops in the deposit-refund system. In case of unorganised shops, their number is estimated to be 4,617 of shop units selling annually total 65 mil. pieces of PET bottles and cans. In examining the robustness of results, we considered the limit of involvement of unorganised shops, i.e. 0 % and 100 %, from which it results 51 % or 100 % of involvement of all shops. From the sensitivity analysis it results that the involvement of unorganised shops in the system, thus the total involvement of all shops has no significant impact on the investment costs. The balance costs vary within the range of +/- EUR 1 mil.

Table 11: Analysis of sensitivity to the rate of involvement in the system

Rate of involvement	Balance costs (in mil. EUR)	Investment costs (in mil. EUR)	Administrative fee (euro cent/ packaging)	
			PET	can
51 %	4.1	80.1	1.4	-0.6
73 %	5.1	80.2	1.5	-0.5
100 %	6.1	80.4	1.6	-0.4

Source: IEP

Annex 3: Comparison of European mandatory deposit-refund systems

Table 12: Overview of European mandatory deposit-refund systems

	System establishment	Materials	Deposit amount	Return rate	Automation	Rate of voluntariness
Finland	1996 cans, 2008 PET, 2012 glass	PET, cans and glass except milk	EUR 0.10-0.40	PET 91%, cans 94% in 2017 (glass in 2014 - 89)	97%	voluntary for producers, mandatory for retail
Sweden	1989 PET, 1992 cans	PET except juices and milk but including alcohol	EUR 0.10-0.20	85% in 2016	95%	mandatory for producers, voluntary for retail
Norway	1999	PET, HDPE, steel, aluminium - except for fresh juices, concentrates, nectars, syrups, vegetable drinks, milk and cocoa	EUR 0.11-0.26	PET 87%, cans 83% in 2016	93%	mandatory for retail
Germany	2003	PET, cans and glass, exceptions: packaging smaller than 0.1 L and over 3 L, ecological packaging, reusable packaging, milk products, fruit and vegetable juices, diet products for toddlers	EUR 0.25 EUR	PET 98%; Cans 96%[8]	80%	mandatory for retail (less than 200m2 only the goods which they sell)
Denmark	2002	PET, cans, glass except juices, cocoa, wines, spirits and milk	EUR 0.13-0.34	total 90% in 2017	80%	mandatory for producers, voluntary for retail
Estonia	2005	PET, cans, glass except spirits, wine, Tetra Pak and glass jars	EUR 0.10 EUR	cans: 73.5%, PET: 87.8%, glass: 88.7%	94%	mandatory for producers, mandatory for retail over 200 m2, between 20-200 m2 they can apply for an exception, no collection is mandatory for less than 20m2
Lithuania	2014	PET, cans and glass from 0.1 to 3 L except milk, wine and spirits	EUR 0.10 EUR	92%	89%	mandatory for retail over 300m2
Netherlands	2005	plastic over 0.5 L except medicine beverages, wine, spirits, strong alcoholic beverages, cardboards, packages for direct sale with beverages, packages with a volume less than 1 decilitre, and beverages, where the producer proves lower annual sales than 500 thousand pieces	EUR 0.25 EUR	95% for PET	89%	NA
Iceland	1989	PET, cans and glass except milk and milk products and juices	EUR 0.13 EUR	total 90%; cans 94%, PET 87%, glass 86%	Mostly manually	NA
Croatia	2005	PET, cans, glass except milk	EUR 0.07 EUR	up to 90%	Mostly manually	mandatory for retail over 200m2

Source: IEP pursuant to reloop and communication with central systems of individual count

[8] Rates of return in Germany (and Croatia) are not very comparable to the other countries because in the Scandinavian model of deposits, the central system transparently monitors every beverage packaging, whereas in the German model, the producers declare themselves the quantity of beverage packages placed on the market and returned.