A Deposit Refund System for the Czech Republic

Final Report

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15th January 2019

Report for Institut Cirkulární Ekonomiky z.ú. & Karlovarské minerální vody a.s.

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Acknowledgements

INCIEN, Karlovarské minerální vody and EKO-KOM for the information and data they provided to assist the modelling.

Executive Summary

Eunomia Research & Consulting (Eunomia) was commissioned by Institut Cirkulární Ekonomiky (INCIEN) and Karlovarské minerální vody to design and model a deposit refund system (DRS) for disposable beverage containers in the Czech Republic. Their aim is to support the circular economy in the Czech Republic and to improve the recycling rate of beverage containers.

The purpose of this study is to determine the costs and implications of a DRS designed to deliver a 90% recycling rate. Currently, there is a degree of uncertainty over the separate collection and recycling rates in the Czech Republic but, following a thorough analysis by INCIEN, it is estimated that approximately 69.5% of PET bottles are separated, and 56% of PET bottles and 30% of metal cans are sent for recycling. These findings differ from the results provided by EKO-KOM, a Czech Green-dot operator. Although there are many reasons to use INCIEN's results, it was agreed that this study would use an estimate of the PET recycling rate (65%) provided by EKO-KOM. This means that the projected improvement in the recycling rate under a DRS is more conservative than if INCIEN's figures were used in the study.

E.1.0 Approach

The first task was to review examples of best practice from existing DRSs and to propose a design for the Czech Republic. The study considered the following DRS components:

- Governance – how the system is set up, who operates it and how;
- Scope (beverage container type) – INCIEN and Karlovarské minerální vody had specified at the outset that the system would either be for PET bottles only, or for PET bottles and aluminium/ steel cans;
- Scope (beverage type) – the range of beverages included in the scheme;
- Deposit level – the value of the refundable deposit added to beverage containers to incentivise returns;
- Return infrastructure – where and how consumers can return their used containers to claim a refund;
- Handling fees – the amount paid to retailers to compensate them for the costs of taking back containers;
- Material ownership – who is responsible for the returned material and who collects the revenues from it;
- Funding – how the system is financed, and by whom, including how unredeemed deposits are used;
- Labelling and fraud prevention – how to identify containers that are part of the scheme and to reduce the losses from fraudulent claims or free-riders; and

- Supporting policy instruments – additional policy measures that could support the scheme objectives and level the playing field for containers excluded from the scheme.

Having identified a suitable design for the Czech Republic, Eunomia conducted a mass flow analysis, using beverage sales data and information from EKO-KOM and INCIEN, to identify the number of beverage containers that are currently recycled, littered, landfilled or incinerated. The waste flow model was additionally used to calculate the changes in these final destinations for used beverage containers under a DRS with a 90% return rate. Secondly, we developed our DRS model and European Reference Model on Municipal Waste Management to assess the financial impacts of the proposed DRS, including:

- The producer fees paid by producers to cover the net costs;
- The level of handling fees needed to compensate retailers;
- The impact on EKO-KOM PET collections;[1] and
- The impact on residual waste collections, separation facilities and municipalities.

The DRS model calculates the costs of: central administration; reverse vending machines (where used); retailer staff time; retailer storage space; collection; counting centres; and haulage to counting centres and processors.

In addition to the financial costs and benefits, it is important to reflect on the environmental benefits of a DRS. INCIEN and Karlovarské minerální vody had commissioned the University of Chemistry and Technology, Prague, to conduct a life cycle assessment (LCA) of a DRS so, instead of using our existing DRS model to assess the environmental impacts, Eunomia has included the monetised financial benefits, based on the findings of the LCA.

E.2.0 DRS Design

The design chosen for the Czech Republic, and modelled in the impact assessment, is summarised in Table E 1-1.

Table E 1-1: Summary of Design

Element	Option Chosen for the Czech Republic
Governance	Centralised; privately owned and operated; targets set by government (and/ or Beverage Container Tax)
Scope – Containers	1) PET; or 2) PET and aluminium/ steel

[1] An authorised producer responsibility organisation collecting packaging waste in the Czech Republic.

Element	Option Chosen for the Czech Republic
Scope – Beverage	Water; soft drinks; beer; and cider included. Wine, spirits and milk are excluded.
Deposit Level	CZK 3
Labelling	National barcodes, unique to the Czech Republic
Return Infrastructure	Return to retail Retailers take back any deposit-bearing container Compacting RVMs for large retailers Manual service for small retailers
Handling fees	Determined by retailers' cost – different for RVMs and manual service
Material ownership	System operator
Funding	Material Revenues Unredeemed deposits Producer fee for every container placed on the market
Supporting Economic Instruments	Beverage Container Tax, graduated to zero for container types with a recycling rate above 90%

E.3.0 Results

The modelling indicates that the DRS would produce savings of €203,000 per annum for current residual waste collections if only PET is included, and €452,000 if both PET and cans are included. As the landfill tax is due to more than treble over the next five years, the costs of residual waste are set to increase. As a result, a higher disposal cost of €80 per tonne was additionally modelled and this would increase per annum savings to €345,000 or €768,000 respectively. These savings represent the avoided cost of sending the used beverage containers to landfill.

The modelling for the bring-sites for PET recycling indicated that the DRS could lead to efficiency savings in collections and sorting of €7.9 million. This would, however, be offset by separation facilities' loss of material revenues, which are estimated to be €12.1 million. There would also be a loss of €10.1 million – €11.0 million in PRO fees, but fees may in any case have to change in the future if the Czech Republic is to comply with the revised Waste Framework and Packaging & Packaging Waste Directives.

The modelled financial costs of the DRS – annually and per container placed on the market – at a 90% return rate, are listed in Table E 1-2 and Table E 1-3. The current split between PET and metal costs is only indicative, as the system operator would need to undertake more detailed analysis to determine which costs should be attributed to PET and which costs should be covered by aluminium/ steel producers. But, if both PET bottles and metal cans are included, the costs to producers would be lower than their current costs under the PRO system (reduced to €9.5 million). Ultimately, producers may not have to pay anything for aluminium cans due to the high material value.

Table E 1-2: System Costs - PET only

Item Future System Operator Costs	Total Cost, € million	Cost/Unit POM, € cents
Central Admin System	0.9	0.07
Handling Fees	38	2.68
Transport Costs	8.5	0.60
Counting Centre Costs	1.4	0.10
Materials Income	-17.7	-1.25
Unclaimed Deposits	-18.5	-1.30
Fraudulently Claimed Deposits	1.7	0.12
Net Cost Funded by Producer Admin Fee	14.3	1.01

Table E 1-3: System Costs: PET & Metal

Item	Total Cost, € million		Cost/Unit POM, € cents	
Future System Operator Costs	PET	Metal	PET	Metal
Central Admin System	0.5	0.5	0.03	0.15
Handling Fees	36.3	7.67	2.56	2.45
Transport Costs	8.2	0.9	0.58	0.28
Counting Centre Costs	0.7	0.7	0.05	0.23
Materials Income	-17.7	-6.9	-1.25	-2.20

Item	Total Cost, € million		Cost/Unit POM, € cents	
Future System Operator Costs	**PET**	**Metal**	**PET**	**Metal**
Unclaimed Deposits	-18.5	-4.9	-1.30	-1.55
Fraudulently Claimed Deposits	1.7	0.4	0.12	0.12
Net Cost Funded by Producer Admin Fee	11.1	-1.61	0.78	-0.52

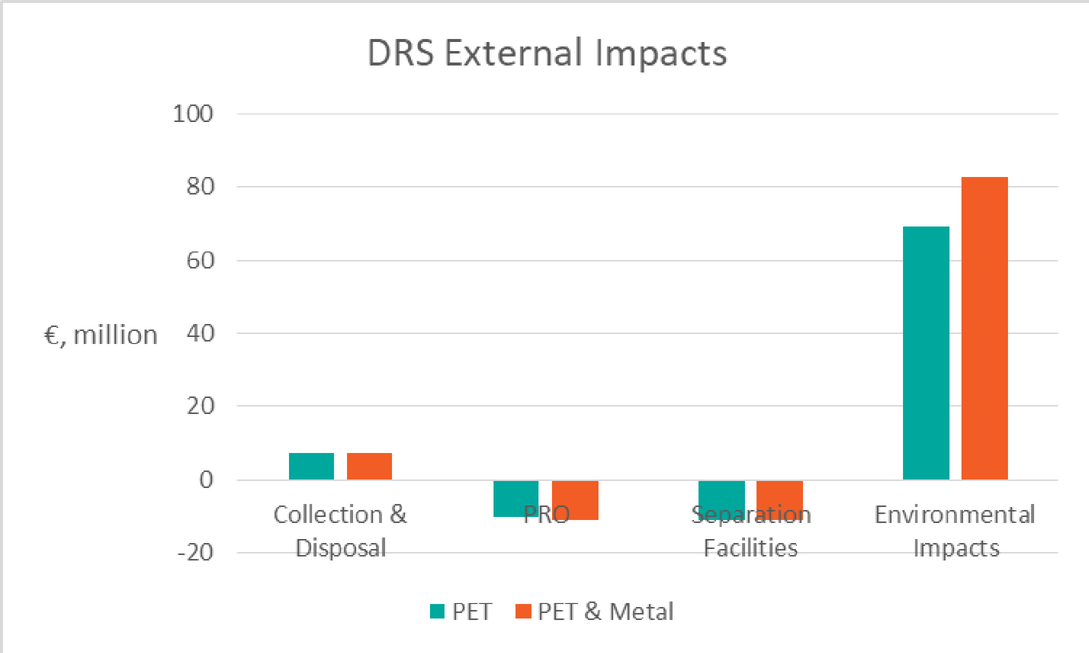
As the DRS relies on retailers taking back used containers and refunding the deposit they reimburse to consumers, it is important that they are paid an appropriate fee for each container they take back, in addition to the refunded deposit. Having calculated the costs for retailers that provide a manual service and those using a reverse vending machine (RVM), the estimated handling fees in the two scenarios are provided in Table E 1-4.

Table E 1-4: Retailer Handling Fees per Unit Redeemed

	PET, € cents	PET & Metal, € cents
Handling Fees – RVM	2.96	2.86
Handling Fees – Manual	2.31	2.03

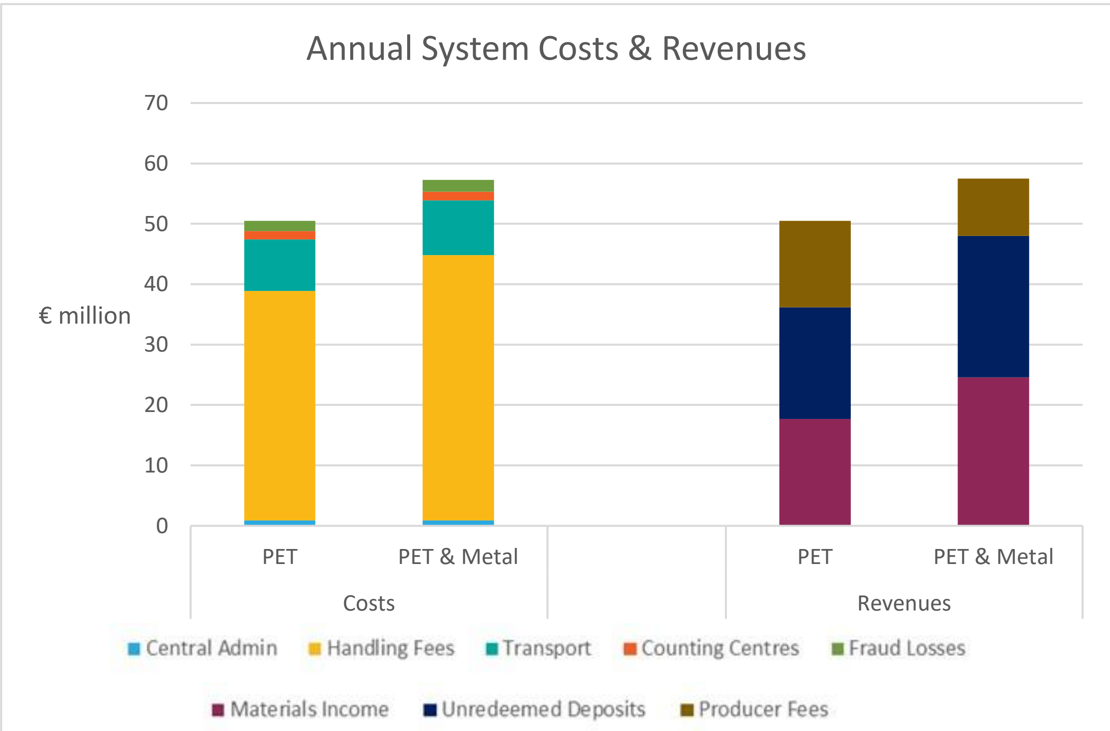
As shown in Figure E 1-1, the monetised environmental benefits and residual waste savings exceed the losses resulting from the DRS (based on current fees and waste management arrangements). It is also worth noting that the monetised environmental benefits are far higher than both the net and gross costs of the DRS. The reduced greenhouse gas emissions in the year the DRS is modelled are valued at €3.7 million, while the DRS reduces the litter disamenity by €79 million. This is a conservative estimate, based only on litter that remains in the terrestrial environment.

Figure E 1-1: DRS External Financial Impacts (€ million)



Savings and benefits are positive figures, costs and losses are negative.

Figure E 1-2: Comparison of DRS Costs and Revenues



Contents

1.0 Introduction

Eunomia Research & Consulting (Eunomia) was commissioned by Institut Cirkulární Ekonomiky (INCIEN) and Karlovarské minerální vody to design and model a deposit refund system (DRS) for disposable beverage containers in the Czech Republic. A DRS charges a small, refundable deposit on specified beverage containers and such an approach is relied upon by a growing number of countries around the world to:

- Increase the recycling rate of single-use beverage containers;
- Reduce littering of these containers; and
- Provide a reliable supply of food-grade recycled PET (rPET).

The study required Eunomia to: define the parameters for a DRS; to model the financial impacts; and to consider potential alternatives for achieving a 90% recycling rate.

INCIEN and Karlovarské minerální vody asked Eunomia to model two scenarios:

1) A DRS for PET bottles only: and
2) A DRS for PET bottles and metal cans.

The remaining design features of a DRS were determined following a review of existing systems in Europe and North America and are intended to achieve Karlovarské minerální vody and INCIEN's target return rate of 90%.

As part of the impact assessment, Eunomia considered the effects on litter but did not model the environmental impacts, as INCIEN and Karlovarské minerální vody had already contracted the University of Chemistry and Technology, Prague (VŠChT) to conduct a life cycle assessment of the DRS. VŠChT provided their results to Eunomia, enabling the impact assessment to include the monetised environmental benefits.

This report includes:

- A brief introduction to deposit refund systems (Section 2.0)
- The reasons for introducing a DRS (Section 3.0);
- The specific circumstances in the Czech Republic (Section 4.0);
- DRS design options (Section 5.0);
- The method for assessing the impact of the proposed design (Section6.0);
- The results of the impact assessment (Section 7.0);
- The environmental benefits (Section 8.0);
- Consideration of alternatives to achieve a 90% recycling rate for plastic bottles (Section 9.0); and
- Conclusions from the study (Section 10.0).

Additionally, a complete technical appendix is included at the end of this report.

2.0 What is a Deposit Refund System?

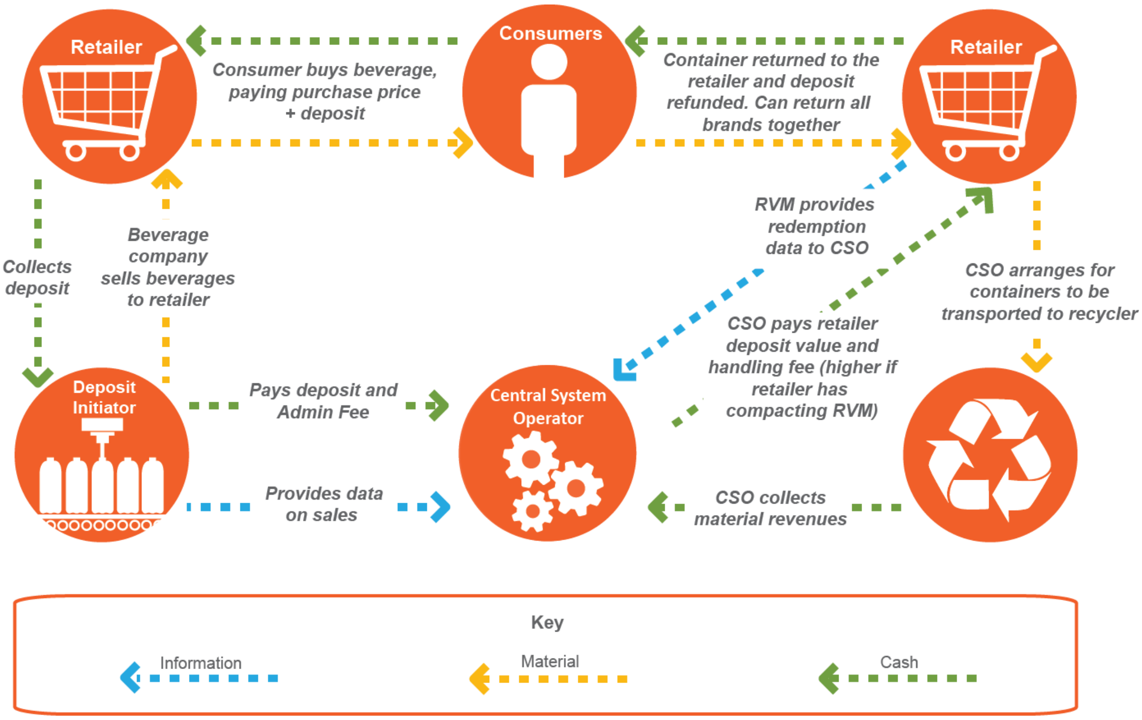
A DRS for one-way containers incentivises consumers to return used beverage containers to be recycled by applying a small, refundable deposit to beverage sales. In most cases, DRSs are a form of extended producer responsibility (EPR) and are at least partially funded by the beverage industry.

Several states, provinces and territories in the USA, Canada and Australia have a DRS. In Europe, countries including Germany, Norway, Lithuania, Estonia, Finland, Sweden, Denmark and Iceland have had a DRS for many years. Malta and Scotland are amongst a number of countries that are currently developing a DRS.

The exact details of the systems vary but Figure 2-1 illustrates the general structure of a centralised DRS that uses the return to retail model. Generally, the process is as follows:

1) Beverage producers initiate the deposit by paying it into a designated deposit account.
2) Retailers pay the deposit to producers/ distributors at the wholesale stage.
3) Consumers pay the deposit to retailers, along with the price of the beverage.
4) Consumers claim a full refund when they return their used beverage container to a designated return location.
5) The return location is reimbursed for the refunded deposit from the deposit account.
6) The returned used beverage containers are transported to a central location to be processed and recycled. The material can be used to manufacture new beverage containers.

Figure 2-1: Flows of Beverage Containers and Funding in a Typical DRS



3.0 Why Introduce a Deposit Refund System?

The key reasons for introducing a DRS are summarised below. The environmental impacts, in terms of the reduced greenhouse gas emissions, are discussed in Section 8.0. There are additional, supplementary benefits, including job creation – reducing unemployment levels for governments – and potentially stimulating the domestic recycling and manufacturing industry by providing more material, but these are not discussed in this report.

3.1 To Improve Recycling Rates

Charging a deposit on beverage containers incentivises consumers to return their used container for recycling, so that they can claim a refund. Across Europe, a number of countries already have a DRS. These have achieved return rates of at least 80% and, in the case of Germany and Norway, over 95%. By contrast, the maximum recycling rate for plastic bottles considered to be possible without a DRS is approximately 70% (as discussed in Section 9.0).[2] This is partly because it is difficult to capture beverage containers that are consumed on the go – while there are often recycling bins next to litter bins, these suffer from high contamination levels. With bottles consumed at home, consumers do not always separate their waste due to a number of factors, including the level of service provision and interest in recycling. A DRS provides both the facilities and incentive to recycle. In the USA, there are 10 "Bottle Bill" states with a DRS. In general, these tend to have a significantly different design to European systems and have lower deposit values, so the return rates are typically lower than those achieved in Europe. Nevertheless, the average recycling rate for deposit-bearing containers in these 10 states is 76%, compared to just 28% for non-deposit beverage containers in the same states.[3]

Under the revised EU Waste Framework Directive (Article 11), EU Member States will be required to recycle 55% of waste by 2025, 60% by 2030 and 65% by 2035. Additionally, the EU has introduced higher targets for packaging specifically in Article 6 of the Packaging and Packaging Waste Directive, with at least 65% required to be recycled by 2025 and 70% by 2030. As part of this, there is a minimum target of 55% for plastic packaging, 80% for ferrous metals and 60% for aluminium packaging.[4]

To achieve these targets, some countries will need substantial changes to policies and practices. The challenge could be even greater for plastic beverage bottles specifically: if adopted, the proposed Directive on the Reduction of the Impact of Certain Plastic Products on the Environment would introduce a 90% collection target for single-use

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[2] ICF & Eunomia (2018) *Plastics: Reuse, Recycling and Marine Litter*, Report for DG Environment
[3] Based on data from the Container Recycling Institute (2017) *2015 Beverage Market Data Analysis*.
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0852&from=EN

plastic bottles by 2025. The European Commission offers the example of a DRS to achieve this, and Section 9.0 considers the scope for other possible approaches to achieve such a collection rate.[5]

3.2 To Reduce Littering

As beverage containers are often consumed on the go (and are significantly larger than frequently-littered items such as cigarette butts or chewing gum), it is estimated that, generally, they account for approximately 40% of litter by volume.[6] While exact litter compositions will vary from country to country, this is in line with a litter composition study in the Czech Republic, which concluded that PET bottles accounted for 30% of litter by weight, and 37% of total litter by volume.[7]

The deposit attached to beverage containers gives them a financial value, so consumers will be less likely to litter them. When beverage containers are littered, other citizens will be motivated to pick them up so that they can claim the refund. As such, it is estimated that a well-designed DRS could reduce the littering of beverage containers by 95%, meaning the volume of all litter would reduce by a third.[8] The monetised benefits of this, in terms of reduced litter disamenity, for the Czech Republic are estimated in Section 8.0.

In addition to the direct costs of collecting and treating/disposing of terrestrial litter (and the negative impacts on the aquatic environment), its indirect costs include: reduced property values; negative effects on mental wellbeing; increasing the propensity for opportunistic crime; and general displeasure at the state of the local environment, known as 'neighbourhood litter disamenity'. Litter can, therefore, have a wider impact on the community.[9]

3.3 To Improve the Quality of Recyclate

Materials collected through a DRS tend to be of a higher quality than those collected through other methods due to the well-defined stream and lower contamination levels. In the US, states without a DRS using single-stream recycling lose 32.2% of plastic at secondary processing facilities.[10] With a DRS, loss rates are significantly lower and processors prefer the material. This consequently provides an increased and more reliable supply of recycled material for beverage container manufacturers and beverage

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[5] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2018:340:FIN

[6] Eunomia (2017) *Impacts of a Deposit Refund System for One-way Beverage Packaging on Local Authority Waste Services*. 11th October 2017

[7] http://data.idnes.cz/soubory/vedatech/95A100219_TAJ_ANALYZAVOLNEPOHOZENYCH.PDF

[8] Eunomia (2017) *Impacts of a Deposit Refund System for One-way Beverage Packaging on Local Authority Waste Services*. 11th October 2017

[9] Eunomia (2013) *Exploring the Indirect Costs of Litter in Scotland.* May 2013

[10] Resource Recycling (2012) *A Common Theme*. February 2012 http://www.container-recycling.org/assets/pdfs/ACommonTheme.pdf

companies that are improving their resource efficiency and committing to increase the recycled content of their containers. For instance, Coca Cola UK, which is targeting 50% recycled content by 2020,[11] has supported calls for a DRS.[12]

It is estimated that 20% (or 8,200 tonnes) of PET bottles currently collected to be recycled in the Czech Republic are lost in the sorting and reprocessing stages, but such loss rates would be minimised in a DRS (see A.2.4). Meanwhile there are no formal separate collections for aluminium packaging, although there are a limited number of bins for mixed metal waste. The material collected, however, is not thought to be as pure as it could be due to contamination.

4.0 Czech Republic Context

4.1 Existing Waste Management

Under the Packaging Act, producers, fillers, importers and distributors are required to ensure that the packaging they place on the market is recovered. They can do this by joining EKO-KOM, a packaging and compliance company that is authorised to undertake these obligations on behalf of producers.

To join EKO-KOM, producers pay both a registration fee of 800 CZK (€31.25) and an annual fee of 800 CZK.[13] In addition, the fees paid per tonne for the materials relevant to beverage containers are as shown in Table 4-1.

Table 4-1: EKO-KOM Compliance Fees (2017)

	CZK/ Tonne	€/ Tonne
Plastics	5,560	205.93
One-way Glass	1,829	67.74
Metals - Steel	1,899	70.33
Metals - Aluminium	2,529	93.67

[11] http://www.coca-cola.co.uk/stories/the-complete-package; https://www.theguardian.com/business/2017/jul/11/coca-cola-to-radically-increase-amount-of-recycled-plastic-in-its-bottles

[12] Increasing Packaging Recovery and Recycling in Great Britain: The Case for Reform of the Producer Responsibility System and the Role of Deposit Return Systems; Coca Cola (July 2017). (https://www.coca-cola.co.uk/content/dam/journey/gb/en/hidden/PDFs/Coca-Cola-Great-Britain-Sustainable-Packaging-Strategy-Discussion.pdf)

[13] http://www.ekokom.cz/en/other/our-company

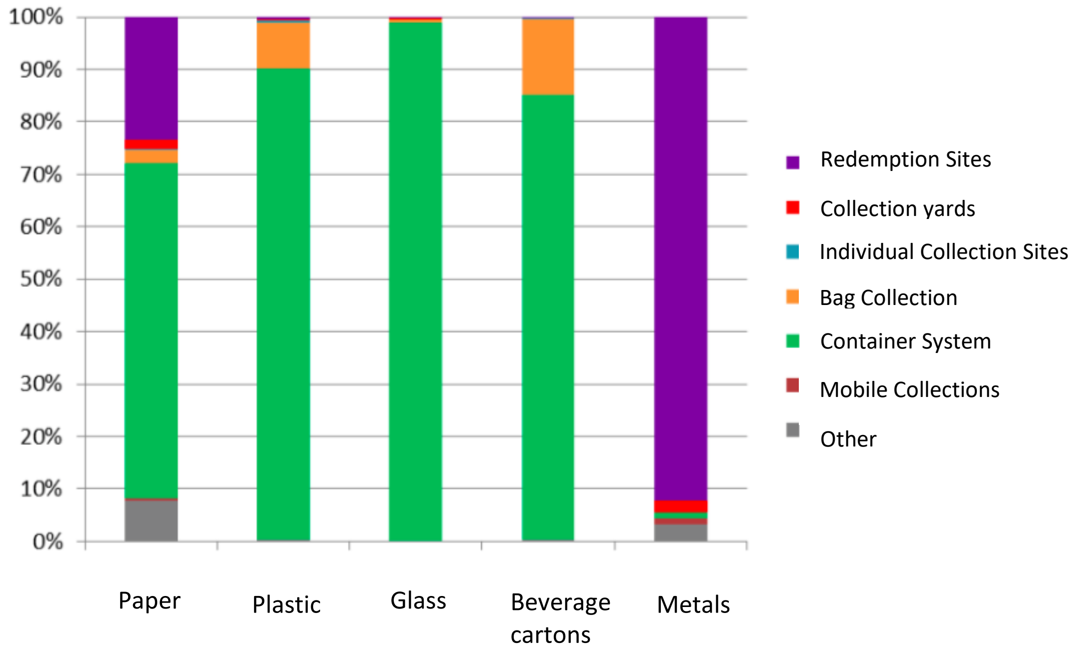
	CZK/ Tonne	€/ Tonne
Beverage Cartons	4,255	157.59

Source: EKO-KOM[14]

EKO-KOM co-finances municipal separate waste collections. Figure 4-2 shows that the predominant method of recycling collection in the Czech Republic is through container sites, with 90% of plastic collected via the container system in 2016. The containers are provided by EKO-KOM, municipalities fund the collections (but are reimbursed for a proportion of the costs by EKO-KOM) and waste separation facilities pay for the sorting and bulking from the revenues they receive for the material. Additionally, a small proportion of plastic (under 10%) is collected through door-to-door collections. These collections are funded by municipalities, who are partially reimbursed by EKO-KOM.

There are limited container collections for metal, with over 90% of metal collected at redemption sites. It is understood that around 70% of mixed waste collection is from container sites, which are funded by the municipalities. A small proportion of residual waste is collected through door-to-door services.[15]

Figure 4-2: Methods of Collection for Different Materials (2016)



Source: EKO-KOM

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[14] Euro figures are provided by EKO-KOM, so do not use the same exchange rate as elsewhere in this report.
https://www.ekokom.cz/uploads/attachments/Klienti/Poplatky/EKOKOM_fees_valid_from_1_1_2017.pdf
[15] Private communication from EKO-KOM.

The reported separation rate for plastic packaging was 69% in 2017, and 62% for metal.[16] However, it is estimated that just 24-35% of metal beverage cans are separated.[17] Moreover, approximately 50% of separated plastic is not sent for recycling, but instead ends up in landfills, incineration plants or cement factories.

This means there is a substantial gap between current rates and the targets set out in the Packaging and Packaging Waste Directive (including 60% for aluminium). Additionally, the revised Waste Framework introduces new rules for calculating recycling rates, which mean that separating waste will not constitute recycling. The weight of municipal waste that is recycled will depend on the proportion that enters “recycling operations”, rather than “preliminary operations”, so the Czech Republic will need to improve both its recycling rate (currently unknown) and measurement method. If the European Commission and EU Member States approve the 90% target for PET beverage bottles, the Czech Republic will need to institute reforms to improve its collection rate.

4.2 Beverage Market

Table 4-1 provides the projected beverage sales in the Czech Republic for 2018, based on trends over the last decade. A third of beverages are sold in PET bottles, over half in glass bottles and just 8% in cans.

Table 4-1: Projected Czech Beverage Sales in 2018 (Millions)

	Beer & cider	Soft drinks	Water	Wine & Spirits	Total
Cans	202.38	114.51	-	0.05	316.94
PET	134.97	777.42	335.66	-	1,248.05
HDPE	-	0.54	-	-	0.54
Glass	1,518.91	94.15	110.75	298.02	2,021.83
Kegs (5 litres)	0.25	-	-	-	0.25
Pouches	-	98.09	-	-	98.09
Cartons	-	79.25	-	7.40	86.65
Total	1,856.51	1,163.96	446.41	305.47	3,772.35

Source: Global Data (2018) Market report on the consumption of Plastic Bottles.

[16] https://www.ekokom.cz/en/other/system-results
[17] Private communication with EKO-KOM.

Using data from EKO-KOM and Karlovarské minerální vody's knowledge of the Czech market, the figures provided by Global Data are believed to underestimate PET and can beverage sales. While Table 4-1 is included in this report to provide a more detailed understanding of the beverage market, including the distribution between different types of packaging and beverages, the figures shown in Table 4-2, provided by EKO-KOM and Karlovarské minerální vody, are reported to be more representative of the current beverage market in the Czech Republic. These figures will consequently be used in the impact assessment.

Table 4-2: Beverage Sales Data to be used in the Impact Assessment

	PET	Aluminium	Steel
Placed on Market (Tonnes)	49,200	8,455	455
Placed on Market (Million Units)	1,562	338.2	12.7

Source: EKO-KOM (Placed on Market - tonnes) and Karlovarské minerální vody (Placed on Market - units)

Section 9 of the Packaging Act allows for a deposit to be charged on returnable packaging.[18] There is currently a deposit system for reusable glass bottles in the Czech Republic, however there is not currently an equivalent system for single-use beverage containers.

5.0 DRS Design Options

There are a number of elements to a DRS and a range of design options for each. While the design process requires a review of good practice and potential alternatives that are generally best avoided, it is also important that the design is tailored to the specific needs and context of the Czech Republic.

This section explains the key components of a DRS. For each component, we consider examples of best practice and the implications of weaker alternatives, before reaching a conclusion on a recommended approach for the Czech Republic. Any figures or costs in this section are for existing systems; the estimated equivalent figures for the Czech Republic are included in Section 7.0.

[18] https://www.mzp.cz/C125750E003B698B/en/packaging_legislation/$FILE/OODP-Act_on_Packaging_No_477_2001-20110111.pdf

5.1 Governance

There are several dimensions to governance: who runs the scheme; in whose interests is it run; how it is initiated; and how it is regulated.

Some schemes are designed and mandated by governments, while others are developed by the beverage industry. There is then a distinction between schemes that are centrally operated by a central system operator (CSO), and those that are decentralised and run by disparate organisations or companies.

Schemes revolving around a CSO tend to offer greater accountability and transparency because there is a single organisation that is clearly responsible for the system and its success, which can publish annual reports and accounts, and which sets fees for producers. This means all producers know exactly what they are required to pay and if the annual accounts are published publicly, producers can use their knowledge of the market to assess whether all competitors are paying their fair share. The central system operator also monitors fraud to try to ensure that all deposits are correctly initiated and refunded, and that all fees are paid.

Centralised systems can be more efficient, as the system operator arranges for all the containers to be collected and transported (rather than individual producers doing this for their own containers) and they can market the material in bulk so that they get the best price.

5.1.1 Examples of Good Practice

Norway

The Norwegian system was established by the beverage industry after the government introduced a beverage container tax. The level of the tax reduces as recycling rates increase from 25%, and container types that have a recycling rate of at least 95% are exempt. The beverage industry concluded that a DRS was the most effective mechanism to achieve the 95% target and minimise their tax liability.

Infinitum is a not-for-profit organisation that owns and runs the DRS on behalf the industry. The 95% target – combined with the tax if it is missed – means Infinitum is accountable for the system's success and is committed to maximising return rates. The fact that the Infinitum board comprises representatives of the beverage and retail industries means that they are driven to achieve these targets as cost effectively as possible, that they are accountable to the companies funding the system, and all interests are taken into account. Infinitum publishes an annual report, including details of its revenue, costs and results. This report includes the number of containers sold with a deposit, which can help producers detect any free-riding.

A system that is owned and operated by the industry is fully in line with producer responsibility principles and means the industry can use its experience and expertise to design the best system.

Infinitum reports that it has worked continuously to improve the efficiency of its system – aiming to reduce costs while increasing the number of containers collected. They invest in advertising campaigns to promote the system and raise awareness amongst consumers. They set fees per container placed on the market on an annual basis, so producers can estimate their costs in advance. Infinitum also monitors fraud and determines the most cost effective fraud prevention measures – balancing the costs of these against the potential losses from fraud.

In 2016, Norway collected 1,012,190,533 containers (95% of deposit-bearing containers sold). Their operating costs that year were €41,497,365, meaning a cost per container of €0.04.[19] As discussed in Section 5.7, producers do not pay anything for aluminium cans, and pay €0.019 for PET bottles.

Sweden

Sweden similarly has a centralised, not for profit system, but includes slightly more state involvement. It is run by Returpack, which is owned by Swedish brewers and retailers, and regulated by the Swedish Board of Agriculture.[20] The Government has specified recycling targets (90%) in a regulation on producer responsibility for packaging. As such, Returpack is held responsible by the industry for its operation, and by the Swedish Government for its results.

Like the Norwegian system, there is a single entity responsible for determining the scheme's design, for collecting containers, liaising with retailers, marketing the system, reporting, setting fees and preventing fraud. This minimises producers' workload and administrative responsibilities associated with the DRS, as they can delegate their responsibilities to the system operator.

In 2017, the Swedish DRS achieved an 85% recycling rate, recycling 1,850,000,000 containers[21]

5.1.2 Weaknesses of Alternatives

Connecticut, USA

As a decentralised system, there is no single entity responsible for the system's operation or success. Legislation requires producers and retailers to participate in the scheme, and the logistics are the producers' responsibility. There are, however, no targets to meet and limited compliance efforts to verify that a deposit is initiated for every container placed on the market.

A lack of transparency can generate mistrust amongst key stakeholders – not least those funding the system. The lack of accountability may also contribute to the low return rate (around 50% in recent years).

Producers' costs are based on the number of units returned, not the number of units sold, so producers cannot predict their costs and have to pay more as the recycling rate

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[19] Infinitum (2017) 2016 Annual Report.

[20] http://pantamera.nu/om-oss/returpack-in-english/about-returpack/

[21] https://pantamera.nu/pantsystem/statistik/pantstatistik/

increases. They not only pay the full collection costs, but also the full handling fee to retailers for every container returned (see Section 5.5). This means producers' costs in Connecticut are higher than they would be in in a centralised system where the costs are distributed across all containers placed on the market and where they are offset by unredeemed deposits and material revenues.

Whereas in Norway and Sweden, the system operator has the flexibility to design the optimum system and to improve and adapt it over time, specific details in Connecticut are fixed in legislation. This includes the deposit value, the handling fee and the scope of the system, preventing the system evolving and adapting with inflation or consumer trends. It also means it is a lengthy legislative process to amend the system and legislators are subject to political lobbying.

As producers are responsible for collecting their own containers from retailers, consumers and retailers are required to sort their used beverage containers by brand and there are more collection vehicles as the containers are transported separately by brand.

Hawaii, USA

The Hawaiian system is unusual in the USA, as it is centralised. Unlike European systems, however, it is state-run so does not support producer responsibility principles and more costs fall on general taxpayers. Producers contribute little to the system's administrative or financial requirements. The system is funded by the state government, unredeemed deposits and a non-refundable container fee that consumers pay along with the deposit.

This means producers have no control over what happens to their used beverage containers, or the fee that is added to the price of their beverages.

Systems that allow the Government to keep the unredeemed deposits do not necessarily achieve the highest return rates, as the deposits can be a valuable revenue stream that is diverted to other services. There are also few mechanisms to hold the Government to account for the success of the system.

In 2016/17, Hawaii's return rate was 65%.[22]

5.1.3 Recommendation for the Czech Republic

Generally speaking, a centralised approach is both more efficient and more effective. With the exception of Germany, all other European systems are centralised and it is recommended that the Czech Republic pursues a similar approach. Similarly, a DRS run by the beverage industry is not only a key part of delivering Extended Producer Responsibility in the Czech Republic, but also has the additional advantage of ensuring industry interests are fully taken into consideration.

[22] http://www.bottlebill.org/legislation/usa/hawaii.htm

The system operator is best placed to determine the optimum system design. As such, in order to ensure the system has the flexibility to evolve and adapt as required, it is important that details of scheme design are not, or at least not too strictly, specified in prescriptive government legislation.

The government will have a role in auditing the system, setting a target (if this is the measure taken forward – an alternative would be a Norway styled beverage container tax – see Section 5.9) and ensuring this is met. In the first year, a 70% target may be more reasonable but, ultimately, the target should be at least 90%. Lithuania achieved 74% in its first year in 2016, but this increased to 92% in its second year as consumers gained a better understanding of the system and became accustomed to returning their containers.[23] Allowing 3 years to build up to the 90% target would appear to be more than adequate. The risk with a 90% target in the second year is that, if the target were missed, it would arguably be too soon to take action – such as increasing the deposit value. This is because it may create uncertainty for consumers who are still getting acquainted with the system and would mean additional costs to producers to change their labels again. Instead, 3 years would give the system time to bed in and would be less likely to cause confusion if aspects of the system were subsequently changed in an effort to increase the return rate.

5.2 Scope – Beverage Type

The scope relates to the range of containers included within the scheme, both in terms of container type, and beverage type. While it could theoretically include packaging such as metal food cans or plastic bottles for household cleaning products, a DRS typically covers beverage containers specifically. This is because they are often consumed on the go so are more likely to be littered or discarded in residual waste; they are consumed relatively quickly so are a significant proportion of single-use packaging; and they are easily cleaned, leaving little residue in the containers. As it is envisaged that the system will be run by industry, expanding it beyond the beverage industry would significantly increase the number of companies involved, potentially creating additional complexities and costs.

The first dimension to scope – the type of containers – was specified at the outset of the study. It is limited to PET bottles in scenario 1 and to PET bottles and metal cans in scenario 2. As such, the merits or otherwise of including or excluding cartons, one-way glass bottles, HDPE bottles, and foil pouches are beyond the scope of this report. If, however, some container types are excluded, a beverage container tax (see Section 5.9) could level the playing field.

The second dimension – discussed below – is which type of beverages are included.

[23] http://www.bottlebill.org/legislation/world/lithuania.htm

5.2.1 Examples of Good Practice

Alberta, Canada

This scheme covers all beverages – including alcoholic beverages, carbonated and non-carbonated soft drinks, juices, milk and dairy products and waters – so no beverages are excluded.

This maximises the potential impact in terms of recycling rates and litter reduction. This approach is arguably the fairest for all beverage producers, as no beverage or company gains an advantage from being included in, or excluded from, the scheme. It has the added benefit of simplicity for consumers, retailers and producers, and means consumers do not have to sort their containers.

Alberta has also kept its system under review, having repealed the exemption for beer in 2001 and for milk in 2009.[24]

Finland; Norway; Israel; Nova Scotia, Canada

These systems apply a deposit to all beverages except milk (or dairy products and milk substitutes more broadly). Milk has traditionally been excluded because of hygiene concerns about residue left in the bottle. This is now less of an issue, as the vast majority of containers are returned to reverse vending machines that compact and store the containers. As milk is more likely to be consumed at home, the bottles can also be easily rinsed.

While there is now an argument to include milk, these schemes nevertheless have an inclusive scope that offers most of the advantages of Alberta's approach.

5.2.2 Weaknesses of Alternatives

Quebec, Canada

The Quebec scheme only includes beer and carbonated soft drinks. This excludes a wide range of drinks, particularly given the growing popularity of bottled water, so the impact of the scheme – on recycling and littering of beverage containers – is more limited. It could mean consumers feel it is less worthwhile to return their containers if they have to sort them and can only return a proportion; it reduces the environmental impact of the scheme; and it limits the extent to which it can achieve economies of scale. It also means that some beverage companies are required to participate in the DRS, while competitors producing relatively similar beverages are not.

5.2.3 Recommendation for the Czech Republic

Water, soft drinks (including carbonated drinks, juices, sports drinks and ready-to-drink teas and coffees) and beer are to be included within the scope of the Czech design. Given the range of material types included in the proposed scheme (PET bottles and

[24] http://www.bottlebill.org/legislation/canada/alberta.htm

metal cans), this is the broadest, practical scope. As such, it will maximise the environmental impact of the scheme and provide a level playing field for producers, as all non-alcoholic beverages – that are potentially competing against each other in the beverage market – are included.

Only 18% of beer is sold in cans or plastic (using the data in Table 4-1). However, as beer is already sold in reusable glass bottles with a deposit, including beer and cider within the scope of the one-way DRS would provide consistency for the beverages. Clarity and simplicity are important for consumers and retailers; it could create confusion if a deposit is charged on most beer and on most cans, but not on beer cans. Additionally, the proportion of beer sold in cans or plastic is reported to be increasing, so the case for including beer in the DRS will only increase.

This means that wine, spirits and milk are excluded. 98% of wine and spirits are sold are in glass bottles (using the data in Table 4-1), so would in any case be outside the scope of the system. Charging a deposit on such a small proportion risks creating confusion and distorting the market, or producers switching to glass bottles. Milk is excluded partly because it is not yet a well-established feature of DRSs, but mainly because only 5% of units sold are in PET bottles.[25] Other systems are expanding to include milk, so the Czech Republic could follow this approach and review the scope of the system once it is up and running and proving successful.

5.3 Deposit Level

The deposit is the mechanism for incentivising returns, so needs to be set at a high enough level to ensure consumers feel it is worth returning their containers. The most successful schemes – those with the highest return rates – tend to have higher deposits.

This needs to be balanced against the risk of fraud, which is a risk in any DRS but the risk will be greater with higher deposit value. Additionally, the deposit should be proportionate to the purchase price of the beverage. The deposit is initiated by beverage manufacturers or distributors, who charge it to the retailer who ultimately passes it on to the consumer.

Deposits are either a single flat-rate for all beverage containers included in the scheme, or are differentiated by container size or the type of beverage. In most systems, the full deposit is refunded but, occasionally, there is only a partial refund (as discussed in Section 5.7.2).

5.3.1 Examples of Good Practice

Norway

Norway achieves a return rate of 95%; while this cannot be solely attributed to the deposit value, it is likely to be a contributing factor. It is a relatively simple deposit

[25] Global Data (2018) *Market report on Milk Packaging Data.* Prepared for Eunomia.

structure of NOK 2 (€0.21) for plastic and metal containers ≤ 0.5 litres and NOK 3 (€0.32) for plastic and metal containers > 0.5 litres. This offers clarity and consistency, while recognising the higher purchase price of larger beverages and ensuring the deposit value is proportionate. The deposit value has also been kept under review, as it will depreciate with inflation and was increased in 2018 to support a higher return rate. [26]

Lithuania

The Lithuanian system has a single, flat-rate deposit of €0.10. This value is appropriate for the Lithuanian economy and cost of living and provides an equal incentive for consumers to return all containers. In 2017, Lithuania achieved a return rate of 92%.[27]

Oregon

Oregon increased its deposit from $0.05 (€0.043) to $0.10 (€0.086) in April 2017. This followed an amendment to the legislation requiring the deposit to be increased if the redemption rate was below 80% for two consecutive years.[28] This flexible approach recognises the link between the deposit and return rates, and the need to keep the deposit value under review. The return rate during January – March 2017 was 59%. Following the increase, Oregon achieved 82% between April and December.[29]

5.3.2 Weaknesses of Alternatives

Connecticut; Massachusetts; New York, USA

In these states, the deposit is enshrined in legislation at $0.05 (€0.043) and has not changed since the Bottle Bills were passed in the 1970s and 1980s. While the beverage industry and retailers prefer to keep the deposit low due to the impact on their cash-flow and the perceived price for consumers (although deposits should be listed separately to the price), with inflation, the deposit has lost value in real terms and this contributes to low return rates (51% Connecticut; 57% in Massachusetts and 66% in New York).

Germany

At €0.25, the German deposit is higher than most. In its favour, it is linked to an impressive reported return rate of 97%. However, the high deposit, combined with Germany's long land borders with countries that do not have a DRS and freedom of movement within the EU, means there is high risk of fraud. As a result, the German system relies on more expensive fraud prevention measures than other systems, with an associated cost for beverage producers. (Fraud prevention is discussed in Section 5.8).

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[26] The deposits were previously NOK1.00 (€0.11) and NOK2.50 (€0.26) but were increased by the Norwegian Environment Ministry in 2018. https://infinitum.no/aktuelt/nye-pantesatser

[27] CM Consulting & Reloop (2018) Deposit Systems for One-Way Beverage Containers: Global Overview 2018.

[28] https://olis.leg.state.or.us/liz/2011R1/Downloads/MeasureDocument/HB3145

[29] https://www.obrc.com/Content/Reports/OBRC%20Annual%20Report%202017.PDF

Newfoundland, Canada

There are two deposit rates: CAD$0.08 (€0.053) for non-alcoholic beverages and CAD$0.20 (€0.13) for alcoholic beverages. While this reflects the higher purchase price of the latter, there can be more opportunities for fraud with alcoholic drinks due to the higher proportion of imports. A significant disparity in the deposit value could exacerbate the fraud risk.

Finland

Finland has four different deposit values. While these are associated with high return rates (87-94%)[30], we would suggest that multiple deposit values could add an unnecessary level of complexity, particularly for a new system. The differentiation for plastic bottles will take account of the increasing price for larger volumes of beverages, but it is important to avoid unequal incentives between different types of material.

- Plastic < 0.35 litre: €0.10
- Plastic 0.35 – 1 litre: €0.20
- Plastic >1 litre: €0.40
- Metal: €0.15

5.3.3 Recommendation for the Czech Republic

A flat rate deposit should be pursued to ensure there is an equal incentive to return all containers and clarity for all stakeholders. The existing deposit for returnable glass bottles in the Czech Republic is 3 CZK (approximately €0.12)[31], and achieves a return rate of approximately 93-94%.[32] One brewery reports a return rate of 98%.[33]

Using successful European systems as a benchmark, 3 CZK is an appropriate value for the one-way containers. Table 5-1 lists the deposit values for the most successful European systems. In Euro, the minimum deposit in each country ranges from €0.10 to €0.25, so €0.12 is in the appropriate range. The fourth column adjusts the deposits for purchasing power parity, so that they can be more accurately compared after discounting the relative strength of the economies and the buying power of a Euro in each of the countries. 3 CZK is equivalent to €0.17 in PPP-adjusted Euro, so this is once again within the ranges of the deposit values in these European countries.

[30] https://www.palpa.fi/juomapakkausten-kierratys/pantillinen-jarjestelma/
[31] Using Exchange rate of €1 = 25.6 CZK
[32] Private communication from INCIEN
[33] https://www.lidovky.cz/byznys/firmy-a-trhy/pivovary-v-cesku-velebi-vratne-lahve-jde-o-velmi-vyhodny-system.A180909_182939_firmy-trhy_ele

Table 5-1: Deposit Values in European Deposit Systems

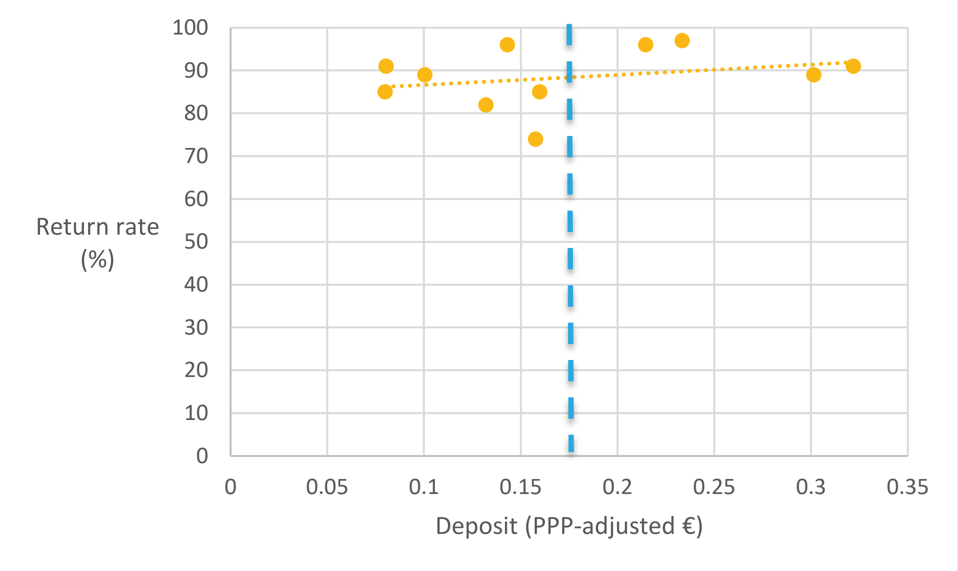
	Deposit	Deposit in Euro[34]	PPP- adjusted Euro[35]	Return Rate*
Denmark	1 – 3 DKK	0.13 – 0.40	0.10 – 0.30	90%[36]
Estonia	€0.10	0.10	0.13	83%[37]
Finland	€0.10 - €0.40	0.10 – 0.40	0.08 – 0.32	87-94%[38]
Germany	€0.25	0.25	0.23	98%[39]
Lithuania	€0.10	0.10	0.16	92%[40]
Norway	NOK 2 – 3	0.21 – 0.32	0.14 – 0.21	95%[41]
Sweden	SEK 1 - 2	0.10 – 0.19	0.08 – 0.16	85%[42]
Proposed for Czech Republic	3 CZK	0.12	0.17	

**All figures for 2017 apart from Germany, which relates to 2015.*

As Figure 5-1: European Deposit Values and Return RatesFigure 5-1 illustrates, with the blue line indicating the proposed deposit for the Czech Republic, €0.12 is very close to the values associated with a 90% return rate. It has the added advantage of already being known and understood by Czech consumers, and has proven to be effective in the refillable programme.

[34] Using average exchange rate over last 90 days (04/09/18) - https://www.xe.com/currencyconverter/convert/?Amount=1&From=NOK&To=EUR
[35] From OECD.Stat. Data extracted 05/07/18
[36] https://www.danskretursystem.dk/presse/#/pressreleases/dansk-retursystem-rekordmange-tomme-flasker-og-daaser-genanvendes-2495981
[37] CM Consulting & Reloop (2018) *Deposit Systems for One-Way Beverage Containers: Global Overview 2018.*
[38] https://www.palpa.fi/juomapakkausten-kierratys/pantillinen-jarjestelma/
[39] CM Consulting & Reloop (2018) *Deposit Systems for One-Way Beverage Containers: Global Overview 2018.*
[40] CM Consulting & Reloop (2018) *Deposit Systems for One-Way Beverage Containers: Global Overview 2018.*
[41] Infinitum (2018) *2017 Annual Report*.
[42] https://pantamera.nu/pantsystem/statistik/pantstatistik/

Figure 5-1: European Deposit Values and Return Rates



While the deposit is not the only determining factor for the return rate (the return infrastructure, discussed in Section 5.4, is similarly particularly important), this suggests that 3 CZK could contribute to a 90% return rate once the system is fully established and well known. If the target is not met after three years, the system operator may want to review whether and why the system is under-performing, including reviewing whether the deposit value is set at an appropriate level.

It should be kept in mind that it is more practical to increase the deposit level than to reduce it (as producers may try to delay placing containers on the market and it could detrimentally affect the system operator's cash flow as the value of deposits paid in will fall, while consumers are still claiming refunds on the previous, high deposit). In any system, it is best practice to keep the deposit value under review, not least because it will lose value with inflation, and increase it if the return rate is too low. This is partly why deposit values should not be specified in legislation.

5.4 Return Infrastructure

This relates to where and how consumers can return their used containers to obtain a deposit refund. Typically, either the return to retail or return to depot model is used (or a combination of the two). Return to retail requires shops that sell containers to take them back and refund the deposit to the customer. Return to depot involves dedicated depots or "redemption centres", specifically for the purpose of taking back used containers and refunding deposits. They could be run directly by the system operator or by private individuals and companies, and can be staffed or simply enable consumers to drop-off their used containers. Figure 5.2 shows a more conventional redemption centre, which could be found on a high street or at an out of town location, while Figure 5.3 illustrates the Oregon BottleDrop. This particular example is an un-staffed shipping container. Rather than refunding the consumer directly with cash, the BottleDrop system credits consumers' accounts once the used containers have been counted.[43]

Figure 5-2: A US Redemption Centre

Figure 5-3: Oregon BottleDrop

Source: OBRC

The return of used beverage containers needs to be as convenient as possible for consumers so that they are encouraged to participate. This is why European systems – which generally have higher return rates than North America – rely on the return to retail model. This enables consumers to take back their containers when they do their shopping or, if they are consuming their beverage on the go, when they pass a shop. A system that asks consumers to go out of their way to return containers creates unnecessary journeys (with an associated environmental cost) and will not support such high levels of redemption. There is then an additional choice of a manual or automated service using reverse vending machines (RVMs). RVMs are automated machines into which consumers can input their used containers in order to obtain their refund. RVMs can identify the container and beverage type, confirm the refund owed and, in some cases, compact the containers to reduce storage space and prevent multiple redemptions. They can also be connected online to the system operator can identify redemption patterns, determine the optimal time to collect the returned containers, and reimburse retailers more quickly. Additionally, some RVMs enable retailers to advertise products or offer promotions to potential customers, and can allow consumers to donate their deposits to charity.

Most return to retail model systems now use a mix, with retailers given the choice of whether to use an RVM. Smaller retailers generally provide a manual service as they do not have space for the RVM and would not receive enough containers to justify the cost. As a general rule, it makes financial sense to invest in an RVM if they are likely to receive at least 500-600 containers each day.

Some systems oblige all retailers to take part but it is also common for small convenience stores to have the choice of opting in. Lithuania, for instance, exempts

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[43] https://www.bottledropcenters.com/Express

those under 300 m^2 and shops in Finland can apply for an exemption if they are under 200 m^2.[44]

If there is an opt-in/ opt-out, there is a risk that consumers will not know exactly which shops they can return their containers to – meaning they have to check and could be turned away, which could discourage them from returning their deposit. On the other hand, it should also be considered that, if the system operator collects containers from every single retailer, this could make the logistics less efficient. In practice in other systems, some small retailers do refund deposits and simply take the containers themselves to larger shops, as they want to provide a service to their customers. While universal retailer take-back is preferable from the point of view of the consumer and the return rate, it is not essential to prescribe this in regulation and the system operator could decide in consultation with retailers what is most appropriate.

In the case of bars and restaurants, they generally pay the deposit to their distributors, but should not necessarily pass this on to consumers for beverages consumed on the premises. The deposits would be refunded to hospitality businesses when the used containers are collected. This means that bars and restaurants would not be expected to provide a formal take-back service that allows consumers to walk in and claim a refund on a deposit they paid elsewhere – they only return used containers that they sell on the premises.

5.4.1 Examples of Good Practice

Norway

Norway uses the return to retail model with a mix of RVMs and manual services, depending on whether the retailer chooses to provide an RVM. Containers can be returned to 15,000 shops, kiosks and petrol stations, meaning consumers do not have to travel far, undertake a special journey to redeem their deposit or sort their containers and return to a number of shops with different brands. [45]

While there are 15,000 return locations, there are only 3,700 RVMs in Norway.[46] Despite this, 93% of containers are returned to an RVM; this enables Infinitum to make the logistics operation as efficient as possible as the RVMs compact the containers and provide data for predicting return patterns and determining collection schedules.

As the system relies on the co-operation of retailers, they are represented on the Infinitum board by members of the Co-Op and grocery chain Rema 1000.

In response to the growth in online shopping, Norway (like Germany) has made provision for people to return their empty drinks containers via a home delivery service provided by retailers. Consumers can buy Infinitum bags from their online retailer, which are

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[44] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.150891/NREPaHFPBR
https://www.finlex.fi/en/laki/kaannokset/2011/en20110646.pdf
[45] Infinitum (2017) *Annual Report 2016.*
[46] https://infinitum.no/om-infinitum

barcoded and embedded with a code to track the bag and its contents.[47] This means all retailers are treated fairly and people who do not have the time, or capacity due to health issues, to visit a shop can still return their containers for a refund. In Norway approximately 1% of returns are via home delivery.

Lithuania

Like Norway, Lithuania is based on the return to retail model. Here, however, the system operator has leased all the RVMs and provides these to retailers, free of charge. While there are arguments for leaving retailers to buy or lease an RVM, Lithuania's approach ensures that all RVMs are compatible with their IT requirements, it saves retailers time, and they may be able to agree more favourable terms with the RVM manufacturer due to the number of RVMs needed for the whole country.

5.4.2 Weaknesses of Alternatives

Connecticut, USA

In this state, retailers are only required to take back the brands they sell. This requires consumers to sort their containers by brand and may mean they have to visit several return points to redeem their deposit. This potentially increases the distance they have to travel and discourages consumers from returning their containers, especially as the deposit is a low value, having remained at the $0.05 (€0.043) set in 1978.

Connecticut's redemption centres have also been closing because they are not economically viable; this partly highlights the need for handling fees to be set at an appropriate level, but also indicates the draw-backs of establishing and relying on depots that need to be able to make a profit from the DRS alone.

Northern Territory, Australia

This only uses depots, so consumers have to make special journeys to claim their refund. This not only undermines the convenience of the system and consequently the return rate, but may also increase the costs and greenhouse gas and air quality emissions associated with the DRS. The redemption rate in Northern Territory is 48%.[48]

Vermont, USA

Like most US states, Vermont uses both retailers and redemption centres. Retailers, however, are allowed to opt out if there is a nearby redemption centre. This means not all retailers are treated equally and leads to potential uncertainty and confusion for consumers. They may be less likely to return their containers if they have to check where they can do so, or if they are turned away by a store.

[47] https://kolonial.no/sok/?q=infinitum
[48] https://ntepa.nt.gov.au/__data/assets/pdf_file/0006/463983/2016_2017_CDS_annual_report.pdf

5.4.3 Recommendation for the Czech Republic

In line with other European systems, the return to retail model has been chosen, with consumers able to return any deposit-bearing container to any beverage retailer, regardless of whether that retailer sells the particular beverage (so consumers do not have to sort their containers by brand or type). Retailers will be compensated for their costs with a handling fee (Section 5.5) and will have the choice of installing RVMs.

The retailers could buy or lease the RVMs themselves, or the central operator could agree a national contract with an RVM supplier. Which approach retailers prefer will depend on their circumstances and size (including whether they are a chain or independent), the availability of credit and whether they are willing to take on the risk of buying the machines. Where retailers are responsible for providing RVMs, they do not necessarily have to buy them out-right. When they to choose to do so, they would typically take out a loan that they would re-pay over a number of years using their income from handling fees. Alternatively, retailers can lease RVMs from the manufacturer and agree a service contract so that the RVM manufacturer retains responsibility for installing and maintaining the RVMs.

Some retailers already have an RVM for glass bottles, which could be adapted to take plastic bottles and metal cans – reducing the upfront costs of the DRS. It is also worth noting that a leasing arrangement could support circular economy principles, as system operators would have an incentive to improve the lifetime of the machine and to design it so that it can be easily repaired.

Once the containers have been returned to retailers, the central operator is responsible for arranging their collection and transporting them to a counting centre (for manually returned containers to be sorted and verified) or to a processor (for containers that have already been counted and validated by the RVM) for baling before being transported for recycling. As illustrated in Figure 5-2, the central operator reimburses retailers for the deposits the refund, using the deposits paid in to the account by producers when the beverage is placed on the market.

The operator uses return volumes and RVM data to determine the most efficient collection schedules. One option is to use back-hauling, so distributors collect containers when they deliver new stock, but this is not necessarily as cost-effective as contracting transport operators specifically to collect the used containers. Retailers may charge more than transport operators to transport the containers and it means the system operator has less control over the type of vehicles used and the collection schedules. Some system operators use a competitive tender process so they can compare the cost of using retailers versus contracting a logistics company.

Figure 5-2: Flow of the Deposit

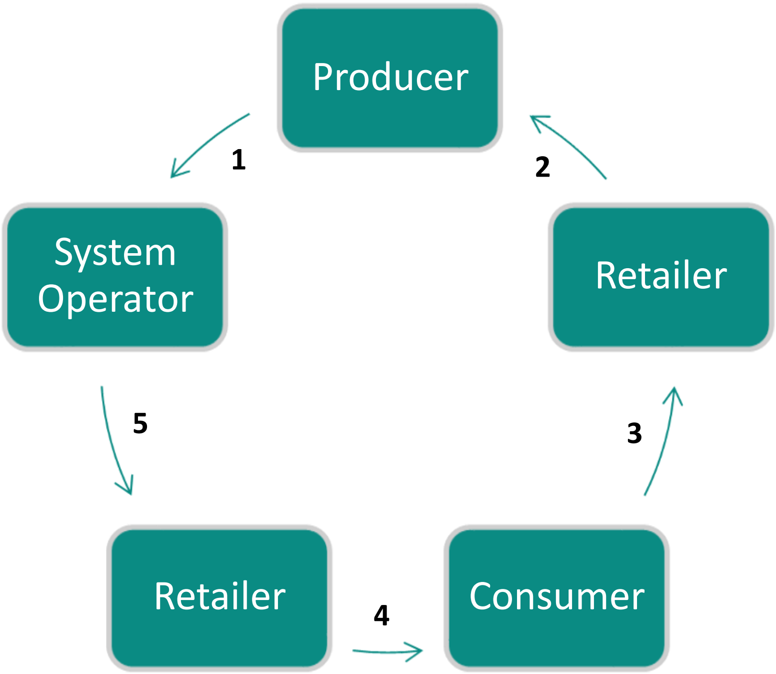
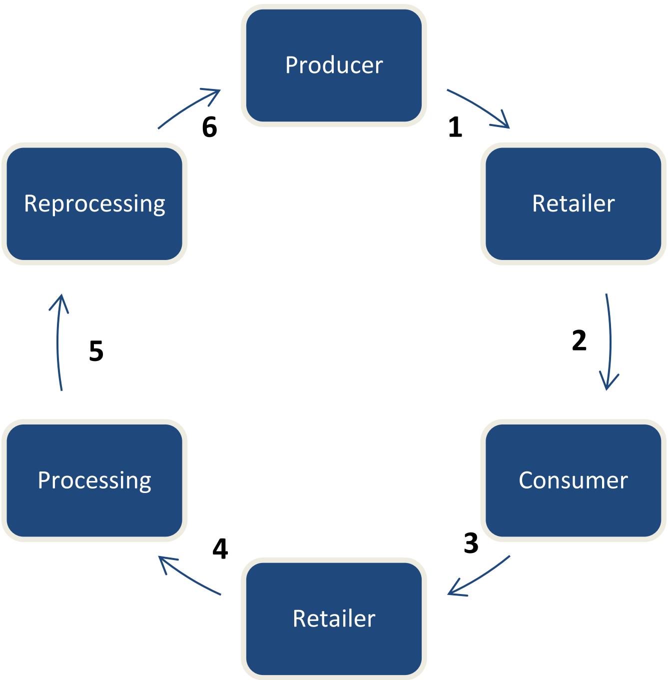


Figure 5-3: Flow of Beverage Containers in Closed Loop System



Section 9, paragraph 4 of the Czech Packaging Act already requires retailers that sell deposit-bearing packaging to take back the packaging and refund the deposit. Some of the provisions – particularly in paragraph 10 – exempt retailers that are smaller than 200m^2.[49] In other countries, small retailers have expressed concerns that they could lose customers to larger shops under a DRS if they are not permitted to provide a take-back service. A retailer in Norway has commented that the deposit system is:

> *"a good thing. People return the bottle and with the money they get from it they buy things from us.*
>
> *"It increases the number of people in our shops. It's good for business."*[50]

As such, it is expected that most small retailers and petrol stations would be provide a take-back service. Generally, they would not receive enough used containers to justify the costs of an RVM, so they would only provide a manual service. While they would be paid a handling fee (as discussed in Section 5.5), such fees are indicative of average costs for staff and retail space. It is possible that small retailers' costs, particularly in high footfall areas where rents may be higher, could be above average the costs. This means they may lose out slightly and, if the impact footfall is not high enough to compensate for any losses, a small number may opt-out if they are given a choice. Retailers do not, however, incur the costs of transporting the containers, as these are paid by the system operator.

As noted above, some small retailers that are not formally part of the DRS still take-back containers from consumers and refund the deposits. This means they incur additional costs, as they are not paid a handling fee (although they can claim a deposit refund), but such retailers have chosen to provide a service to their customers.

5.5 Handling fees

Most deposit systems based on the return to retail model pay retailers a handling fee for every container they take back to compensate retailers for the costs they incur. Systems that include redemption centres may also pay handling fees, depending on who operates the centres. (They could be owned and operated by a central system operator, in which case a handling fee would not be necessary).

A handling fee is not typically paid to restaurants, bars and cafes where beverages are consumed on the premises, as consumers are not specifically returning their containers to them or creating additional costs.[51] As businesses in many countries are required to

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[49] https://www.mzp.cz/C125750E003B698B/en/packaging_legislation/$FILE/OODP-Act_on_Packaging_No_477_2001-20110111.pdf

[50] https://www.bbc.co.uk/news/science-environment-42953038

[51] See, for instance, Denmark - https://www.danskretursystem.dk/kundeservice/pant-depositum-oekonomi/haandteringsgodtgoerelse/

pay for the collection of their commercial waste, they should actually save money as the DRS operator will take responsibility for collecting beverage containers.

5.5.1 Examples of Good Practice

Norway

The handling fee is intended to reflect retailers' costs (in terms of staff time, retail space foregone and any RVM costs) and is used to promote more efficient options and, consequently, to reduce the overall system costs.

Where manual collection, or collection via a non-compacting RVM is undertaken, the retailer receives a handling fee of 5 øre (€0.005) per can and 10 øre (€0.01) per plastic bottle.[52] Where a compacting RVM is installed, the retailer receives a handling fee of 20 øre (€0.02) per can and 25 øre (€0.03) per plastic bottle.[53] The higher handling fee reflects the fact that a compacting RVM creates efficiencies in subsequent transportation of the collected beverage containers, due to the increased bulk density. Compaction also significantly reduces the opportunity for fraudulent multiple claims for refunds from the same used beverage container.[54] Different values are attached to different materials, as these again carry different storage costs.

The fees are set by Infinitum, whose board includes representatives of both the beverage and retail industry, so all interests will be taken into consideration and the decision-making is transparent.

It also means retailers can make an informed decision about whether to invest in an RVM.

Handling fees in Norway are paid by the system operator out of a central funding pot.

Estonia

In Estonia, the system operator and retailer associations have agreed a formula to calculate the handling fee. The formula is intended to include all of the costs involved and to reach a figure that is cost and revenue neutral. This is reviewed annually to account for changes in costs, such as the value of retailer space and the rate of staff wages.

Handling fees for cans returned to compacting RVMs are nearly 3 times higher than cans returned manually because they are cheaper for the system operator to collect and transport from the retailer, but conversely increase retailers' costs.

Unlike Norway, the Estonian handling fee for non-compacting RVMs is higher than the manual fee. RVMs without compaction are still more convenient for the consumer and

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[52] Infinitum (2017) Manual Collection Points, available at http://infinitum.no/english/manual-collection

[53] Infinitum (2017) Collection Points with a Reverse Vending Machine, available at http://infinitum.no/english/collection-points-with-a-reverse-vending-machine

[54] Personal communication with Kjell Olav Maldum, Managing Director, Infinitum AS

can provide useful data to the system operator, but do not generate the same efficiencies. The handling fee can incentivise retailers to choose compacting RVMs. As the compactors will need to be replaced at some stage during the RVM's lifetime, retailers can agree a service contract with the RVM manufacturer that will cover the cost of a new compactor.

The handling fee for glass returned manually is higher than the other materials because of the additional space glass bottles take and the need to store them more carefully.

As in Norway, the handling fees are paid by the system operator from their central pot.

Table 5-2: Handling Fees in Estonia (€)[55]

	Cans	Plastic bottles	Glass
Manual	0.0115	0.0115	0.0130
RVM without compaction	0.0215	0.0215	0.0250
RVM with compaction	0.0331	0.0331	N/A

5.5.2 Weaknesses of Alternatives

California, USA

Processing fees in California are intended to cover redemption centres' net costs after material revenues. This means that the redemption centres carry the risk of fluctuating material prices and they have to be monitored more closely in case there are significant falls or increases that could necessitate a review of fees. Even so, the fees in California are not set at a high enough level to cover costs, which is contributing to centre closures and, consequently, falling return rates. Additionally, the fees are based on a retrospective assessment of costs, preventing redemption centres from forward-planning or investing in facility improvements. Between January 2016 and April 2017, one fifth (300) of California's recycling centres closed.[56]

Oregon, USA

Retailers in Oregon do not receive a handling fee so are not compensated for their role. This may in part be why Oregon is having to extend its network of redemption centres, and consider alternative solutions such as the BottleDrop (Figure 5-3). At BottleDrops, consumers can drop-off bags of used containers (tagged to identify them) and their

[55] https://eestipandipakend.ee/wp-content/uploads/2012/01/Leping-jaem%C3%BC%C3%BCjaga-lisa-1-H%C3%BCvitise-m%C3%A4%C3%A4rad-18_19.pdf
[56] http://www.lao.ca.gov/Publications/Report/3649

accounts will later be credited with the deposit refunds, once the used containers have been counted.[57]

Connecticut, USA

All retailers receive the same handling fee in Connecticut, regardless of whether they have an RVM so retailers do not receive any assistance with the extra costs of a machine.

Additionally, the level of the handling fee is specified in the legislation, so it is less easily revised to reflect changing costs. The fee was $0.01 (€0.009) when the law was originally passed in 1978. For beverages other than beer, this was amended in 1983 to $0.02 (€0.017), while the handling fee for beer has been set at $0.015 (€0.013) since 1986, so the value to retailers has declined with inflation.[58] Setting the handling fee in legislation not only means that revising it can require extra bureaucracy and time but can also mean political considerations affect the fee. With the fee paid by producers, politicians will be under pressure from the beverage industry to maintain a low value, while retailers will lobby for an increase.

In Connecticut, producers are responsible for paying the handling fee directly to retailers. This means that producers with a higher return rate pay more than producers whose containers are returned less frequently.

Michigan, USA

Retailers here receive a share of 25% of unredeemed deposits (the state keeps the remaining 75%), distributed according to the volume of containers they handle. This means there is no consistency, retailers cannot plan for an estimated income, and the total amount of “handling fees” will fall as the proportion of containers retailers take back increases.

5.5.3 Recommendation for the Czech Republic

A handling fee should be paid to retailers for every container they take back. As hotels, cafes and restaurants (HORECA) are not providing a separate take-back service, they are not paid handling fees.

The levels should be calculated annually based on discussions between the system operator and retailer representatives, and an assessment of the implications for logistics costs. If the RVMs are the retailers’ responsibility, the handling fee should be higher than the fee for those providing a manual service, given that they incur more costs but ultimately generate efficiency savings for the system.

If the RVMs are provided by the system operator, there is a choice of how to reflect this in the handling fee. For instance, in Denmark the RVMs are provided by the system operator and they pay a higher handling fee for a manual service, compared to retailers

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57 https://www.bottledropcenters.com/
58 http://www.bottlebill.org/legislation/usa/history/cthis.htm

with an RVM.[59] In Lithuania, the RVMs are similarly provided by the system operator, but they still pay more for retailers with an RVM than to retailers providing a manual service.[60] For the purposes of the impact assessment, it is assumed that the RVMs are the retailers' responsibility.

5.6 Material Ownership

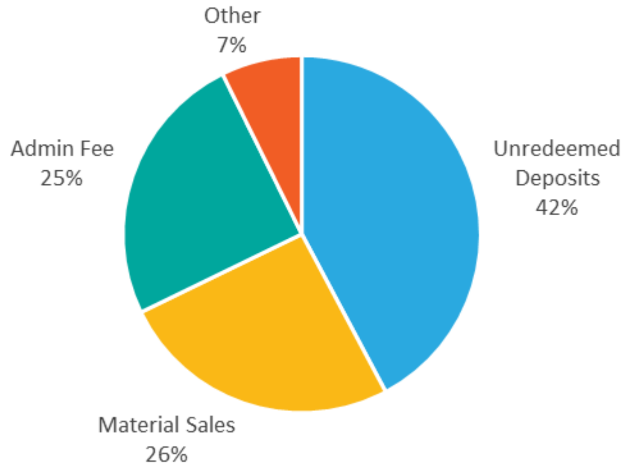
The material collected via a DRS is high quality and less contaminated than other collection methods due to the single collection stream. As a result, the material can be an important source of revenue and there are several options for its ownership. These are generally linked to the nature of the system operation; the most successful schemes will use the volumes returned in a DRS to market the material *en masse* and secure a better price.

5.6.1 Examples of Good Practice

Norway

Infinitum owns the material and is responsible for organising the containers' collection, processing and sale. Infinitum then invests the revenue back into the system, reducing the level of fees producers need to pay to cover the costs. As Figure 5-4 illustrates, the material revenues provide more than a quarter of Infinitum's funding. A single material owner means all the material can be collected and processed together – as it does not need to be separated by brand – which will support efficiencies.

Figure 5-4: Funding the Norwegian DRS in 2016



Source: Infinitum Annual Report 2017. "Other" is thought to include revenue streams such as one-off registration fees and interest.

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[59] https://www.danskretursystem.dk/kundeservice-gammel/pant-depositum-oekonomi/haandteringsgodtgoerelse/

[60] http://grazintiverta.lt/verslui/pardavejams/

Sweden, Finland, Denmark Estonia and Lithuania all operate centralised systems and, like Norway, the system operator collects the returned material and uses the revenue to partially cover their operating costs.

5.6.2 Weaknesses of Alternatives

USA: Connecticut; Massachusetts; New York; Vermont; Iowa; Maine; Michigan.

In these US states, the material is owned by the deposit initiator – the beverage producer or distributor. It is these companies' responsibility to organise the collection of containers which, as this adds to their costs and administrative workload, can increase antipathy to the DRS. While the beverage industry often outsources the collections to another company, multiple companies making their own arrangements can still be less efficient than a single system operator that can consider all retailers together and design the most efficient collection routes. Having multiple companies not only means that journeys are potentially duplicated, but also that retailers may have to deal with several collections from different producers.

It also means that containers have to be sorted by brand, adding to the costs and inconvenience incurred by retailers and/ or consumers. As producers are marketing smaller quantities of material, they may not get the best possible price.

Germany

Retailers in Germany are not paid a handling fee but are instead the material owners. While the revenue from the material sales will help to compensate them for the costs of the service they provide, it has the same drawbacks as the US systems for producers. Additionally, as material prices fluctuate significantly, retailers in Germany cannot predict the income they will receive so they cannot be confident that their costs will be covered.

5.6.3 Recommendation for the Czech Republic

In line with best practice elsewhere, the material should be owned by the system operator, who is responsible for organising the transport and processing, and will retain the funds to invest in the system. Ideally, the material would be processed and re-processed within the Czech Republic to support jobs in the recycling industry and to guarantee a readily available supply of high-grade recycled PET for Czech beverage manufacturers and bottlers. Revenue from the sale of specific materials should be used to offset the material-specific (i.e. aluminium, PET) producer fees.

While it is assumed in the impact assessment that the system operator sells the returned material to a reprocessor on the open market, producers who set up the system may choose to discuss alternative arrangements that would enable them to use the returned containers to manufacture new containers more directly. This would mean producers have an incentive to improve the recyclability of their containers.

5.7 Funding

Along with the material revenues, there are a number of options for the unredeemed deposits (deposits paid by consumers when they buy their beverage but not refunded because the container was not returned) and administration/ producer fees to cover the net costs. This section considers the different options for unredeemed deposits and funding the net costs of the system.

5.7.1 Examples of Good Practice

Norway

Alongside material revenues, Infinitum uses unredeemed deposits to cover some of their operating costs; as shown in Figure 5-4, unredeemed deposits represent 42% of Infinitum's funding, despite Norway's high redemption rate of 95%.

The remaining costs are mostly covered by an administration fee, which producers pay for every container they place on the market. These are listed in Table 5-3. There is a negative fee for aluminium cans because revenues from the material collected exceed the costs of processing the aluminium cans. Producers entitled to a negative fee are not required to initiate the full deposit. Otherwise, these producers would be subsidising the costs of producers using plastic.

The fee structure is additionally used to incentivise eco-design and ensure that producers pay for the additional costs if they are using materials that are less easily recycled, unnecessary packaging, or materials that have a lower value.

As discussed in Section 5.8, producers pay an additional fee if they do not use Norway-specific barcodes.

Table 5-3: Norwegian Producer Fees

Beverage Container Type	NOK/Beverage Container	€/ Beverage Container
Aluminium Can	-0.03	-0.003
Steel Can	0.21	0.022
Additional fee if can has plastic sleeve	0.03	0.003
PET Bottle	0.18	0.019
HDPE Bottle	0.33	0.035
Additional fee for light blue plastic	0.08	0.008

Beverage Container Type	NOK/Beverage Container	€/ Beverage Container
Additional fee for coloured plastic	0.15	0.016
Additional fee for standard barcode	0.03	0.003

Source: https://infinitum.no/kostnadskalkulator

In addition to the per container fee, producers pay a one-off registration fee of NOK 10,000 (€1,050) for every type of container they place on the market. [61] This covers the costs of registering the container in the system and checking it is RVM-compatible.

Sweden

Sweden similarly invests unredeemed deposits in the system. [62] Producer fees for PET bottles are 0.22kr (€0.021) and 0.52kr (€0.050) for bottles of up to one litre, and over one litre, respectively. As in Norway, there is no fee for aluminium cans because of the high material value. [63] For the small proportion of cans made of steel, there is no producer fee, but there is a sorting fee of 0.25kr (€0.024) per can, based on the incremental investment and handling costs to sort between aluminium and steel cans. A sorting fee, of 0.05kr (€0.005) is also charged for coloured PET bottles.[64] While we cannot assert the cause and effect, it is worth noting that almost all cans are aluminium, and nearly 90% of PET bottles are clear in Sweden.

It is reported that the system operator, Returpack, for the purposes of stability, tries to minimise changes in the fee structure. However, these will be amended if the system is running at an ongoing loss, or excessive profits are being made.

5.7.2 Weaknesses of Alternatives

Connecticut, USA

Like many US states, the unredeemed deposits are paid to the state. While there is an argument that this contributes to the costs of processing containers not returned to the DRS, they are not hypothecated for recycling services, but are paid into a general fund. The state can become dependent on this revenue, so does not have an incentive to increase the return rate – for instance by increasing the deposit value.

As Connecticut, like most US states, operates a decentralised system, there are no producer fees. Instead, producers are responsible for the costs of collecting and

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[61] https://infinitum.no/slik-blir-du-medlem
[62] https://pantamera.nu/wp-content/uploads/2017/11/Bilaga-3-Avgifter-20171106.pdf
[63] Personal communication with Ingrid Bjurnell, Returpack
[64] Personal communication with Ingrid Bjurnell, Returpack

processing their containers, and paying handling fees to retailers. While these costs will to varying extents be off-set by the material sales, it essentially means the beverage companies with a high return rate are penalised because producers' costs are determined by the numbers returned, so they will be even less inclined to positively promote the system with their customers. Basing costs on the numbers placed on the market is not only more equitable, but is more in line with the producer responsibility principle.

Connecticut's Bottle Bill, as in other states, has faced significant opposition from producers and calls for repeal. This is in part because of the costs for retailers and producers, and partly because of the low redemption rate.

Nova Scotia, Canada

Here, only half the deposit is refundable, with the other half being used to fund the system along with unredeemed deposits and the material revenue. This means the costs of the system fall more on consumers directly than producers, and risks causing confusion or mistrust if not all the "refundable deposit" is refunded.

5.7.3 Recommendation for the Czech Republic

The unredeemed deposits, like the material revenues, should be paid to the system operator; this is the most efficient and transparent approach. As the system operator is collecting all the data and is responsible for reconciling accounts, they can reimburse retailers for the deposits and pay the handling fee.

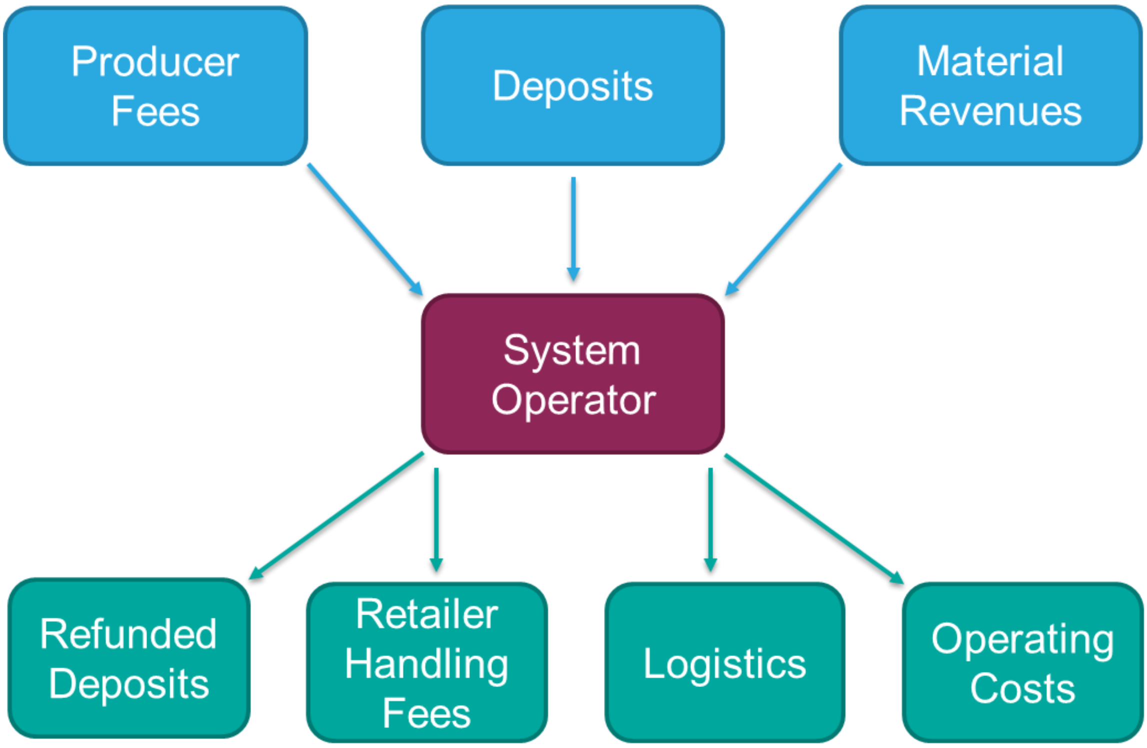
The remaining balance of the operating costs – once unredeemed deposits and material revenues have been deducted – should be covered by a fee paid by producers for every container they place on the market. The fee will vary with the container material to reflect the higher costs and lower values associated with some materials. In addition, it is likely that producers will pay one-off registration fees or membership fees to cover the administrative costs associated with joining the system and registering containers on an electronic database.

While it is ultimately up to a system operator to set the producer fees, it is recommended that they use the fee structure to promote eco-design and recyclability, so the fee would be lower for containers only using a single material or for plastic that is clear, for instance, and higher if the producer uses a mix of plastics in the beverage design, or designs the beverage in a way that reduces its recyclability (such as by adding plastic sleeves). This means the returned containers can be used to manufacture new containers more cost-effectively and efficiently. Promoting such a closed-loop system is also in the interests of producers as, in this funding model, they carry the risk associated with the materials market. If material prices fall over a year, producer fees will rise to compensate for this but, if producers use the recycled material for new containers, they will be then be the beneficiaries of lower market prices.

While producer fees are currently the most common mechanism to encourage eco-design, the system operator may ultimately explore alternative approaches in consultation with producers.

Figure 5-5: System Revenue Streams and OutgoingsFigure 5-5 illustrates the proposed sources of funding for the Czech system (in blue) and the main categories of expenditure (in green).

Figure 5-5: System Revenue Streams and Outgoings



5.8 Labelling & Fraud Prevention

Any deposit system is susceptible to fraud. Deposit fraud can occur anywhere along the system, but a particular risk is at the back-end, when a refund is claimed on a deposit that was never paid, usually because containers have been imported to the country or when containers excluded from the scope of the DRS are returned. This type of fraud is accordingly more common when there is substantial cross-border travel and trade, and neighbouring countries either do not have a DRS or the deposit is lower. Double redemption of containers and/or receipts is another possibility; in this case, the deposit that was only paid once is refunded multiple times.

At the front-end of the process, there is the potential for producers or distributors to under-report their sales data, meaning not enough deposits are initiated and fees are avoided.

In addition to the container label being used to provide information to retailers and consumers, the label provides the primary means of detecting and preventing fraud if the barcode is registered with the system operator and scanned by the RVM or at the counting centre.

Generally, there are three tiers of security specifications: Germany has the highest, Norway would be medium and most North American states have low fraud prevention measures. The level should be determined by the value of the deposit and the opportunity for fraud.

5.8.1 Examples of Good Practice

Norway

Norway has developed a sensible compromise that not only balances the costs to producers against the costs of fraud but also recognises producers' capabilities will vary.

Container labels are required to include the deposit logo (pictured) to signify the level of deposit paid.

Additionally, producers can choose whether to use a universal barcode (which allows the beverage to be sold in any country), or a barcode unique to Norway. These are registered with the system and recognised by RVMs, which can then approve a refund or reject the container.

Unique barcodes are more expensive for producers, as they require separate stock keeping units for each country. Conversely, they reduce the costs of fraud for the DRS, as they prevent containers bought outside Norway being returned for a refund that was not paid in the first place. As a result, the producer fees are lower for containers that use a unique barcode.

All barcodes are registered with Infinitum and are scanned by the RVMs, which can reject containers that are not registered. Additionally, data from the RVMs enable Infinitum to monitor remotely return volumes and detect any unusual patterns that would indicate fraud.

5.8.2 Weaknesses of Alternatives

Germany

The German system, overseen by DPG Deutsche Pfandsystem, is reported to be effective in preventing fraud, however it also adds considerably to producers' costs (approximately €0.005 per container).[65] In Germany, this is justified by the high deposit value (€0.25) and the long land borders with countries that do not have a DRS, combined with the freedom of movement within the EU. The latter provides the opportunity for fraud, and the deposit provides the incentive; it also means that the cost to producers of fraudulently claimed deposits will be disproportionately high. Consequently, there is a two-step verification process.

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[65] Eunomia et al. (2011) *Options and Feasibility of a European Refund System for Metal Beverage Cans. Final Report. Appendix 6: Cost Benefit Analysis*. 16th November 2011.

In addition to a unique barcode, container labels must include the DPG marking (pictured). This uses special DPG security ink that is read by the RVM's infrared scanning technology. Packaging manufacturers and label producers must have a licensing agreement with DPG to certify that they can buy and use DPG ink. Manufacturers of the ink will only supply it to licensed companies, and only licensed companies can acquire the necessary quality assurance unit to check the print quality of the marking.

The German system accordingly means additional costs and bureaucracy that, whilst believed to reduce the likelihood that only deposit-bearing containers are redeemed, would not be justified in other systems that have a lower deposit.

US Bottle Bill states

Here, the logo is used to indicate to consumers that a deposit has been paid in Bottle Bill states. As can be seen in the picture, it simply consists of an abbreviation of the states and the deposit value. As such, the containers are sold in a number of states with the same labelling and there is no means of verifying whether it was bought in a Bottle Bill state and a deposit was paid. As the deposit in most of the states is only $0.05 (€0.043), producers have judged that the additional cost of enhanced security measures is not warranted. It is, however, worth noting that companies like Pepsi have voluntarily added a "deposit code" in Michigan, where the deposit is $0.10 (€0.086). Pepsi's size and sales volumes mean maintaining separate stock keeping units for individual states is more feasible.

5.8.3 Recommendation for the Czech Republic

There are opportunities for importing non-deposit containers from Slovakia, Poland and Austria, which do not currently have a DRS. However, it is unlikely that people will import containers from Germany, given that the German deposit is significantly higher that the proposed Czech deposit.

A middle-way that requires unique barcodes, specific to the Czech Republic, strikes an appropriate balance for the Czech Republic.

The central operator would issue a standardised logo, which should also be used to distinguish between one-way and reusable deposit containers.

5.9 Supporting Policy Instruments

Additional policy instruments, such as a packaging tax, are sometimes introduced alongside a DRS for a number of possible reasons:

- As a means of incentivising the achievement of targets;
- To level the playing field if not all containers are included within the scope of the DRS, or for all packaging types;

- To generate additional revenue to cover the costs of processing containers not collected by the DRS; or
- To promote eco-design of beverage containers (although this is not currently a main driver).

5.9.1 Examples of Good Practice

Norway

Norway imposes an excise duty per unit of single-use beverage packaging placed on the market. The tax consists of both a base tax and an environmental tax, the rates of which are shown in Table 5-4. Rather than legislative targets, as in some other countries, this environmental tax is the key mechanism for incentivising high return rates.

Table 5-4: Norwegian Beverage Packaging Excise Duty

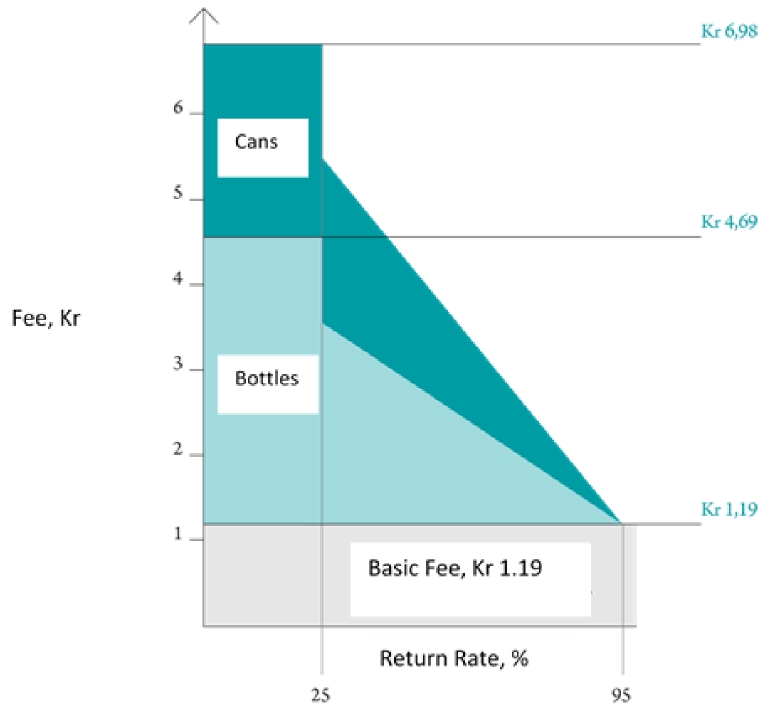
Tax on beverage packaging	NOK/ container	€/ container
Basic tax, disposable packaging	1.19	0.12
Environmental Tax		
A) Glass and metal	5.79	0.61
B) Plastic	3.50	0.37
C) Cartons and cardboard	1.43	0.15

Source: https://www.regjeringen.no/no/tema/okonomi-og-budsjett/skatter-og-avgifter/avgiftssatser-2018/id2575160/

As Figure 5-6 illustrates, to incentivise producers to promote recycling, the tax is reduced as recycling rates increase:

- Recycling rate < 25% = Full tax
- Recycling rate 25-94% = Tax inversely proportional to return rate
- Recycling rate ≥ 95% = Exempt

Figure 5-6: Norwegian Beverage Container Tax for Containers in the DRS



Source: Infinitum

It is this tax exemption that not only encourages producers to participate in the scheme, but also to ensure it is successful in achieving high return rates.

The tax is also applied to cartons and pouches, which are outside the system. Indeed the tax on cartons is significantly higher than the Infinitum producer fees listed in Table 5-3. This prevents producers from choosing packaging types outside the scope of the DRS to try to reduce their costs, and means all producers are required to pay for the waste they place on the market.

Sweden

The Swedish producer responsibility regulations do not require the producers of cans and plastic bottles to contribute to the Extended Producer Responsibility (EPR) system for packaging. As producers of cartons do have to contribute to the EPR scheme, they are still required to contribute to the costs associated with the packaging they place on the market.

5.9.2 Weaknesses of Alternatives

Finland

There is a Beverage Packaging Tax of €0.51 per litre on certain alcoholic beverages and soft drinks, but producers are exempt if these drinks are part of an approved return system. The exemption includes the following conditions:

- A deposit is charged on the container;
- Return rates of 75% in first year and 95% by the fourth year are achieved; and
- The container is recycled.

This theoretically means that all producers contribute to the costs of dealing with the packaging they place on the market. Finland is not, however, included as an example of best practice because cartons are also exempt from the tax, despite not being included in the deposit scheme. Producers using cartons accordingly gain an unfair advantage and there is a risk that other producers will replace their packaging with these cartons, which are less easily recycled than cans or plastic bottles.

Denmark

Denmark applies a volume-based tax to beverage containers, but exempts those that are included in the deposit system. While this – like the Swedish and Norwegian systems – means carton producers make a financial contribution despite not supporting the DRS, non-carbonated soft drinks are exempt from the tax so it does not create a completely level playing field.

Other systems

While the Danish and Finnish accompanying measures are not ideal, they nonetheless are a positive part of the regulatory framework surrounding a DRS. Systems that do not include any form of accompanying policy instrument risk giving a financial advantage to those beverage containers not included in the scheme and risk producers choosing packaging that is excluded.

5.9.3 Recommendation for the Czech Republic

It is expected that the DRS would replace producers' obligations for relevant primary packaging to the EKO-KOM Green Dot system. Nevertheless, it is important to ensure that producers using cartons, pouches, or one-way glass bottles, do not gain an unfair advantage. This is particularly as cartons and pouches are less easily recycled. As such, the Czech Government should consider introducing a beverage container tax that applies to container types that do not have a 90% recycling rate.

5.10 Summary of DRS Design

Table 5-5 lists the key features of the recommended design discussed above. To assess the financial impacts, Eunomia has modelled the costs, as explained in the following section.

Table 5-5: Summary of Proposed Design for the Czech Republic

Element	Option Chosen for the Czech Republic
Governance	Centralised; privately owned and operated; targets set by government (and/ or Beverage Container Tax)
Scope – Containers	1) PET; or 2) PET and aluminium/ steel
Scope - Beverage	Water; soft drinks; beer; cider
Deposit Level	CZK 3
Labelling	Unique barcodes
Return Infrastructure	Return to retail – any container can be returned to any participating retailer Compacting RVMs for large retailers Manual service for small retailers
Handling fees	Determined by retailers' cost to reflect differences in RVM and manual costs.
Material ownership	System operator
Funding	Material Revenues Unredeemed deposits Producer fee for every container placed on the market
Supporting Economic Instruments	Beverage Container Tax for container types with a recycling rate below 90%

Figure 5-7 illustrates the journey of beverage containers, information and money in the proposed Czech DRS. The diagram distinguishes between un-compacted and compacted containers because the former – returned manually – have not been formally counted by an RVM. Consequently, they need to be processed at a counting centre before being taken to the processor so that the system operator knows the value of deposits and handling fees owed to retailers without an RVM.

Figure 5-7: Summary of Czech Design

6.0 Impact Assessment

Eunomia's DRS model calculates the overall system resources and costs associated with implementing a DRS. The model has been specifically adapted for the Czech Republic and the system detailed above. To compare the costs of the DRS with the current costs of collecting and processing containers that are littered, recycled or treated as residual waste, Eunomia additionally modelled the bring-site system to provide a baseline and assess the impact of removing most deposit-bearing containers from the existing system. The component parts of the models are discussed in brief here, with full details provided in the technical appendix.

6.1 Mass Flows

The first step in a cost benefit analysis of the change resulting from the DRS is to consider the material flows in the Czech Republic, how many beverages are sold, and how the empty containers are currently managed through the waste stream once the beverage has been consumed. Data for this analysis was gathered through consultation with EKO-KOM, INCIEN and other stakeholders, supplemented with additional market data from a review of consumption and waste data in the Czech Republic. Table 6-1 sets out the main data sources used, with full details presented in the technical appendix.

Table 6-1: Main Data Sources used for Material Flow Analysis

Data	Plastic	Aluminium / Steel
Beverage Container Sales – the number of containers sold split by size category	EKO-KOM (tonnes placed on the market) and Karlovarské minerální vody (units placed on the market)	
Average weight per container		
Current waste management routes, from collection to disposal	Separation and recycling rate provided by EKO-KOM and processed by INCIEN in 2016 PET Material Flow Analysis[1]	Recycling rates: APEAL[2] & European Aluminium[3] Litter: assumed same littering rate and end destinations split as plastic

Sources:

1. *Material Flow Analysis of PET bottles in the Czech Republic, 2016. Provided by INCIEN.*
2. *APEAL (2018) Good practices in separate collection, sorting and recycling of steel for packaging, June 2018*
3. *European Aluminium (2018) Press Release – 2015 recycling rate, June 2018*

A summary of the beverage material flows used for modelling are provided in Table 6-2 and Table 6-3 below. It is very difficult to predict future changes in other assumptions, such as beverage consumption, material values, labour costs etc., and therefore it was appropriate to consider the costs only over one year. The analysis uses the latest available data and, for the DRS, it is assumed that the 90% target has been reached.

Table 6-2: Summary Material Flows - Plastic Only Scenario

	Baseline		DRS	
	Tonnes	%	Tonnes	%
Put on the market (incl. free riders) [66]	49,446		49,446	
Collection[67]				
DRS returns (including cross border)	0	0	44,630	90.3
Other collection routes & littered	49,446	100.0	5,262	10.6
Final Destination				
Recycled[68]	32,148	65.0	46,324	93.7
Residual disposal (landfill & incineration)	16,068	32.5	3,322	6.7
Litter that remains in the natural environment	1,230	2.5	246	0.5
Recycling Rate, %		65.0%		93.7%

[66] EKO-KOM's official statement
[67] Total in the DRS scenario exceeds 100% due to inclusion of cross-border containers
[68] EKO- KOM's official statement

Table 6-3: Summary Material Flows - Plastic + Metal Scenario

	Baseline (Tonnes)			DRS (Tonnes)		
	Plastic	Metal	Total	Plastic	Metal	Total
Put on the market (incl. free riders)	49,446	8,900	58,346	49,446	8,900	58,346
Collection						
DRS returns (including cross border)	0	0	0	44,630	7,881	52,511
Other collection routes & littered	49,446	8,900	58,346	5,262	1,098	6,360
Final Destination						
Recycled	32,148	2,670	34,818	46,324	8,217	54,541
Residual disposal (landfill & incineration)	16,068	6,008	22,076	3,322	717	4,039
Litter that remains in the natural environment	1,230	221	1,451	246	44	290
Recycling Rate, %	65.0%	30.0%	59.7%	93.7%	92.3%	93.5%
Litter Rate, %	2.5%	2.5%	2.5%	0.5%	0.5%	0.5%

6.2 Baseline Model

A simplified version of the European Reference Model on Municipal Waste Management has been used to calculate the effects on the recycling and mixed waste schemes associated with the change in waste flows under a DRS.

A 'baseline' model is created that represents the current service for areas with urban, semi-urban and rural housing densities. Inputs are based on values provided primarily by EKO-KOM, and also by INCIEN, where known, and are otherwise Eunomia assumptions (more information is provided in the technical appendix). Key variables are then adjusted to calculate the changes in waste flows, collection frequency, and associated costs.

For PET bottles, the introduction of a DRS entails a reduction in beverage containers collected within the plastics containers and in residual waste. It is assumed that, with a DRS, the container distribution for all container collections remains the same, each container fills more slowly, and the containers are assumed to be collected at the same level of fill, but less frequently.

The modelling focusses on communal container collections, as these are by far the dominant method of collection in the Czech Republic for plastic and mixed waste. There is not assumed to be any significant impact on collection costs for households served by a bag collection for mixed plastics. Similarly, no change in collection costs are modelled for collections of individual household containers, which make up around 30% of mixed waste collections. When reducing the amount of material collected, savings tend to come from reducing the frequency of collections. As households usually have a collection on the same day of the week, savings from reduced frequency are more difficult to achieve (although they may be possible in a small number of cases where the volume collected per cycle is already low and the collection frequency can be reduced). We do include in the modelling the change in revenue and reduction in disposal costs for households that do not have a communal container collection.

For metal, the predominant method of collection is at redemption sites. The impact on collection costs of the small number of communal metal containers is not assumed to be significant. Metal communal container collections are therefore not included in the modelling. The impact on revenues is commented on, but kept distinct from overall cost analysis as it is unclear who currently receives these revenues.

6.3 DRS Model

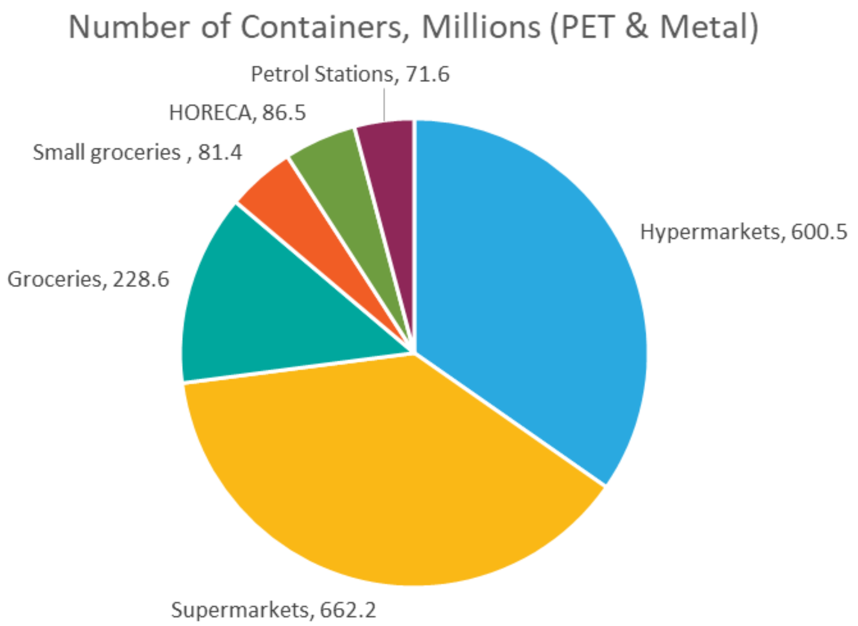
6.3.1 Retail Landscape

The DRS model requires information on the number of retailers in the Czech Republic. It is also necessary to specify how many of the retailers will be part of the scheme (i.e. act as a collection point for customers to bring DRS containers for redemption), and the take-up of RVMs. The businesses joining a future DRS scheme include food service (HORECA) establishments (restaurants, cafes, hotels, bar etc.) and petrol stations as well as small and large retailers (supermarkets and grocery stores). Consumers are not actively returning used containers to HORECA establishments, but these businesses will require collections for the beverages sold and consumed on site.

As it is unclear whether all retailers will be involved in the scheme, we have assumed that 88% of smaller businesses (defined as those below 50 m^2 and petrol stations) and all other retailers will sign up to the scheme. RVM take-up is likely to be close to 100% for larger retailers, who would take-back sufficient quantities of containers to make RVMs an attractive option to retailers. For smaller businesses, a much lower take-up of RVMs is modelled as most businesses do not have the floor space or the necessary quantities of containers returned to make RVMs a viable option.

The assumed number of containers returned annually (in the PET and metal scenario) to each category of retailer is shown in Figure 6-1. Due to the assumptions on the distribution of returned containers and on which retailers have an RVM, three-quarters of containers are returned to RVMs in the modelling.

Figure 6-1: Volume of Containers Returned



6.3.2 Retailer Costs

The costs of handling containers at retail outlets is borne by the retailers themselves, but offset to varying degrees by handling fee income. We modelled the costs to retailers and used these to estimate the correct level for the handling fee. These fall into three categories:

- The costs for purchase and maintenance of RVMs;
- Costs of staff time in various activities relating to maintaining RVMs, processing material receipts, receiving manually returned containers and overseeing pick-ups; and
- Storage/space costs for RVMs and storage of collected containers (i.e. retail space foregone).

Our modelling was conducted on the basis that all RVMs are compacting – thus reducing the volume of material which significantly lowers the costs of collections logistics.

There are approximately 500 RVMs in use in the Czech Republic as part of the refillables programme; we have assumed that retailers with these will continue to use these machines, but have allowed for €1.5 million to upgrade the machines so that they are equipped to accept and compact one-way containers. Many retailers will have an on-going maintenance contract with their RVM supplier, so will be able to discuss with them the costs of the upgrade.

6.3.3 Collection Logistics and Haulage

The DRS model includes a simple collection model to estimate the costs of collecting DRS material from retailers. The model calculates the number of vehicle days required and estimates the total cost based on the cost of operation per vehicle. The number of vehicle days is a factor of: collection frequency (this varies by store size); the volume picked up per collection; vehicle capacity; and the time spent driving and collecting containers. To maximise efficiency, two collection rounds are modelled, one for larger retailers (hypermarkets and supermarkets) and the other for smaller retailers and HORECA businesses.

We have assumed that 12 tonne trucks will be used for collections, with a fleet of trucks at 14 regional depots (one for each region), each used for collection rounds within that region. From here on, it is assumed that uncompacted material, which requires further counting, is hauled in large trucks from these centres to one of two counting centres (see Section 6.3.4), where the material is counted and baled ready for reprocessing. These costs are calculated separately based on a fixed rate of haulage per km.

6.3.4 Counting Centre and Processing

The purpose of the counting centres is to process any manually-collected material through counting machines and then to compact and bale this material. In the modelling, 348 million plastic bottles and 115 million cans are returned manually. The counting machines count and register uncompacted used beverage containers that have been collected manually. The spatial distribution and potential number of counting centres was considered. The higher the number of counting centres, the greater the capital and operational costs. This is, however, balanced against a saving on haulage costs due to shorter travel distances from regional depots to the counting centres. Our analysis demonstrated that two counting centres proved the most economical option, potentially based in or nearby to Prague and Olomouc (although further analysis will be necessary in future to further refine these locations). The cost modelling takes into account the full range of costs at counting centres, including: maintenance costs of counting machines and balers, power consumption, staff costs, and rental costs.

6.3.5 Material Revenues

Material revenues are calculated from the tonnages of collected containers sold into the market, having been bulked or baled at the counting centre. These are based on information provided by reprocessors in the Czech Republic (for PET) and from a review of average prices seen in European markets (for steel and aluminium).

6.3.6 Unredeemed Deposits

One source of revenue to help fund the system is the value of the deposits that have been paid by consumers but not collected. In a system with a return rate of 90%, 10% of the total deposits in the system will be kept by the central system operator. Although we are modelling a hypothetical year in which a 90% return rate is achieved, the proportion of unredeemed deposits is likely to be higher in the first year.

6.3.7 Central Operating Costs

The central administration system undertakes a number of tasks, these include maintaining the DRS IT system which handles all information flows, invoicing and payments, communication and marketing, and combating fraud. The costs of this system are based on discussions with existing DRS operators in Europe and include staff costs, set up costs, rental costs for office space, and other administrative, IT, legal and marketing costs.

7.0 Results

7.1 Impact on Existing Waste Services

The Czech Republic currently litters or disposes in residual waste approximately €6.9 million worth of PET bottles each year and €5.4 million of metal cans. The DRS, based on the estimates of the tonnage placed on the market and currently recycled used in the modelling, could mean an additional 14,176 tonnes of PET are recycled each year and, if cans are included, 5,547 more tonnes of aluminium and steel.

The impacts of a deposit scheme would be to:

- Reduce staff and vehicle collection costs of plastic bring bank containers as they require less frequent collection;
- Potentially to a lesser degree reduce collections costs of residual bring bank containers;
- Reduce the sorting cost but also the material revenue obtained from collected plastics;
- Reduce bulking and disposal costs of residual waste; and
- Reduce fees paid to EKO-KOM as beverage producers will be registering the beverage containers with the DRS instead.

As detailed in Section 6.2, no collection cost savings are modelled for metal container collections or door-to-door collections.

Table 7-1 presents the cost results of the collection modelling, while Appendix A.4.2 provides a breakdown by different housing types of the impact on collection frequency and sites visited per vehicle per day. The results show that for plastic:

- There is a large fall in the staff and vehicle container collection costs, equivalent to 34% of the modelled baseline costs. This is primarily because of the large drop in plastic being collected, which means that containers fill more slowly and so collection frequency can be significantly reduced. Additionally, removing PET improves compaction on the vehicle, and so higher tonnages can be collected per vehicle.
- There is no change in container costs. It is assumed that the existing number of containers would be maintained.

- Sorting and bulking costs reduce because of the reduction in material collected.
- However, it is estimated that around €12 million of revenue would be lost out of the existing container and bag collections, which is more than the combined savings.

The net impact, excluding the impact on EKO-KOM fees, is modelled as an annual additional cost of €4.3 million to the current separate collection and management of plastics. This is because the separation facilities' loss of PET revenues outweighs the savings in staff, vehicle, sorting and bulking costs. There are small savings in residual staff and vehicle collection costs (equivalent to 0.2% - 0.3% of current residual staff and vehicle collection costs), and more significant savings in residual disposal (non-separated waste that is landfilled or incinerated), with a net positive impact on mixed waste costs of €200,000 - €450,000 depending on whether metal is included in the scheme or not. The figures presented in Table 7-1 assume a residual disposal cost of €26 per tonne (gate fee of €6 per tonne and landfill tax at €20 per tonne). However, landfill tax is planned to increase from €20 to over €70 by 2023. Therefore the savings from avoided disposal costs are likely to be underestimated. Table 7-2 presents a sensitivity where residual disposal costs increase to €80 per tonne, based on an increase in landfill tax from €20 to €74.

Table 7-1: Annual Cost Impact on Existing Waste Management Following DRS Implementation (savings are negative and additional costs are positive)

	Organisation Impacted	Plastics Separate Collection (€ 000)	Residual (€ 000)		Combined (€ 000)	
			PET DRS	PET & Metal DRS	PET	PET & Metal
Staff Collection Costs	Municipalities / PRO	- 2,501	- 17	- 37	- 2,518	- 2,538
Vehicle Collection Costs	Municipalities / PRO	- 4,398	- 33	- 72	- 4,431	- 4,471
Sorting	Separation Facilities	- 766	n/a	n/a	- 766	- 766
Bulking & Hauling	Separation Facilities	- 192	- 41	- 92	- 233	- 284
Material Revenues	Separation Facilities	12,110	n/a	n/a	12,110	12,110
Disposal Cost	Municipalities	n/a	- 113	- 250	- 113	- 250
PRO Fees	PRO	n/a	n/a	n/a	10,132	10,956

	Organisation Impacted	Plastics Separate Collection (€ 000)	Residual (€ 000)		Combined (€ 000)	
			PET DRS	PET & Metal DRS	PET	PET & Metal
Total	**Combined**	**4,253**	**- 203**	**- 452**	**14,181**	**14,757**

Table 7-2: Disposal Sensitivity: Annual Cost Impact on Existing Waste Management Following DRS Implementation

	Organisation Impacted	Plastics Separate Collection (€ 000)	Residual (€ 000)		Combined (€ 000)	
			PET DRS	PET & Metal DRS	PET	PET & Metal
Disposal Cost	Municipalities	n/a	- 345	- 768	- 345	- 768
Total	**Combined**				**13,949**	**14,239**

It is important to consider the impact on stakeholders providing waste services in the Czech Republic, so these are summarised in Table 7-3.

Table 7-3: Impact of Introducing DRS on Stakeholders

Stakeholder	Impact
PRO	Will lose €10,131,756 (PET only) or €10,955,736 (PET and metal) in annual fees that producers are no longer paying. As discussed in Section 10.1, however, revenue from fees for other packaging products may increase due to the EU Directives and the requirement for producers to pay the full costs of dealing with the packaging they place on the market. Additionally, €6,949,000 (PET only) or €7,009,000 (PET and metal) is saved in collection costs. These costs are initially paid by municipalities but, in 2017, they received a 66% refund from EKO-KOM.[69] It is not clear to what extent savings would be passed on to EKO-KOM, but their costs may well reduce. It is also understood that EKO-KOM covers some of the sorting, bulking and hauling costs, so they may share some of the €999,000

[69] Private communication from INCIEN.

	(PET) or €1,050,000 (PET and metal) savings with the separation facilities.
Separation Facilities	Will save some bulking, hauling and sorting costs but, as they also lose the material revenues for the PET they currently collect, they will lose €11,111,000 (PET only), or €11,060,000 (PET and metal). This could be mitigated by improving recycling other packaging types.
Municipalities	Will save €113,000 (PET) or €250,000 (PET and metal) in disposal costs currently but, as indicated in Table 7-2, these savings will increase if the landfill tax increases, or a landfill ban is introduced. Additionally, they are very likely to share some of the €6,949,000 (PET only) or €7,009,000 (PET and metal) collection cost savings. Municipalities' litter collection and clean-up costs are also likely to reduce due to the 80% reduction in litter.

For the scenario where the DRS includes metal, a further €1.9 million is lost in revenue due to the removal of cans from the recycling system, potentially primarily from redemption sites. The data in Figure 4-2 cover all scrap metal, so is not specific enough to estimate which parts of the system currently receive revenue from beverage cans or, consequently, from which collection system this revenue would be lost.

While this metal would no longer be recycled through the current services, overall the DRS would recycle an additional €4.8 million of metal. It should also be noted that, in a DRS, not all containers are redeemed by the original consumer: typically, some will still be littered or discarded and picked up by someone else to claim the deposit. With the material worth approximately €0.023 per aluminium can, the €0.12 deposit is of much greater value than the material revenue. Therefore businesses or individuals that currently collect beverage cans for recycling might displace this lost revenue, either through continuing to collect a smaller number of cans and redeeming the deposit value, or by hosting redemption points so that they are entitled to handling fees.

7.2 DRS Set-Up Costs

Table 7-4 lists the initial investment needed to establish the DRS. It is likely that the system operator would take out a low-interest loan, which would be supported by the positive cash-flow created by the time-lag between the deposits being initiated and refunded to consumers. In the first few years, when the system is not expected to reach its 90% target, the higher value of unredeemed deposits will help to pay-off the loan. As the set-up costs would not need to be paid up-front in one lump sum, these are annualised into the annual running costs detailed in Section 7.3.

The most significant cost is the €85.2 million for RVMs. This analysis has assumed that these costs are borne initially by retailers, using a loan to be repaid, over seven years on average, with their income from handling fees (see Section 7.4). Alternatively, retailers may choose a lease agreement with the RVM supplier, which would significantly reduce the initial capital requirements and could mean the supplier includes a maintenance contract. Another alternative is for the system operator to provide the RVMs to retailers, in which case the total €95.9 million would be the system operator's responsibility.

The analysis assumes that the remaining €10.7 million set-up costs are covered by the system operator's loan, paid back through unredeemed deposits, material revenues and producer fees. This €10.7 million is accordingly included in the annualised system costs detailed in Section 7.3. These initial capital costs could once again be reduced if the collection vehicles are leased or if back-hauling and existing distribution vehicles are used. Even if the system operator buys the vehicles, there could be some savings if they are able to secure a reduced price due to the number of vehicles required. The costs of the trucks are based on the price of a single vehicle but, as 117 trucks are needed, the system operator may be able to secure a better price, which would reduce the overall system costs detailed in Section 7.3.

Table 7-4: Initial Capital Requirements

	No. Units	Capital Cost/Unit	Total Capital Cost
RVMs			
RVMs - Smaller shops	1,243	€20,000	€24,864,157
RVMS - Supermarkets	2,065	€28,500	€58,854,526
RVM Renovation - Refillables	500	€3,000	€1,500,000
RVMs - Total			***€85,218,683***
Collections			
Collection Vehicles	117	€70,000	€8,216,154
Collections - Total			***€8,216,154***
Counting Centres			
Counting Machines	4	€130,000	€650,000
Compactor & Baler	4	€230,000	€920,000
Installation in Counting Centre	2	€50,000	€100,000
Counting Centre - Total			***€1,670,000***
Central System Operator Setup Costs			

	No. Units	Capital Cost/Unit	Total Capital Cost
IT - capital investment			€400,000
Office - furniture and equipment			€20,000
Project (setup) management			€100,000
Communication			€300,000
Central Set Up Costs - Total			***€820,000***
Total Initial Capital Requirement			**€95,924,837**

7.3 System Costs and Producer Fees

Table 7-5 details the annual costs of a DRS for scenario 1 (PET-only) in terms of the total costs and the cost per container placed on the market (POM). The total annual costs, including estimated fraud losses, would be €50.5 million; 35% of this would be covered by the value of the recovered PET and, even with a 90% return rate, 37% is covered by the unredeemed deposits. The net system costs are €14.3 million, which equates to a producer fee of €0.0101 per PET bottle placed on the market.

Table 7-5: DRS Costs for PET Scenario

Item Future System Operator Costs	Total Cost, € million	Cost/Unit POM, € cents
Central Admin System	0.9	0.07
Handling Fees - Reimbursing Retailers (RVMs, Labour and Space)	38.0	2.68
Transport Costs	8.5	0.60
Counting Centre Costs	1.4	0.10
Materials Income	-17.7	-1.25
Unclaimed Deposits	-18.5	-1.30
Fraudulently Claimed Deposits	1.7	0.12
Net Cost	**14.3**	**1.01**

Item Future System Operator Costs	Total Cost, € million	Cost/Unit POM, € cents
Funded by Producer Admin Fee	**-14.3**	**-1.01**

If both PET bottles and metal cans are included, the annual costs are €57.5 million, with 43% covered by material revenues and 41% by unredeemed deposits. The net costs are €9.5 million, which would mean a producer fee of approximately €0.0078 for each PET bottle placed on the market. The modelled producer fee for aluminium is negative because of the lower costs and higher value.

The actual costs will vary and will depend on the price for aluminium the system operator is able to secure. The split between PET and metal costs is also more theoretical at this stage, so the system operator would undertake a more detailed analysis to determine what proportion of costs should be covered by each type of material. Additionally, they may distinguish between steel and aluminium, and charge a higher fee for steel, as happens in countries like Norway. Once the system is established and the system operator knows the real costs, they could incorporate "negative fees" by following the Norwegian example and allowing producers to pay a slightly reduced initial deposit when it is paid to the system operator, but they would then be refunded the full value – as would retailers and consumers.

Table 7-6: DRS Costs for PET and Metal Scenario

Item	Total Cost, € million		Cost/Unit POM, € cents	
Future System Operator Costs	**PET**	**Metal**	**PET**	**Metal**
Central Admin System	0.5	0.5	0.03	0.15
Handling Fees - Reimbursing Retailers (RVMs, Labour and Space)	36.3	7.67	2.56	2.45
Transport Costs	8.2	0.9	0.58	0.28
Counting Centre Costs	0.7	0.7	0.05	0.23
Materials Income	-17.7	-6.9	-1.25	-2.20
Unredeemed Deposits	-18.5	-4.9	-1.30	-1.55
Fraudulently Claimed Deposits	1.7	0.4	0.12	0.12
Net Cost	**11.1**	**-1.6**	**0.78**	**-0.52**

Item	Total Cost, € million		Cost/Unit POM, € cents	
Future System Operator Costs	**PET**	**Metal**	**PET**	**Metal**
Funded by Producer Admin Fee	**-11.1**	**1.61**	**-0.78**	**0.52**

The calculated annual cost of collections from the HORECA sector is nearly €1 million. The system operator may consider whether these businesses could contribute to the programme funding, given that they will no longer have to pay for much of their commercial waste to be collected.

Additionally, the system operator could discuss with larger retailers whether they could backhaul their used containers to their central distribution depots, from where the system operator would collect them. This would potentially reduce the number of journeys required by the DRS – reducing the greenhouse gas and air quality emissions. However, reports from other DRSs indicate that it is not necessarily more cost-effective depending how retailers undertake such backhauling, and the vehicles they use, and thus how much they might seek to charge the system operator for this service.

As discussed in Section 547.4, the results are also sensitive to the assumptions we have made about RVM use.

7.4 Retailer Handling Fee

Table 7-7 and Table 7-8 provide an indication of the estimated handling fees in each scenario. The fees are lower in scenario 2 than scenario 1 because of the higher volumes and lower costs associated with processing and storing metal cans. In scenario 2, the system operator may choose to pay a different fee for PET and metal.

Table 7-7: Retailer Handling Fees in Scenario 1 (PET only)

	Total Cost, € million	Handling Fee/Unit Redeemed, € cents
Handling Fees – RVM	31.4	2.96
Handling Fees – Manual	6.6	2.31

Table 7-8: Retailer Handling Fees in Scenario 2 (PET and Metal)

	Total Cost, € million		Handling Fee/Unit Redeemed, € cents	
	PET	**Metal**	**PET**	**Metal**
Handling Fees – RVM	30.6	5.65	2.86	2.86
Handling Fees – Manual	5.6	2.02	2.03	2.03

The costs are highly sensitive to the assumptions made about through-puts and the proportion of retailers likely to have an RVM. For instance, the fee will increase if more small and medium-sized retailers have an RVM, but the fee will reduce if fewer small retailers have an RVM. (The assumptions are detailed in Appendix A.3.1).

As discussed in Section 7.2, it is assumed that retailers are paying for the RVMs over a 7 year period on average. How long it takes in reality will depend on the volume of containers received and on the cost of the RVM model chosen by the retailer (as the modelling has used average estimates). As demonstrated in Table 7-9, using these averages, small grocery shops are unlikely to recoup the cost of RVMs from handling fee income alone. This is why it is assumed that only 2.5% of small groceries would invest in an RVM. This would be due to other considerations, such as the potential increased customer footfall and the ability to offer promotions through RVMs, or practical reasons such as limited staff availability.

Table 7-9: Years Needed to Pay for RVMs from Handling Fee Income

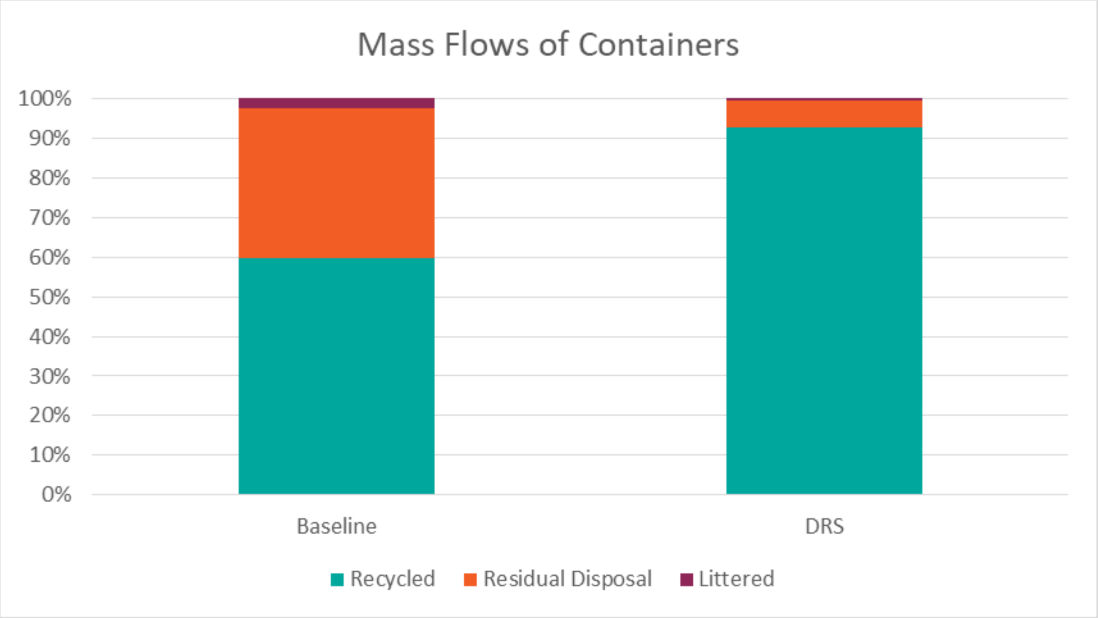
Type of Retailer	Number of Containers per RVM per Month	Years Before RVM Costs Covered
Hypermarkets > 2500 m^2	52,130	4
Supermarkets 401-2500 m^2	32,679	7
Groceries 51-400 m^2	2,764	59
Small groceries 50m^2	1,241	130
Petrol Stations	2,589	63
All	27,751	7

8.0 Environmental Impacts

While it is important to calculate the costs of the DRS, any balanced impact assessment should also take into account the benefits. These can include reduced unemployment and a reliable supply of recycled material, but environmental considerations are often the key drivers for a DRS. As such, Eunomia has attributed financial values to the environmental impacts so that the costs and benefits can be more accurately assessed.

As Figure 8-1 illustrates, the DRS increases the proportion of containers that are recycled, and consequently not littered, landfilled or incinerated, by more than 50%.

Figure 8-1: Mass Flows of Containers with and without a DRS



The increased recycling produces environmental benefits, which have been calculated in the life cycle assessment (LCA) conducted by University of Chemistry and Technology, Prague. It is understood that this analysis took into account the impact of the additional equipment and transportation associated with the DRS.

The outputs from the LCA included the emissions of greenhouse gases and other air pollutants. Using these outputs, Eunomia calculated the change in emissions as a result of the DRS and attributed damage costs to produce a monetary value for the environmental benefits delivered by the DRS. More information on the costs and methodology is provided in Appendix A.4.2.

The results of these calculations are shown in Table 8-1. This shows that, if both PET bottles and metal cans are included, the reduction in greenhouse gas (GHG) emissions as a result of the DRS is valued at €3.7 million. While there is a slight increase in air pollutants, the DRS still produces a net environmental benefit of €3.6 million (or €2.2 million if only PET is included).

Table 8-1: Total Change in Monetised Environmental Impacts (Air Emissions), € thousand

	PET	Metal	Total
GHGs	-€ 2,301	-€ 1,404	-€ 3,704
AQ	€ 63	€ 14	€ 78
Total	-€ 2,237	-€ 1,389	-€ 3,627

Additionally, littering not only entails clean-up costs, but also has a negative impact on communities and businesses. While it is difficult to quantify this impact, it is clear that the reduced litter as a result of the DRS will have a positive welfare impact. To truly reflect the costs and benefits of the proposed DRS for the Czech Republic, it is important to include an estimate of the reduced litter disamenity. Appendix A.5.3 provides more information on this process and the results are provided in Table 8-2. Eunomia estimates that the litter reduction resulting from the DRS is worth €79 million (or €67 million if only PET is included). This is a conservative estimate as it is only based on litter that remains in the environment, whereas any litter (even if it is subsequently collected) has a disamenity cost.

Marine litter has also been excluded as, while litter from the Czech Republic will contribute to this and reduced marine litter benefits the global community, there is potentially an argument that the Czech Republic will not derive as much benefit as coastal countries, where beach tourism could be affected, for instance. The total litter disamenity savings could consequently be significantly higher than estimated here.

Additionally, municipalities could be expected to benefit from lower clean-up costs and so may derive further savings from the reduced litter resulting from the DRS. Clean-up costs are not, however, included in the analysis, as there is insufficient reliable data on how much is spent on litter collections and there is no objective way to allocate a proportion of the costs to beverage containers specifically. It is not, for instance, clear whether litter collections would be conducted less frequently and/ or take less time if fewer beverage containers were littered.

Table 8-2: Total Change in Litter Disamenity, € million

	PET	Metal	Total
Terrestrial Litter	-€ 67	-€ 12	-€ 79

This analysis demonstrates that the environmental benefits of the DRS (€82.6 million if PET and metal are included) exceed its total costs. If environmental costs were internalised into the costs of products placed on the market, rather than being borne by the general public, the savings for beverage producers would be in the € millions.

Table 8-3: Summary of Monetised Environmental Savings

	PET	Metal	Total
Environmental Impacts	€2,237,000	€1,389,000	€3,627,000
Terrestrial Litter	€67,000,000	€12,000,000	€79,000,000
Total	€69,237,000	€13,389,000	€82,627,000

9.0 Alternatives for 90%

With an estimated 65% recycling rate for PET bottles and just 30% of cans separated, there is a significant gap between the Czech Republic's current performance and the standards it will need in order to meet the proposed Directive on the Reduction of the Impact of Certain Plastic Products on the Environment (collecting 90% of single-use plastic bottles by 2025) and the revised Packaging and Packaging Waste Directive targets for ferrous metals (80%) and aluminium (60%).

While the Czech Republic is meeting the 55% target for plastic packaging under the current reporting requirements, the 2018 revisions to the Waste Framework Directive introduce new rules for calculating attainment against the targets: the proportion of municipal waste that is recycled is measured by the amount of waste that reaches recycling operations, rather than preliminary operations. This means the 11% loss rate for plastic bottles will need to be accounted for and it will not be sufficient to only separate the materials.

To meet a 90% target, the Czech Republic would need to recycle an additional 12,353 tonnes of PET bottles, as a minimum. The European Commission has proposed that, to achieve the separate 90% collection target by establishing either:

1) A DRS; or
2) Separate collection targets for relevant EPR schemes.[70]

It is notable that the European Commission has not offered any specific alternative mechanism to the DRS, and this seems to be indicative of the correlation between the highest recycling rates and DRS systems. Nevertheless, it is important to consider if there are potential alternatives, and INCIEN and Karlovarské minerální vody have asked Eunomia to reflect on possible alternatives as part of this study.

9.1 Lessons from Other Countries

The current maximum recycling rate for plastic bottles in countries without a DRS – taking into account loss rates – is estimated to be 70%. This is likely to be due a combination of factors, such as lack of infrastructure, limited consumer education and engagement, a lack of ambition or targets, and inappropriate or insufficient incentives for producers and consumers. While a limited number of countries may report higher figures, there are doubts over whether these would be achievable under the new WFD and PPWD measurement and reporting methods, due to loss rates.[71]

While metal beverage cans are sometimes extracted from incinerator bottom ash to boost the recycling rate, this does not generate the same high-quality material from

[70] http://ec.europa.eu/environment/circular-economy/pdf/single-use_plastics_proposal.pdf
[71] ICF & Eunomia (2018) *Plastics: Reuse, Recycling and Marine Litter – Impact Assessment of Measures to Reduce Litter from Single Use Plastics.* Final Report and Annex for DG Environment. May 2018.

waste that can be collected separately. Additionally, energy from waste facilities – particularly those that provide limited energy recovery – are further down the waste hierarchy than recycling. As such, the European Commission has made clear that EU funding, and any public subsidies, should prioritise waste prevention, reuse and separate collection.[72]

9.2 Options for the Czech Republic

The Czech Republic has already announced a landfill ban on recyclable waste, which is due to come into effect in 2024,[73] and other options include an incineration tax and extending the Pay as You Throw (PAYT) system. These, however raise enforcement challenges, there is a risk that they could lead to more fly-tippling or littering and they do not ensure that recyclable material is separately collected.

No bring system currently comes close to 90% separation rate for plastics, especially once contaminated material is discounted. According to EKO-KOM, the average distance to an individual's nearest collection site is 92 metres. This suggests that there is not much scope to increase the frequency and availability of the containers to reduce still further the distance consumers need to travel. Indeed, it is reported that EKO-KOM increased the number of containers from 118,400 to 144,500 over the last year, but the separation rate only increased from 68% to 69%.[74] Door-to-door separate collections for the whole population would be more convenient but, as discussed below, these are not necessarily always a viable option.

Just 1.5% of municipalities (covering 4% of the population) have door-to-door recycling collections, and, in large cities in particular, there are no such collections at all.[75] This reflects the additional challenges in densely populated urban areas with multi-occupancy buildings. The 2011 census indicated that there were 4.1 million occupied dwellings, 55% of which were in multi-dwelling buildings.[76]

Weekly collections with so many more pick-up points would incur additional costs and special measures would be needed in multi-occupancy buildings. In flats and apartments where people cannot accommodate multiple recycling containers for different materials, communal recycling containers are more common. These are however, at greater risk of contamination – impairing the quality of the material collected and requiring additional sorting. To mitigate this, it would help to invest in educational campaigns. Additionally, to address on-the-go consumption, a high density of recycling bins would also be needed in public spaces.

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[72] http://ec.europa.eu/environment/waste/waste-to-energy.pdf

[73] European Environment Agency (2016) *Municipal Waste Management: Country Fact Sheet.* October 2016.

[74] Private communication from INCIEN.

[75] Private communication from INCIEN.

[76] Ministry of Regional Development (2017) *Housing in the Czech Republic in Figures*. August 2017.

While these measures would help to promote recycling for other products and packaging, a DRS is generally recognised as the best method for collecting beverage containers and producing high-grade rPET for new beverage bottles. A DRS both ensures there is the necessary infrastructure for consumers to conveniently return their used containers, and provides a financial incentive for them to do so. If combined with supporting instruments and targets, a DRS also means producers are incentivised to achieve high recycling rates.

10.0 Conclusions

10.1 DRS Impact Assessment

Karlovarské minerální vody, like other beverage companies, has recognised the merits of improving recycling rates to increase the recycled content of their beverage containers and reduce the environmental impact of their products.

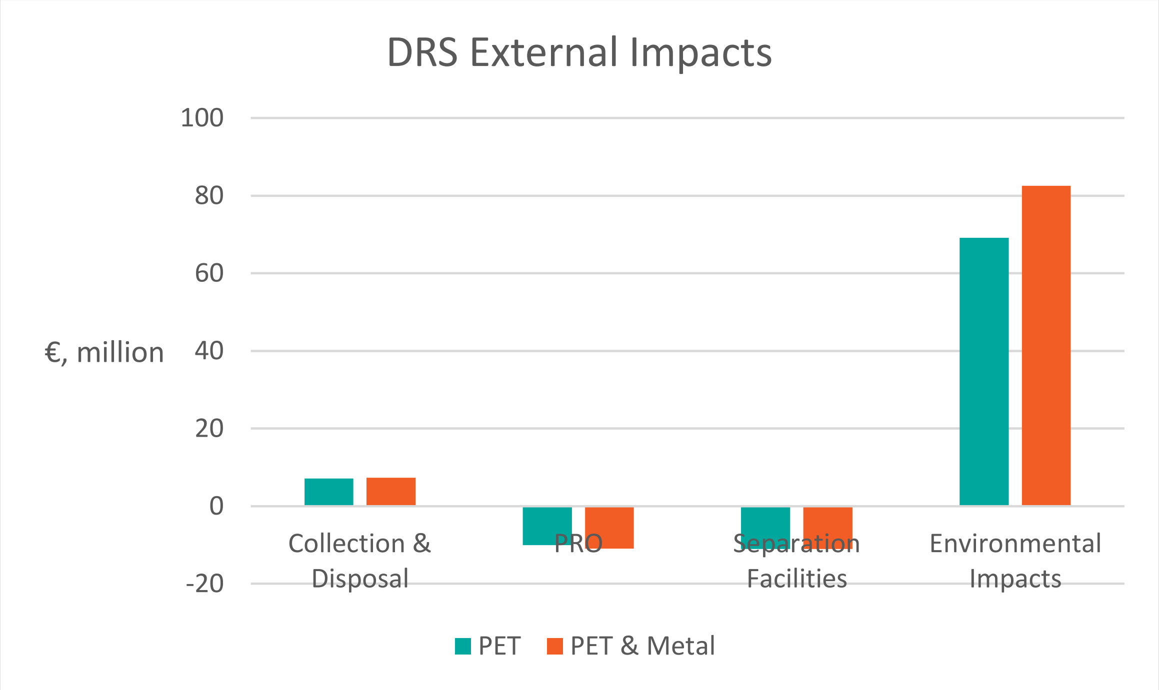
Table 10-1 summarises the key findings of the impact analysis. While there are efficiency savings to be made – especially with residual waste – it should be recognised that EKO-KOM, separation facilities and scrap collectors will lose a source of revenue from the materials and, in the case of EKO-KOM, fees from beverage producers. Producers would be paying €9.5 - €14.3 million instead of the €10-€11 million they pay in PRO fees (meaning lower overall costs in the PET and metal scenario) and, critically, this is for a 90% recycling rate with much lower contamination levels and loss rates. As such, all costs need to be considered in the context of the environmental benefits.

Table 10-1: Summary of System Costs & Impacts

	PET	PET & Metal
Gross Annual Operating Cost	€48,800,000	€55,470,000
Gross Annual Cost (inc. fraud)	€50,500,000	€57,490,000
Annual Costs for Producers (Net of revenues & unredeemed deposits)	€14,300,000	€9,490,000
PET Producer Fee per unit PoM	€0.010	€0.008
Retailer Handling Fee per unit returned	€0.0231 – €0.0296	€0.0203 – €0.0286
PRO Lost Fees	€10,132,000	€10,956,000
Separation Facilities Losses	€11,111,000	€11,060,000

Collection Savings	€6,949,000	€7,009,000
Disposal Savings	€113,000 – €345,000	€250,000 – €768,000
Environmental Impacts	€2,237,000	€3,627,000
Litter Disamenity	€67,000,000	€79,000,000

Figure 10-1: External Impacts of Introducing a DRS



Savings and benefits are positive figures, costs and losses are negative.

As can be seen from Figure 10-1, the DRS generates savings for municipalities. It may mean that EKO-KOM changes its fees for other packaging to compensate for the lost revenue; EKO-KOM may in any case need to adjust its strategy and fee structure as a result of the new EU Directives and the requirement for producers to pay the full costs of dealing with the packaging they place on the market. Additionally, if the Czech Government were to introduce a beverage container tax, the revenue from this could be used to support existing recycling facilities. It should also be noted that, with separation rates of 69% for plastic packaging and 62% for metal, there is scope to offset any losses from beverage containers by increasing the recycling rates for other forms of packaging. Significantly, Article 8a of the revised EU Waste Framework Directive introduces minimum requirements for cost coverage in extended producer responsibility schemes. These indicate that producers are financially responsible for the costs of separate collections, transport and treatment of the products they place on the market; full cost coverage would most likely mean an increase in EKO-KOM fees and the contribution producers make to municipal recycling services and separation facilities.

A breakdown of the costs of the DRS are shown in Figure 10-2 and Figure 10-3. As can be seen, the majority of annual expenditure is used to compensate retailers for the costs of providing the take-back service to consumers and supporting a high return rate.

Figure 10-2: System Costs (PET only)

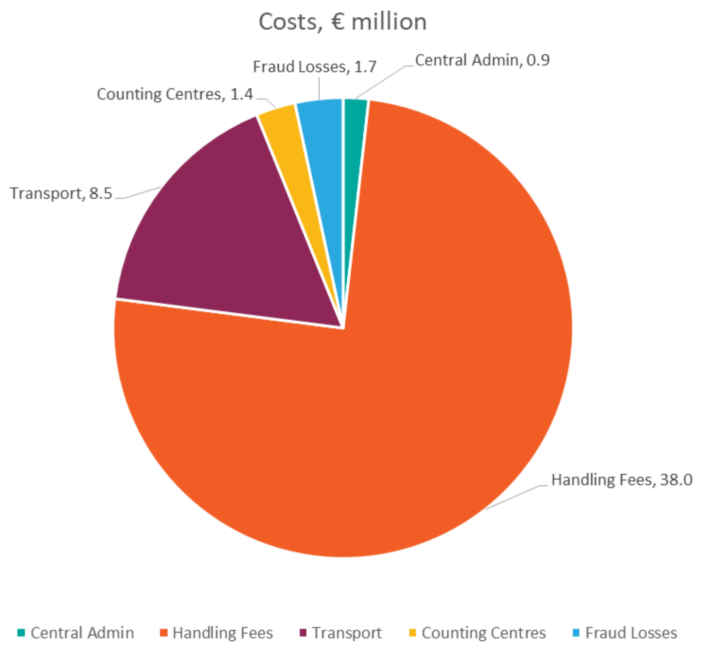
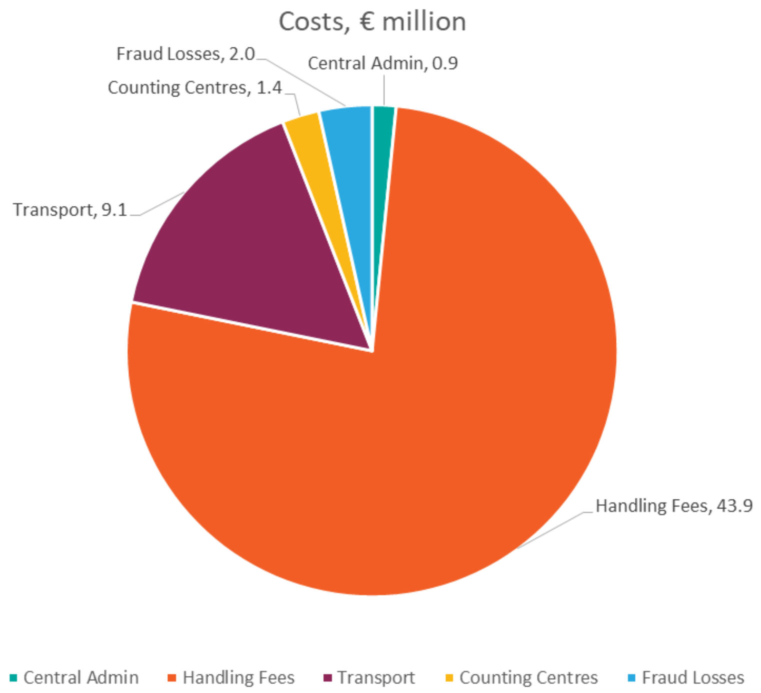


Figure 10-3: System Costs (PET & Metal)



On the current analysis, Figure 10-5 shows how more than three quarters of these DRS costs will be covered by unredeemed deposits and material revenues.

Figure 10-4: System Revenues (PET Only)

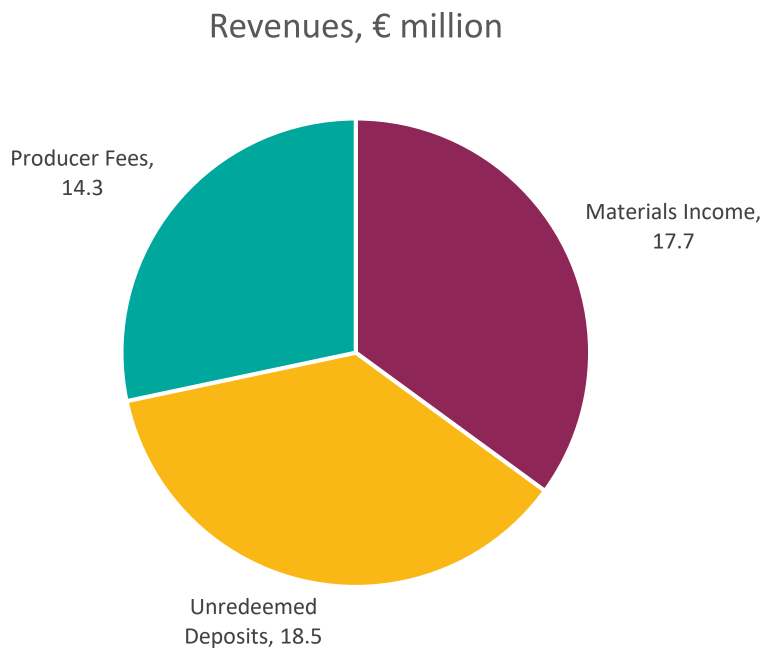
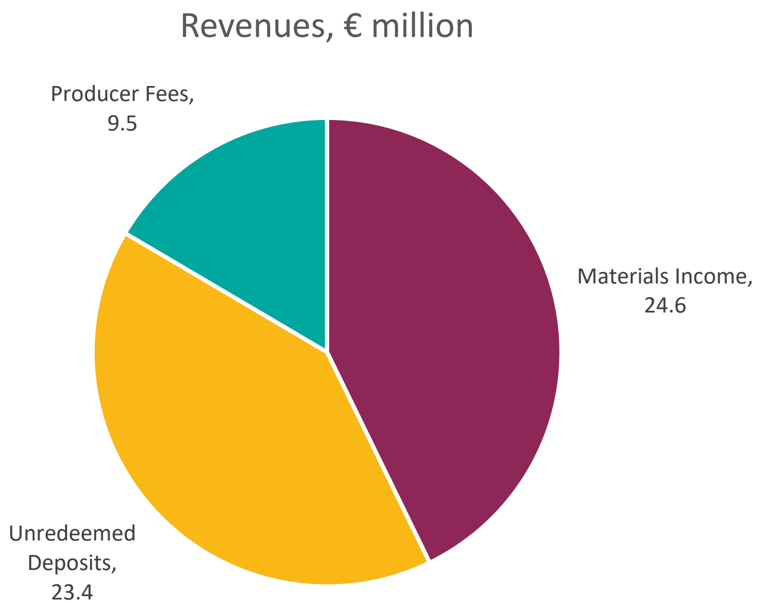


Figure 10-5: System Revenues (PET & Metal)

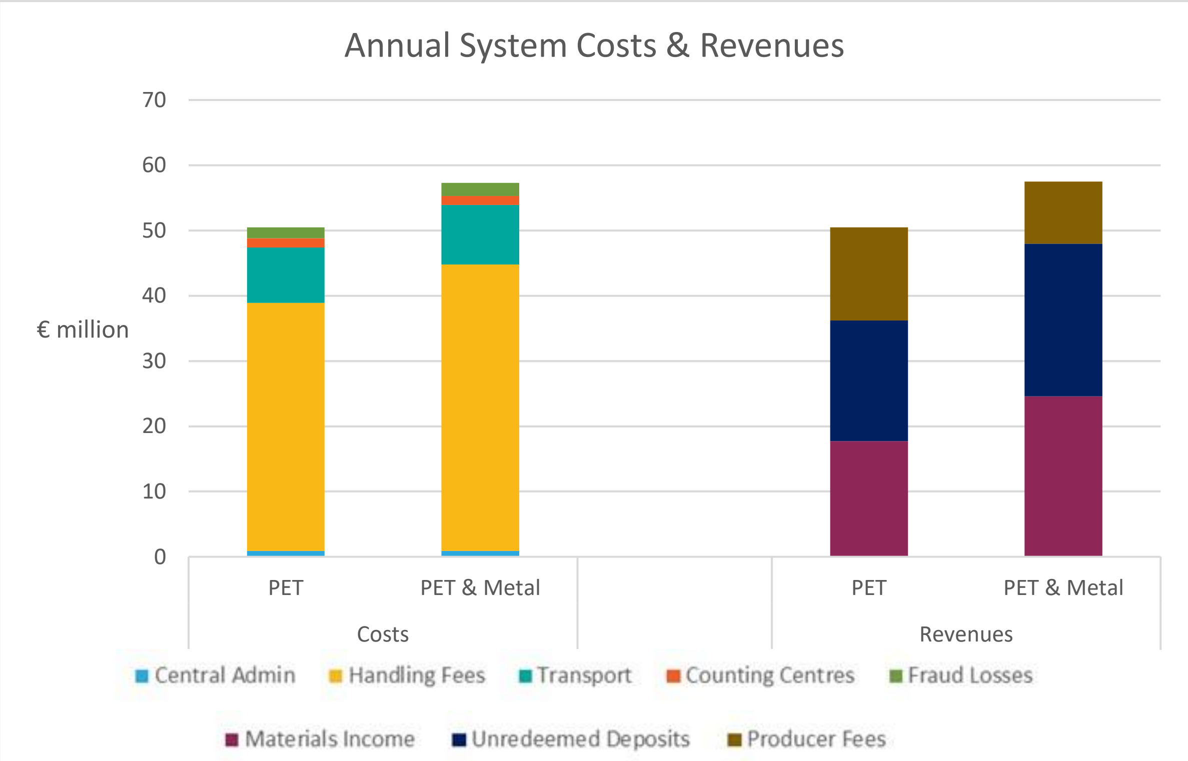


If both PET and metal is included in the DRS, the overall costs to producers are lower than they are currently (reduced to €9.5 million from €11.0 million). Using the average weights we have assumed in the DRS and the EKO-KOM fees in Table 4-1: EKO-KOM Compliance Fees (2017), producers pay €0.0064 for each PET bottle and €0.0023 for an aluminium can. A DRS for both PET and metal, in the system we have modelled, would mean lower fees than in the current PRO system for producers using cans. For PET producers, the costs are higher (modelled at €0.0078 – €0.01 per bottle), but it should be remembered that a DRS is expected to capture more containers and provide better quality material, which these producers can then use to manufacture new containers. They would be paying for a 94% recycling rate, rather than a 65% separation rate.

As noted above, PRO fees may have to increase in the future. This would not only offset EKO-KOM's lost revenue, but would also mean that the savings for beverage producers joining the DRS could be even greater. Moreover, DRS fees could well reduce as the system operator improves the programme's efficiency. If beverage sales increase, meaning more containers are included within the scope of the scheme, then the fee per container will reduce further. Recent trends indicate than aluminium can sales are increasing and a higher proportion of aluminium will again have a positive impact on costs due to the lower processing costs and higher revenues associated with aluminium cans.

Including metal cans as well as PET bottles means the DRS collects 18% more containers at a net additional cost of €7 million. Significantly, however, this reduces the costs covered by producers by 34% and fees for PET producers by 23% if metal is included.

Figure 10-6: Comparison of DRS Costs and Revenues



10.2 Assessment of DRS and Potential Alternatives

Localised, separate collections from households would help to increase the proportion of beverage containers that are recycled, and could be combined with a landfill tax and incineration tax. There is, however, no evidence to indicate that these are guaranteed, or even likely, to achieve 90%. Like a DRS, any alternative would require additional investment (e.g. in collection vehicles and kerbside containers) and incur ongoing costs, not least in wages. Given the likelihood that a well-designed DRS will achieve the best possible recycling results, a DRS could be considered a lower-risk investment for producers. Indeed, EKO-KOM's investment over the last year in 26,100 additional containers seems to be delivering diminishing returns, given the modest increase in the separation rate. EKO-KOM is also targeting a 65% utilisation rate by consumers, whereas the DRS would have a much more ambitious target.[77]

The practical challenges associated with the Czech Republic's housing stock mean there is a limit to the extent to which recycling can be made more convenient. If consumers in the Czech Republic do not want to take their used bottles 92 metres to the nearest container, an insufficient number may be motivated to sort their waste using a kerbside system, even if kerbside collections are feasible. While there is a degree of inconvenience with a DRS, this is minimised by ensuring consumers can return their containers when they do their shopping, and it is offset by the financial incentive to redeem their deposit. While financial incentives could be included through other mechanisms, such as PAYT, it is worth considering that prospect theory indicates that people are more motivated to avoid a loss than they are to secure a benefit, so the threat of losing their deposit could be more influential than any rewards, for instance reduced tax bills if they reduce their residual waste.

It should also be noted that a DRS has additional benefits that are not necessarily applicable in other systems, such as litter reduction and less contamination. Additionally, in our proposed design, the producer fee would be varied to promote eco-design.

Nevertheless, the Czech government, and producers of other types of packaging waste, will need to consider options to improve the recycling rates of other products, particularly as Article 10 of the revised Waste Framework Directive requires separate collections. So it is not suggested that a DRS is the only solution. It can, however, be part of a package of measures intended to facilitate or incentivise separate collections.

10.3 Next Steps

While there are steps the Czech government, and producers, can – and arguably should – take to reduce waste and increase recycling of all products, results in other countries indicate that a well-designed DRS is the best mechanism to maximise the recycling rate of beverage containers specifically.

It is recommended that Karlovarské minerální vody work with other beverage manufacturers and distributors in the Czech Republic to consider the benefits of a DRS and a closed loop recycling system for their businesses. While there is a role for the Czech government in monitoring the performance of the programme and legislating for recycling targets, it is not recommended that they legislate for a specific, prescribed DRS

[77] https://www.ekokom.cz/en/other/our-company

design. This is best determined by the system operator, which will have a financial incentive to develop the most effective and efficient system.

While this study has looked exclusively at PET bottles and metal cans, the system operator, or producers at an earlier stage, could explore options to expand the scope of the DRS to include other beverages, one-way glass bottles, pouches and cartons.

The keys to the success of a DRS are the incentive derived from the deposit level and the convenience of returns; providing the system operator has a financial incentive and legal responsibility to deliver a high recycling rate, they are best placed to develop and adapt the system as, for example, consumer habits change or business practices evolve.

Technical Appendix

A.1.0 Introduction

This technical report provides a detailed account of the process used to assess the costs and impacts of the DRS, summarises the data used and explains the assumptions we have made as part of the modelling process.

A.2.0 Mass Flows

A.2.1 Overview

The first step in a cost benefit analysis of a change in the DRS was to consider the material flows in the Czech Republic, how many beverages are sold, and how the empty containers are currently managed through the waste stream once the beverage has been consumed.

One important factor to consider when looking at the potential impacts of a change in DRS is the assumption about when the analysis takes place. It is very difficult to predict future changes in other assumptions, such as beverage consumption, material values, labour costs etc., and therefore it was appropriate to considering the costs only over one year.

Before modelling the baseline, we consulted with INCIEN and other stakeholders and conducted a literature review of waste data in Czech Republic to understand what data is available. A detailed description of the data used and the resulting waste flows are provided in the following sections.

A.2.2 Beverage Container Sales / Waste Arisings

Data on the consumption of plastic (PET only) bottles and metal cans was sourced from EKO-KOM and Karlovarské minerální vody. Total sales of beverage containers for which a deposit is proposed are estimated at 1,913 million, as shown in Table A 1.

Table A 1: Total Beverage Container Sales in Czech Republic for which a Deposit is Proposed, Million Containers

	Plastic (PET)	Aluminium cans	Steel cans
Total Beverage Container Sales (million containers)	1,562	338	13

Steel cans are used in Czech Republic, however the vast majority of beverage containers are aluminium. Following discussions with EKO-KOM via INCIEN, it was agreed that we would assume that 4% of cans (5% by weight) are steel.

The weights of containers were based on data from EKO-KOM and Karlovarské minerální vody, these are shown in Table A 2.

Table A 2: Average Weight per Container Type, grams

Container	Average weight per container (grams)
Plastic (PET)	31
Aluminium cans	25
Steel cans	35

A.2.3 Current Waste Management

Comprehensive data on the management of PET bottles, from collection to disposal, was sourced from a 2016 material flows analysis.[78] This analysis sets out and quantifies how material is collected, the amount of littering, and the pathways of collected material to final disposal or recycling.

A similar material flow analysis for metal cans was not available and other data sources were used to obtain the required data for DRS modelling i.e. recycling and litter rates. Recycling rates for metal cans were sourced from data provided by EKO-KOM, who estimate a rate of between 25% and 35% based on their expert judgement. [79] Current recycling rates used in our modelling are presented in Table A 3. There is no available data for steel beverage cans with the only available industry data relating to all steel packaging types, not just beverage cans. We have therefore assumed a similar recycling rate as for aluminium cans.

Table A 3: Current Recycling Rates in Czech Republic for Beverage Containers, %

Beverage Container Type	Recycling Rate, %
Plastic (PET) bottles	65%
Metal cans	30%

[78] *Material Flow Analysis of PET bottles in the Czech Republic*, 2016. Source: INCIEN
[79] Private communication with EKO-KOM

For the purposes of estimating the quantity of metal cans littered, we assumed that the littering rate and end destinations (i.e. the proportion of litter collected vs. left in the environment) was the same as reported for plastic. The quantities of litter modelled in the baseline are presented in Table A 4. This is for all litter – the quantities collected and the quantities that remain in the environment.

Table A 4: Model Assumptions for Current Litter Quantities in the Czech Republic, Tonnes[80]

Beverage Container Type	Amount of litter, tonnes
Plastic (PET) bottles	2,460
Steel cans	22
Aluminium cans	421

A.2.4 Material Losses

Material losses occur at both the sorting and reprocessing stages, and these were included in our mass flow model to calculate the total quantity of material that is actually recycled (i.e. the final output from the reprocessor). Loss rates for plastic bottles were taken from the PET material flow analysis, while for metal cans these were based on the average loss rates observed for separate collections from previous waste collection studies conducted by Eunomia. The loss rates used are shown in Table A 5. It is estimated that 8,200 tonnes of PET are lost.

Table A 5: Loss Rate Assumptions

Beverage Container Type	Loss Rate, %
Plastic (PET) bottles	20.3%
Metal cans	1.9%

A.2.5 Deposit Return Scheme Assumptions

Return rates for DRS material are modelled at 90% for all scenarios. The distribution of return rates for plastic and metal are presented in Table A 6. In the PET and metal scenario, figures are based on % differences from the overall rate reported for the

[80] Source: INCIEN

Norwegian DRS and adjusted for the different relative amounts of plastic bottles and metal cans in the Czech Republic.[81]

Table A 6: Modelled Return Rates for DRS

Material	Scenario	
	Plastic and metal	Plastic only
Plastic (PET) bottles	90.3%	90%
Steel cans	88.5%	
Aluminium cans	88.5%	
Overall	90%	90%

Of the 10% of material not collected via the DRS, we have assumed that, after accounting for litter, roughly equal amounts of material will be collected as residual waste and through non-DRS recycling collections.

An 80% reduction in litter is also assumed following implementation of the DRS. This is a conservative estimate based on a comparative review of the effect of DRSs on littering behaviour.[82] All remaining material is managed by mixed waste collections conducted by municipalities.

A.2.6 Waste Flow Summary

Summaries of the beverage material flows used for modelling are provided in Table A 7 and Table 6-2Table A 8 below.

[81] Infinitum (2016) *Annual Report 2016*

[82] Eunomia (2017*) Impacts of a Deposit Refund System for One-way Beverage Packaging on Local Authority Waste Services*, 11th October 2017

Table A 7: Summary Material Flows - Plastic Only Scenario

	Baseline		DRS	
	Tonnes	%	Tonnes	%
Put on the market (incl. free riders)	49,446		49,446	
Collection[83]				
DRS returns (including cross border)	0	0	44,630	90.3
Other collection routes & littered	49,446	100.0	5,262	10.6
Final Destination				
Recycled	32,148	65.0	46,324	93.7
Residual disposal (landfill & incineration)	16,068	32.5	3,322	6.7
Litter that remains in the natural environment	1,230	2.5	246	0.5
Recycling Rate, %		65.0%		93.7%

Table A 8: Summary Material Flows - Plastic + Metal Scenario

	Baseline (Tonnes)			DRS (Tonnes)		
	Plastic	Metal	Total	Plastic	Metal	Total
Put on the market (incl. free riders)	49,446	8,900	58,346	49,446	8,900	58,346
Collection						
DRS returns (including cross border)	0	0	0	44,630	7,881	52,511
Other collection routes & littered	49,446	8,900	58,346	5,262	1,098	6,360
Final Destination						

[83] Total in the DRS scenario exceeds 100% due to inclusion of cross-border containers

	Baseline (Tonnes)			DRS (Tonnes)		
	Plastic	Metal	Total	Plastic	Metal	Total
Recycled	32,148	2,670	34,818	46,324	8,217	54,541
Residual disposal (landfill & incineration)	16,068	6,008	22,076	3,322	717	4,039
Litter that remains in the natural environment	1,230	221	1,451	246	44	290
Recycling Rate, %	65.0%	30.0%	59.7%	93.7%	92.3%	93.5%
Litter Rate, % (Remaining in environment)	2.5%	2.5%	2.5%	0.5%	0.5%	0.5%

A.3.0 DRS Model

The DRS model calculates the overall system resources and costs from implementing a DRS. The component parts of the model include:

- Modelling of the retailer landscape: numbers of containers collected and the distribution of returns to participating stores;
- Estimation of retailer costs in order to estimate the handling fee required to compensate retailers for their costs in receiving containers;
- Estimation of the costs of collecting DRS containers from participating retailers, and onward haulage costs;
- Estimation of counting centre costs;
- Estimation of material revenues obtained from sold recyclate;
- Estimation of central administrative costs of the system; and
- Estimation of unredeemed deposits.

A.3.1 Retail Landscape

The number of retailers and RVMs assumed are outlined here.

For the Czech system most retail outlets and businesses in the food service (HORECA) industry (restaurants, cafes, hotels, bars etc. – for the containers they sell on the premises only) will be part of the DRS scheme. We have assumed that some exemptions might exist in the DRS legislation, for example, stores below a certain size, or that are in close proximity to larger retailers, and that these exemptions will only affect smaller retail shops and HORECA businesses. As shown in Table A 9, this means that only 88% of retailers under 50m[2] and 88% of petrol stations are assumed to provide a formal take-back service, and consequently require collections organised by the DRS system operator. For example, a shopping centre may have several beverage retailers, so it may make sense for the retailers in the centre to group together and support RVMs in a communal part of the shopping centre, rather than each one taking back containers and requiring collections.

The estimate of the numbers of stores taking up RVMs was based on experience from other DRS systems. The key factor in installing RVMS is the number of containers redeemed per day (throughput), which needs to be high enough for RVMs to become appealing to most retailers. A higher throughput creates a greater incentive for retailers to automate the redemption process, and also means that stores are more rapidly compensated (via handling fees) for the capital cost of purchasing an RVM. Thus larger shops, which have a greater throughput of containers, will almost all install RVMs, while, at the opposite end of the size spectrum, small retailers and most HORECA businesses are unlikely to install RVMs. In the case of HORECA, this is particularly unlikely because consumers are not actively returning used containers to them.

The number of RVMs per retailer was estimated based on industry estimates of the optimum throughput per RVM. This will ensure there are sufficient numbers of RVMs to cope with the large volume of PET bottles assumed to be redeemed through the RVM network.

Table A 9: Numbers of Retailers and RVM take-up

Retailer Type	Number of Retailers	% Requiring Collection	% Using RVM vs Manual	RVMs Per Retailer
Hypermarkets > 2500 m2	320	100%	100%	3 (PET only) 2.5 (PET + Metal)
Supermarkets 401-2500 m2	1,351	100%	95%	1.25
Med / large groceries 51-400 m2	6,891	100%	10-15%	1
Small groceries < 50m2	5,464	88%	2.5%	1
HORECA	33,596	75%	0.16%	1
Petrol stations	2,305	88%	2.5%	1

Source: Number of retailers – Private communication with Karlovarské minerální vody

The distribution of returned containers between different kinds of stores was based on detailed sales distribution data (Table A 10). A simplifying assumption is made that containers will be returned to the same type of store as they are purchased from. There is one exception made to this assumption for cans returned to petrol stations. The data suggest that 20% of all cans are returned to petrol stations. This value is judged to be much too high, and so instead it is assumed that the % of metal can returns to petrol stations is the same as for plastic.

Table A 10: Distribution of Container Returns, %

Retailer Type	Plastics Bottles	Metal Cans
Hypermarkets > 2500 m2	35.5%	30.9%
Supermarkets 401-2500 m2	40.0%	30.2%
Med / large groceries 51-400 m2	11.3%	21.8%
Small groceries < 50m2	4.0%	7.9%
HORECA	5.0%	5.0%
Petrol stations	4.1%	4.1%

A.3.2 Retailer Costs

The costs of handling containers at retail outlets is borne by the retailers themselves, reimbursed through the handling fee.

Retailer costs modelled to estimate the level of the handling fee required fall into three main areas:

- The costs for purchase and maintenance of RVMs;
- Costs of staff time in various activities relating to maintaining RVMs, material receipts, receiving manually returned containers and overseeing pick-ups; and
- Storage/space costs for RVMs and storage of collected containers.

Key assumptions for costs involved in RVMs are set out in Table A 11 below.

Table A 11: RVM Cost and Resource Assumptions

Retailer Type	Key Assumptions
RVM cost	€20,000 (small) - €28,500 (large) annualised over seven years. €2,000 installation fee €2,500 annual operating and maintenance Backroom adaption costs (8% of capital costs) Renovation every five years *Total cost of average €8,100 per RVM per annum*
Space Required[84]	4m^2 per RVM
Staff Time (cleaning, emptying bins, operating)[85]	Average of 11 hours per month per RVM

The costs are modelled on the basis that all RVMs will have compactors fitted – this considerably improves the efficiency of collections (and lowers the cost) as more material can be collected in one vehicle load, due to the higher material density when compacted. We are also informed that there are approximately 500 RVMs which are currently used for refillable glass containers. These could be converted to collect PET and cans and therefore obviate the need to purchase a new RVM at these locations. A conversion cost of €3,000 was modelled.[86]

For manually collected containers, it is assumed to take 48 seconds to take back 15 containers, whereas only 3 seconds to process a receipt from an RVM.

[84] Based on discussions with RVM manufacturer
[85] Assumption following discussions with DRS operators in Europe
[86] Private communication with Karlovarské minerální vody

Storage space capacity is assumed to be $10m^2$ for hypermarkets, $6m^2$ for supermarkets, $4m^2$ for medium and large grocery shops, $2m^2$ for small grocery shops and petrol stations and $1m^2$ for HORECA businesses.

The time spent by retail staff assisting with DRS collections is assumed to vary from 5 mins (for HORECA businesses) up to a maximum of 20 mins (for hypermarkets).

Staff time and storage space are translated into costs, assuming:

- An average retail staff cost of €3.89 per hour;[87] and
- An average rental cost of €11.50 per m^2 per month, a conservative rental cost based on reviewing costs in different city regions.

A.3.3 Logistics and Costs of Collection

A simple collection model was developed to estimate the number of vehicle days required per annum to collect the containers, and the cost of operation per vehicle. The costs of collection are built up by calculating the number of vehicles required to collect from stores, based on:

- A certain frequency of collection for stores of different sizes (or when storage space is full);
- The volume collected per pick-up from stores (and therefore how many stores can be collected from before the material needs to be taken to the drop-off location);
- The time taken to travel between stores and back to the depot; and
- The total capacity of the vehicle.

These are run through the collection resource calculation to work out the number of vehicles required in total to collect the material. The costs are comprised then of:

- Vehicle capital and maintenance costs (see below);
- Fuel costs (based on average calculated distances travelled on the rounds, assumed vehicle fuel efficiencies and a cost of diesel of €1.18);
- Labour costs, based on an hourly rate of €5.04/hr; and
- Overheads/contingency of 10%.

The bulk density of the material changes depending on whether or not cans and bottle are compacted in RVMs. Storage space remains the same, so the modelled impact of RVMs is to reduce the required frequency of collection from stores in addition to increasing the tonnage that can be collected on one load, making collections more efficient.

[87] Private communication with Karlovarské minerální vody

The bulk densities of the containers are assumed as follows:[88]

- Plastic bottles – 36 kg/m^3 compacted and 20 kg/m^3 un-compacted;
- Cans – 80 kg/m^3 compacted and 30 kg/m^3 un-compacted;

It is assumed that a fleet of 12 tonne trucks would be purchased for collections, with the following specifications:

- Capacity - 39.5m^3
- Capital cost - €70,000
- Maintenance - €7,000 per annum
- Fuel efficiency – 3.8 km/l

Vehicle costs are annualised over 9 years at 5% interest.

Collection logistics are modelled separately for large (hypermarkets and supermarkets) and small retailers. This setup was found to be the most efficient: a greater quantity of material is collected per pickup on the 'larger retailer' round (Table A 12), this fills the vehicle to capacity quicker and means that two collection rounds are possible in one day.

Table A 12: Logistics Assumptions (Outputs from Distance Analysis)

	Larger Retailers	Small Retailers
Average volume per pickup (m^3)	7.4	0.9
Travel time between retailers	20 minutes	8 minutes

It is assumed that material will be collected from stores once their storage space is full. Collections are set to take place at least once every 4 weeks or more frequently. The number of pickups per week modelled for each retailer type are presented in Table A 13.

Table A 13: Number of Pickups per Week

Retailer Type	Number of Pickups per Week
Hypermarkets > 2500 m2	2.46
Supermarkets 401-2500 m2	1.14
Med / large groceries 51-400 m2	0.25
Small groceries < 50m2	0.25
HORECA	0.25

[88] Private communication with TOMRA

Petrol stations	0.40

The time spent collecting material at a retailer varies with store size and is modelled to be consistent with the assumptions detailed in Section A.3.2.

The total number of 12 tonne trucks required is estimated at 113 when only plastic is collected, and 117 for a DRS that covers both plastic and metal cans.

Separately, the costs of containers are calculated based on use of single-use sacks for the collection of plastic bottles and cans, at a purchase cost of 30 cents per bag. It is estimated that 5 million bags would be required per annum if only plastics were collected, and 6.1 million if the DRS also included metal cans.

A.3.4 Haulage

The 12 tonne truck rounds are assumed to be regional – each of the 14 regions having a vehicle depot in a central location. From here on, it is assumed that uncompacted material, which requires further counting, is hauled in large trucks from these centres to one of two counting centres (see Section A.3.5), where the material is counted and baled ready for reprocessing.

The compacting process in RVMs renders the barcode on beverage containers un-readable. In doing so the possibility of double counting is eliminated and therefore there is no need to recount the container at a counting centre. Compacted plastic and cans are therefore assumed to be baled at the regional depots and transported directly to reprocessors.

The total volume, number of trips needed and distance is calculated from modelling the percentage of containers collected in each regional depot (based on the population of these regions), and applying approximate transport distances mapped on google maps. Haulage for uncompacted material from regional depots to counting centres is costed at €1.74/km.[89]

A.3.5 Counting Centre and Processing Costs

A counting machine is an automated machine which, put simply, counts and registers used beverage containers that have been collected manually by an individual retailer. They are high-speed devices which accept a commingled stream of beverage containers as their input. Any container included in the system, be it plastic or metal can be recognised by the machines. The barcode on each container is scanned, and the

[89] Private communication with Karlovarské minerální vody

information is uploaded onto a database in order for the central system to determine what deposits and handling fees need to be paid to which retailers.

An analysis was conducted to determine how many counting centres should be modelled – with options including one large central counting centre, or 2 or more counting centres distributed strategically across the country. The analysis clearly demonstrated that 2 counting centres proved the most economical. The reduction in haulage distance with 2 counting centres was considerable (approximately halving the average distance compared to a scenario with one central counting centre) and the resulting saving more than compensated for the additional cost of building another counting centre. With three counting centres the further reduction in haulage distance is minimal, and the additional costs of building another facility leads to a net increase in costs compared to a two counting centre model. Assuming that one counting centre is situated in or just outside Prague, we tested a few potential sites for the other centre with the aim of minimizing haulage distances from the surrounding regions. This analysis concluded that Olomouc would be a good potential location for the second counting centre.

The costs modelled at the central counting centre, and the assumptions underlying these costs, are listed below in Table A 14.

Table A 14: Counting Centre Costs

	Assumption	Total Annual Cost	
		Plastic only	Plastic and metal
Investment	3 or 4 counting machines (plastic only / plastic and metal scenarios) and two compactors and balers, annualised over 5 years at 5% interest	€316,000	€351,000
Cleaning and Maintenance	€2,000 maintenance contract cost & 2 hours per day maintenance labour	€13,700	€18,300
Power consumption	Based on operating time and power consumption under load, at €151/MWh	€73,100	€76,500
Other Labour	26 staff members, enough to have 1.5 staff per machine at all operating hours	€101,000	€135,000

	Assumption	Total Annual Cost	
		Plastic only	Plastic and metal
Rent	€54 per m^2 per annum, space requirement of 7,000 m^2 including space for delivery bay, bulking, storage, office space etc + 100m^2 space per counting machine	€772,000	€778,000
Other	Supplies	€2,000	€2,000
Total		**€1.28 million**	**€1.36 million**

A.3.6 Material Revenues

Material revenues are calculated from the tonnages of collected containers sold into the market, having been bulked or baled at the counting centres and regional depots.

Material revenues for PET bottles were obtained from discussions with reprocessors in the Czech Republic. A value of €397 per tonne was used, based on the costs for each PET type and market shares shown in Table A 15.

Table A 15: PET Market Shares and Material Revenues

PET type	Material revenue, € per tonne	Market share, %
Transparent	€ 550	38%
Blue	€ 340	35%
Green	€ 340	15%
Brown, Orange	€ 195	5%
Colour Mix	€ 117	7%
Overall	€ 397	N/A

Prices for aluminium and steel cans were based on average prices from a review of European markets, using data sources from WRAP and MRW (UK markets) and EUWID (predominantly the German market).[90] [91] The EUWID Market data cannot be reproduced due to copyright restrictions but can be accessed at the EUWID website.[92] The prices used for modelling were derived from the mid-point of the minimum and maximum prices seen over the last 5 years – using a longer time series of data is necessary as secondary material markets are fairly volatile over shorter time periods. The final values used for modelling were €905 per tonne for aluminium and €127 per tonne for steel.

A.3.7 Unredeemed Deposits

One source of revenue to help fund the system is the value of the deposits that have been paid by consumers but not collected. In a system with a return rate of 90%, 10% of the total deposits in the system will be kept by the central system operator.

A.3.8 Central Operating Costs

The central system requires administration, for tasks including:

- Maintaining and administrating the IT system that underlies the recording and processing of information to keep track of deposit and handling payments due and paid across the network;
- Carrying out the resulting invoicing/payments;
- Producing and promoting communications and marketing for the system;
- Combating fraud; and
- Central system operator company administration, management and governance.

The costs assumed for this central administration are outlined below in Table A 16.

[90] http://www.wrap.org.uk/content/materials-pricing-report
[91] https://www.mrw.co.uk/materials/weekly-prices
[92] https://www.euwid.de/en/

Table A 16: Central Administration Costs

Cost Component	Assumption	Total Annualised Cost
Set-up Cost	€820,000 set-up cost (400,000 on IT, 300 on communications, 120 on project management and office set-up)	€141,000
Office	300m^2 office based on €15.18 per m^2 per month	€54,600
Staff	11 FTE	€238,000
Admin, IT, Legal	Including ongoing license for and maintenance of IT system	€350,000
Marketing		€150,000
Total		**€935,000**

A.4.0 Container Collection Modelling

A.4.1 Assumptions

Assumptions used in the modelling are based on data provided by INCIEN and EKO-KOM. Where specific data was not available, Eunomia assumptions based on standard industry assumptions or from the European Reference Model on Municipal Waste Management are used.

The container collection model includes costs for:

- Resources;
- Container costs;
- Sorting costs;
- Bulking and haulage costs; and

- Estimation of change in material revenues obtained from sold PET or in disposal costs of mixed waste (includes households without communal container collections).

The model first calculates the frequency of collections required. It then models the resources required to collect at this frequency. The frequency of collections depends on:

- The number of containers per site (1 for plastics, 2 for mixed waste);
- The number of households served per site (Table A 17);
- The yield of material per household (Table A 18); and
- The fill-rate before the container is emptied (76%).

The number of vehicles required then depends on the above and:

- Time taken to travel between sites and to tip;
- The capacity of the vehicle.

The resource costs are comprised then of:

- Vehicle capital, insurance and maintenance costs (see below);
- Fuel costs (based on average calculated distances travelled on the rounds, assumed vehicle fuel efficiencies, shown in Table A 17, and a cost of diesel of €1.18); and
- Labour costs (based on an hourly rate for drivers of €5.04/hr and for loaders of €4.58).

All vehicles are assumed to be 26 tonne trucks, with the following specifications:

- Capacity (weight) – 11 tonne
- Capacity (volume) – 23m^3
- Capital cost – €190,000
- Maintenance – €19,000 per annum
- Insurance – €9,500 per annum

Vehicle costs are annualised over 9 years at 5% interest.

For material revenues/disposal costs, gate fees, bulking and haulage, and sorting costs, it is assumed that:

- Mixed waste gate fee (including landfill tax) – €26.10;
- PET – 80% is sold as high-grade PET at an income of €397 (as in Table A 18 above), the rest goes into either lower grade material or to disposal and is assumed to net to no value;
- Bulking and haulage – €10 per tonne; and
- Sorting cost (recycling only) – €100 per tonne.

The bulk density of the material in the plastics vehicle increases by 41% when the DRS is in place because PET does not compact as well as the rest of the mixture.

Table A 17 lists the assumptions that change by rurality. Regions were classified as urban, semi-urban and rural depending on their population density. This was used to calculate the number of households within each rurality classification. It is assumed that containers in more rural areas serve fewer households and so fewer container washes are required. Furthermore, increased container lifetime is possible because these containers are emptied less frequently.

Table A 17: Container Collection Assumptions that Change by Rurality

	Urban	Semi-Urban	Rural
Bring Site Density (Households/Site)	75	38	19
Fuel Efficiency (km/l)	1.4	1.4	1.8
Container Washes	8	7	4
Container Lifetime	10	14	20

Table A 18: Yield of Material Collected (kg per household per year)

	Baseline	DRS (plastic only)	DRS (plastic & metal)
Plastic	31	23	
Mixed Waste	634	633	631

A.4.2 Detailed Results by Rurality

Table A 19: Average Collection Frequency in Days Between Collections

	Housing Density	Baseline	DRS (plastic only)	DRS (plastic & metal)
Plastic	Urban	2.5	3.4	
	Mixed	4.9	6.8	
	Rural	9.8	13.6	
Mixed Waste	Urban	1.5	1.5	1.5
	Mixed	3.1	3.1	3.1
	Rural	6.1	6.1	6.2

Table A 20: Average Number of Sites Visited per Vehicle per Day

	Housing Density	Baseline	DRS (plastic only)	DRS (plastic & metal)
Plastic	Urban	138	166	
	Mixed	138	150	
	Rural	114	114	
Mixed Waste	Urban	106	106	106
	Mixed	105	105	105
	Rural	93	93	93

A.5.0 Environmental Impacts

A life cycle assessment of the environmental impacts of production, collection and disposal of DRS materials was conducted by the University of Chemistry and Technology, Prague. The outputs of this work include the quantity of emissions of greenhouse gases and other air pollutants caused by these activities in the baseline scenario and in the DRS. Here we describe our approach to valuing these impacts.

There is also a need to consider the environmental impacts of litter. There is a dearth of relevant studies allowing the valuation of the disamenity associated with litter, but it is simply too important, in our view, to be assigned (implicitly) a zero value. Our approach is set out in Appendix A.5.3.

A.5.1 Greenhouse Gas (GHG) Valuation

Greenhouse gas valuation is based on estimates of the damage cost of carbon used by the European Environment Agency (EEA) to value the climate impacts of rulemakings. The damage cost is a measure, in Euros, of the long-term damage caused by a ton of carbon dioxide or equivalent (CO_2e) emissions in a given year. This Euro figure also represents the value of damages avoided for a small emission reduction (i.e., the benefit of a CO_2 reduction).

The approach used in this study is the same used in the cost benefit analysis of landfill bans undertaken by Eunomia; full details of the calculations used can be found in the appendices of the document.[93]

Estimates of the social cost of greenhouse gases increase over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change, and because GDP is growing over time and many damage categories are modelled as proportional to GDP.

Given that the benefits associated with GHG emissions reduction are posited to increase in the future, the year in which the modelling is set will affect the overall monetised value of emissions. Ideally we would model waste flows over time, apply the correct value year-by-year, and calculate the net present value of the total benefits. Given that the study is forward looking, it seems sensible to choose a year, not too close, but not too far ahead. The value for 2020 have thus been used in the calculation of greenhouse gas associated damage costs. We have used the official EEA value of €32 per tonne of CO_2e. The impacts of the two other major greenhouse gases – CH_4 and N_2O – have also been calculated, using multipliers of 25 and 298 respectively (relative to the cost of carbon).

A.5.2 Air Quality Valuation

We have considered the impacts upon air quality that are expected to result from the treatment processes, including both direct and indirect impacts (the latter relating to avoided impacts associated with energy generation and the recycling of materials).

Our approach is to apply external damage costs to emissions of a range of air pollutants, allowing for the quantification of impacts in monetary terms.

The analysis that follows is focussed upon emissions to air. Whilst waste treatment processes may also in some cases affect soil and water quality, data regarding the precise nature of these impacts is less robust, and valuation data is scarcer still.

The Czech specific damage costs used in this study are sourced from the European Reference Model on Municipal Waste Management, with the methodology based on previous work conducted by the EEA.[94,95] We have focused on the main types of air emissions, that is, those for which robust valuation data exists, and which account for the vast majority of emissions (Table A 21).

[93] Eunomia (2010) *Landfill Bans Feasibility Research*, Final Report for WRAP, March 2010, http://www.wrap.org.uk/downloads/FINAL_Landfill_Bans_Feasibility_Research.f5cf24f9.8796.pdf

[94] Eunomia (2016) *Support to the Waste Targets Review*, Report for DH Environment, July 2016

[95] The methodology used is summarised in: European Environment Agency (2011) Revealing the Costs of Air Pollution from Industrial Facilities in Europe, EEA Technical Report No 15/2011, November 2011

Table A 21: Air Damage Cost Assumptions

Compound	Damage Cost, € / tonne (2018 prices)
NH3	€ 25,766
NOx	€ 11,258
PM2.5	€ 27,147
PM10	€ 17,627
SO2	€ 11,012
VOCs	€ 631
Arsenic	€ 469,972
Cadmium	€ 38,003
Chromium	€ 50,671
Nickel	€ 5,194
1, 3 Butadiene	€ 633
Benzene	€ 101
PAH	€ 1,665,803
Formaldehyde	€ 279
Dioxins/furans	€ 35,469,562

A.5.3 Litter Disamenity

A number of studies have sought to quantify, in monetary terms, the 'welfare loss' – i.e. the extent to which citizens are negatively impacted – from the existence of littered items in their local neighbourhood. This welfare loss is often referred to as the 'disamenity' arising from litter – much of which is considered to be due to the 'visual disamenity' which is understandable given that litter can transform the look and feel of a place.[96] The studies have typically sought to place a monetary value on this disamenity through determining the amount that respondents would be willing to pay for a marginal improvement from the current situation, in terms of a proportional reduction in the levels of litter.

It is possible to measure litter by weight, number of items and volume. However, it is likely that visual disamenity is most closely related to the overall volume of litter, which depends both on the number and unit volume of littered items, rather than the weight, or only the number. While litter is composed of a number of different materials and items, of which single use plastics will comprise a proportion, there is no research available, to the best of our knowledge, on how the impact varies by material and item type.

In a recent study for DG Environment of the European Commission, Eunomia calculated the overall willingness to pay for reduced litter on land at the European level as follows:

Drawing on what we consider to be the best available study, the Wardman et al. (2011) study, in order to establish the overall disamenity associated with local land-based litter across the EU, we first take the unweighted average of a 'to best' improvement across the area types (inner-city, suburban, rural).[97] This equates to €16.50 per adult per month in 2011. Inflated to 2018 values, this is equivalent to €18.62 per month in 2018 values, or €244 per adult per year.[98,99]

We then scale this figure across each Member State based on per capita GDP adjusted by purchasing power parity (PPP). Ideally, we would have detailed analyses of litter composition and prevalence across all EU Member States to use in scaling the disamenity values. However, there are very few composition analyses and those available are not readily comparable. Accordingly, it is appropriate to simply scale by PPP-adjusted GDP, noting that the figure may lead to a slight overestimate in some less-littered locations, and an under-estimate in other more-heavily littered locations.

It is important to note that the calculated disamenities relate only to neighbourhood disamenity, and do not cover the impact of litter that might be found on journeys to areas beyond one's neighbourhood, such as on walking excursions for example. Therefore, these estimates do not provide a complete picture of the total land-based disamenity associated with littered items. Indeed, in terms of neighbourhood litter, citizens may to an extent start to see this as somehow 'normal' (while still having a

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[96] The association between a littered environment and perception of public safety / fear of crime is an example.

[97] Mark Wardman, Abigail Bristow, Jeremy Shires, Phani Chintakayala and John Nellthorp (2013) Estimating the Value of a Range of Local Environmental Impacts, Report for Dept. for Environment, Food and Rural Affairs, 1 April 2011, available at http://randd.defra.gov.uk/Document.aspx?Document=9854_LEQFinal.pdf

[98] UK GDP deflators at market prices, and money GDP December 2017 https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-december-2017-quarterly-national-accounts

[99] Converted from Sterling to Euros at an exchange rate of €1.13:£1

strong preference for it not to be there). However, for litter encountered on a walking trip in a beautiful area, for example, the sense of upset, and indeed potentially anger, that might be experienced when littered items are encountered, might be proportionally higher than when it is seen in a day-to-day context.

Proportional reductions in disamenity will be calculated linearly based on anticipated reductions in volume. In respect of land-based litter, to assume a linear reduction (given the argument of diminishing returns) could well be to underestimate the benefit of such reductions – especially given that they will be of beverage containers. However, we take this approach in order to derive a conservative estimate.

The calculated litter disamenities for the Czech Republic are €135 thousand per tonne for terrestrial litter. While there are also values we could attribute to marine litter, given that litter from the Czech Republic can be transported to the marine environment via rivers, we have excluded the estimated reduction in marine litter from this analysis. This is because the benefits in terms of marine litter may not be solely accrued by the Czech Republic but may be perceived as global impacts.