ECOCYCLES
ISSN 2416-2140

OPEN ACCESS
Scientific journal of the
European Ecocycles Society


**Ecocycles**, Vol. 11, No. 2, pp. 51-66 (2025)
**DOI**: 10.19040/ecocycles.v11i2.593

**RESEARCH ARTICLE**

# Assessing international Deposit-Refund Systems: Lessons and transferable practices for Hungary

**Aliz Vuk[1*], Andrea Bauerné Gáthy[2]**
[1] *Institute of Economics, Doctoral School of Management and Business, University of Debrecen, Debrecen, Hungary*
[2] *Institute of Economics, Faculty of Economic and Business, University of Debrecen, Debrecen, Hungary*
**Corresponding author's email: vuk.aliz@econ.unideb.hu*

***Abstract*** – In recent decades, the steady increase in plastic packaging waste has presented humanity with an increasingly difficult challenge. In order to solve the waste management problem, a deposit refund system is one option that has been proposed. This system was introduced in Hungary on January 1, 2024. In order to improve this system, our study aimed to collect good practices from countries that have been using DRS for a long time. To this, we conducted a comparative analysis of the six countries (Sweden, Iceland, Finland, Norway, Denmark, Germany) that have been using the system the longest. We examined plastic waste and its recycling rate, recycling and return rates, the number of return points per capita, the relationship between average wages and deposit fees, and the types of systems. Finally, we compiled a list of best practices and highlighted those that we believe could be used to improve the Hungarian system. This includes the convenient location and smooth operation of vending machines, communication with consumers, the involvement of multiple actors, and the use of mobile collection points.

***Keywords*** – Deposit Refund System, Best practices, Hungary

**Received**: August 05.2025 **Accepted:** November 16.2025

## 1. INTRODUCTION

Over the past 10 years, the volume of packaging materials has increased by 25% and is expected to grow by another 19% by 2030. Plastic packaging accounts for 47% of packaging materials, representing 40% of plastic demand (Council of the EU, 2023). Plastic packaging itself contributes significantly to the environmental impacts associated with the linear plastic production and consumption system due to the prevalence of short-lived, single-use packaging. The linear plastic model causes, among other things, raw material shortages, fluctuations in energy markets, supply dependency, and increasing amounts of waste and pollution. The amount of plastic waste from packaging is gradually increasing, despite the fact that the recycling rate for plastic waste has increased in the EU (64% in 2021). The volume of plastic waste from packaging is expected to increase by 46% by 2030 (Council of the EU, 2023). These complex and interdependent challenges require holistic approaches that need to be designed and implemented with the involvement of various stakeholders. In terms of EU regulations, Directive 94/62/EC (2020) on packaging and packaging waste was the first to be adopted and has been revised several times. This Directive lays down rules for EU Member States to ensure that packaging placed on the EU market complies with certain requirements, with a view to preventing and managing packaging waste and achieving recycling targets for different types of packaging waste. However, numerous evaluations of the directive have shown that it has not succeeded in reducing the negative environmental impact of packaging (European Commission, 2022). This directive was followed by several others, such as Directive 2008/98/EC (2008): Waste Framework Directive, Directive 2018/851/EC (2018): Extended Producer Responsibility Schemes, and Directive 2019/904/EC (2019): Single-Use Plastics Directive. Then came the action plan for the circular economy (European Commission, 2020), the Green Deal. In November 2022, the European Commission presented a proposal for a regulation on packaging and packaging waste, which would replace the existing directive. In addition, targets have been set for separate collection (77% by 2025 and 90% by 2029) and for the use of recycled PET (25% of products should be made from recycled PET by 2025 and 30% by 2029) (Callewaert et al., 2023).

The deposit refund system (DRS) is an alternative policy instrument for extended producer responsibility in waste management. The DRS system typically means that consumers pay a deposit on beverage containers, which is refunded when the packaging is returned to designated collection points. The system is based on offering consumers an economic incentive to return empty bottles to designated stores to ensure that they are reused or recycled. In the case of beverage bottles, these systems are already in use in more than 40 regions around the world and have achieved excellent results. As a way of ensuring extended producer responsibility, DRS is effective in redirecting waste streams from final disposal to reuse or recycling (ZeroWasteEurope, 2019, Lorang et al., 2022).

Among European countries, only 13 had DRS in place by 2007 (*Figure 1*), with Lithuania being the only new addition in the following 14 years, in 2016. Subsequently, starting in 2022, its introduction began gradually in several countries, and in some countries the idea of introducing DRS was put on the agenda. The country that has been using DRS the longest is Sweden (1984), followed by Iceland (1989). However, some countries have opted for alternatives to DRS. In Italy, Coripet (a consortium of PET packaging manufacturers) launched eco-compressors and has installed more than 800 since 2021. Eco-compressors identify packaging based on the barcode on the bottle, and anyone who deposits a PET bottle in one of these machines receives points that can be exchanged for discounts in stores and prizes (Buzzoni, 2023). Abejón et al. (2020) analyze in their article whether it would be worthwhile to replace the current EPR system with DRS in Spain. They conclude that the commercial structure in Spain and the specific characteristics of the outlets selling beverages are the result of factors that may differ from the situation in other European countries, and that it would therefore not be appropriate to introduce the DRS. A study by Cabot (2024) shows that France does not consider DRS to be an effective solution from an environmental perspective, preferring instead to introduce a reuse fee. .

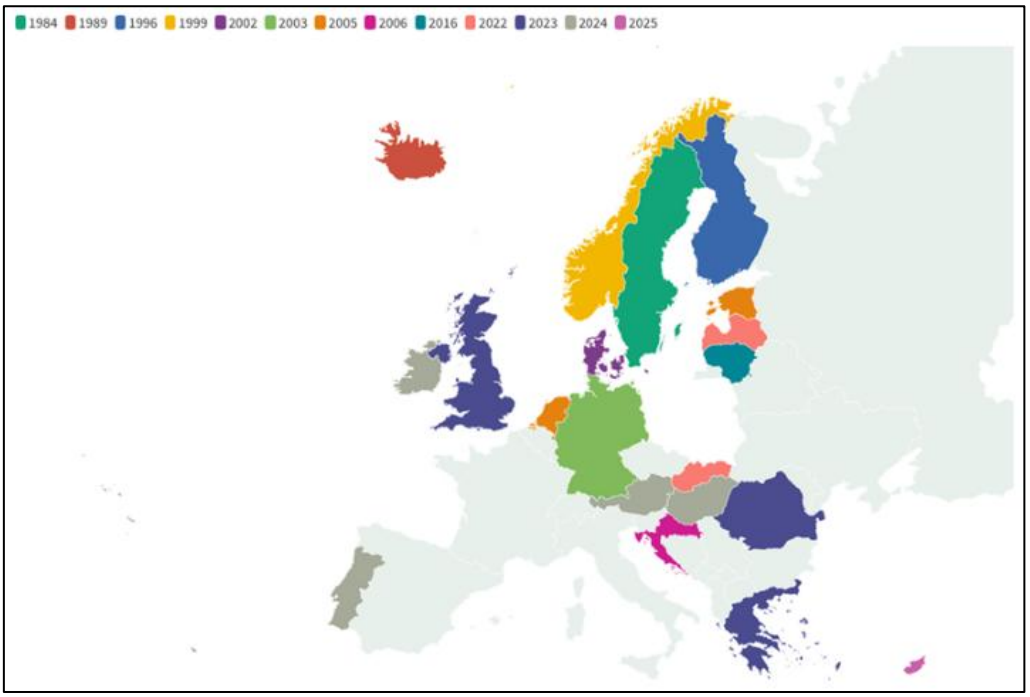


**Figure 1 Timing of DRS introduction in European countries**

*Source: Author's own contribution based on SENSONEO (2024)*

The aim of our research is to present good practices from countries that have been using DRS for a long time, which can be used to improve the Hungarian system. We formulated two research questions, which are as follows:

Question 1: What best practices have helped countries to implement DRS more effectively?

Question 2: What are the similarities and differences between the Hungarian deposit refund system and the DRSs of the countries studied?

## 2. METHODOLOGY

Assuming that the six countries with the longest operational history of using a DRS system are those with the most experience, we analysed in detail the specific features and effectiveness of the systems operated by Sweden, Iceland, Norway, Finland, Denmark and Germany.

To get a better idea of how effective they are, we looked at data from different statistical databases and reports. In many cases, not all the necessary data was available because the collection of data related to DRS may not be operational in the selected country. The methods we used and the databases we utilized are summarized in the following table (*Table 1*).

This study considers the estimation technique used, Maximum Likelihood Estimation (MLE), in SEM data analysis using AMOS software. According to Hair's view in Ghozali, the MLE method is estimated to provide effective results if applied to samples between 150 and 400 respondents (Haryono, 2016). Several pieces of literature have shown recommendations regarding the size of the SEM analysis sample with MLE estimation. Loehlin (2004) suggests that the minimum sample size needed to reduce bias in all types of SEM estimation is 200 respondents. Sarwono (2010) recommends that the ideal sample size ranges from 200 to 400. In 1996, James P Stevens, in his book entitled Applied Multivariate Statistics for the Social Sciences, provided guidance that the sample size for MLE estimation should be at least 15 times the number of variables observed (Religia, 2023), while Bentler & Chou (1987) suggested that the sample size should be at least five times the number of free parameters in the model used..

**Table 1 Summary table of methods used**

| | | | |
|---|---|---|---|
| 1. | Quantity of plastic packaging waste | Eurostat | Methodology: "*This indicator includes plastic packaging waste. 'Packaging' in this context means all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer. 'Non-returnable' items used for the same purposes shall also be considered to constitute packaging. 'Packaging waste' means any packaging or packaging material covered by the definition of waste in the Waste Framework Directive 2008/98/EC, excluding production residues (Art.3(1): 'waste' means any substance or object which the holder discards or intends or is required to discard).*" (Eurostat, 2024a) |
| 2. | Quantity of recycled plastic packaging | Eurostat | Methodology: "*The indicator is defined as the share of recycled plastic packaging waste in all generated plastic packaging waste. Packaging waste covers wasted material that was used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer, excluding production residues. The ratio is expressed in percent (%) as both terms are measured in the same unit, namely tonnes. Recycling rate of plastic packaging waste counts exclusively material that is recycled back into plastic (material recycling / generation).*" (Eurostat, 2024b) |
| 3. | Rates of recycling and return | Dansk Retursystem | |
| | | Swedish Statistics Office | Methodology: "*Observation "Recycling, percent" is calculated by dividing the recycled amount of packaging by the amount of packaging put on the market*." (Swedish Environmental Protection Agency, 2022) |
| 4. | Rates of return of packaging required by the DRS | SENSONEO | |
| 5. | Relationship between return points and the population | Reloop report | |
| | | World Bank datas | |
| 6. | The amount of the deposit in terms of average wages | International Monetary Fund datas | |
| 7. | Comparison of DRS types | Calabrese et al. (2021) | |

*Source: Author's own contribution, 2025*

The following chapter presents examples of the six countries that were the first to introduce DRS and the experiences gained so far in Hungary.

## 3. EXAMPLES

### 3.1 The cases of the first countries to introduce DRS

#### *3.1.1 Background to the introduction of DRS in Sweden*

In Sweden, negotiations on the introduction of mandatory DRS for single-use aluminium packaging began in the late 1970s, resulting in an increase in the number of single-use packages and a decrease in the use of refillable glass packaging. A voluntary deposit system for refillable glass packaging had been in place since 1886. Social pressure, the failure to meet the government's 75% recycling target, and the fact that pilot projects successfully demonstrated that there were no hygiene risks played an important role in the introduction of DRS. In 1982, Returpack was established as the operator of the DRS. DRS was first used on aluminium

cans (from 1984), then extended to PET bottles 10 years later (in 1994). The original legislation specified the materials 'aluminium' and 'polyethylene terephthalate', but this was changed to "metal" and 'primarily polymeric material' (Suter, 2019). The deposit obligation does not apply to beverages containing at least 50% milk, vegetable, fruit or berry juice. However, since 2015, syrup producers have been able to join the scheme voluntarily, and since 2018, fruit juice producers have also been able to do so. The legislation sets a minimum recycling rate of 90% for beverage packaging covered by the DRS, but does not specify penalties for non-compliance. In Sweden, there are no longer any refillable PET bottles or cans (Spasova, 2019). The latest legal framework for DRS is based on the Ordinance on Producer Responsibility for Packaging (2022:1274). In 2022, two separate regulations came into force: the EPR Regulation (2018:1462) and the Regulation on return systems for plastic bottles and metal cans (2005:220). These regulations state that DRS will be mandatory for fruit juice packaging from 2023 and for dairy products in metal containers from 2028 (Tugran, 2023).

### *3.1.2 Background to the introduction of DRS in Iceland*

Iceland has had a deposit refund system for non-refillable metal, plastic and glass packaging since 1989. This makes Iceland the first country to introduce a nationwide deposit refund system for a wide range of beverage containers. In addition, the DRS system currently accepts compressed and crushed packaging, preventing it from ending up in the environment (Spasova, 2019). The legal framework is based on Law No. 52/1989 (Law on the Prevention of Environmental Pollution Caused by Disposable Packaging) and Decree No. 750/2017 (Decree on the Collection, Recycling and Deposit Refund of Disposable Beverage Packaging) (Tugran, 2023). The system is based on the law and regulation on disposable beverage packaging, which requires that a fixed deposit fee must be paid for all beverages in disposable metal, glass or plastic packaging. This whole amount is ISK 16 (EUR 0.11) for all packaging (Spasova, 2019). In 2021, the deposit fee was increased slightly from ISK 16 to ISK 18 (EUR 0.13) (Tugran, 2023). The DRS covers all ready-to-drink beverages, wines and spirits. Exceptions are milk, milk-containing products and fruit juice extracts. The Ministry of the Environment set a target of 90% for aluminium cans and PET bottles and 85% for glass bottles by 2020, which was achieved in 2011. The Icelandic DRS system is operated by Endurvinnslan, which was established in 1989 (Mager et al., 2022).

### *3.1.3 Background to the introduction of DRS in Finland*

In Finland, refillable bottles were already returned in the 1950s. The first system was for these refillable bottles and was run by breweries. In 1994, at the instigation of the DRS, the government introduced a tax on the packaging of alcoholic and non-alcoholic beverages (Spasova, 2019). The tax is set at EUR 0.51 per litre and did not apply to packaging participating in the DRS (Tugran, 2023). In order to be exempt from the tax, beverage manufacturers and retailers initiated the setup of a DRS for single-use beverage bottles in 1996. In 2004, a new operator was established to handle refillable PET and glass bottles. With the change in packaging tax, the single-use deposit system was extended to PET bottles in 2008 and to single-use glass bottles in 2011 (Spasova, 2019). The main legal framework for the DRS is provided by the Government Decree on the take-back system for beverage packaging (526/2013) and the Waste Act (646/2011) (Tugran, 2023). The DRS is based on a related regulation on collection systems for returnable beverage containers. The regulation specifies the minimum deposit fee for each type of packaging. The operator of the DRS, PALPA, has determined the deposit amount in accordance with the regulation (0.15 EUR for metal, between 0.10 and 0.40 EUR for plastic bottles depending on size, and 0.10 EUR for glass). For all packaging types covered by the deposit system, the minimum target for recycling and reuse is 90% for each year (Ettlinger, 2016).

### *3.1.4 Background to the introduction of DRS in Norway*

In Norway, the deposit system has a long history, with the first system introduced in 1902 for refillable glass packaging. Following that, a tax was imposed on beverage packaging in 1974, and since 1994 it has consisted of two components. There is a basic tax and an environmental tax, which decreases proportionally if over a collection rate of 25% and disappears if over a collection rate of 95% (Sutton, 2018). The tax applies to wine, spirits, beer and non-alcoholic beverages in their original packaging, with the exception of milk beverages. As a result of the legislation, beverage manufacturers and retailers established a company called Norsk Resirk in 1996 to manage a deposit system for recyclable aluminium cans and plastic bottles (Spasova, 2019). The system promoting collective success achieved its objectives: the tax on bottles ended in 2011 and the tax on cans in 2012, as both achieved a collection rate of 95% (Tugran, 2023). In 2014, the company changed its name to Infinitum, which refers to the fact that these packages can be reused infinitely (Spasova, 2019).

### *3.1.5 Background to the introduction of DRS in Denmark*

In Denmark, the use of DRS dates back to 1910, when breweries introduced a system to reduce the cost of reusing glass bottles. The government began regulating this system in the 1950s. Since 1989, it has been mandatory for bottles to be refillable, participate in the DRS system and be approved by the Danish Environmental Protection Agency. As a result, the return rate was 99% and each bottle was reused 35-40 times (Bragadóttir et al., 2014). The current DRS system was prompted by EU infringement proceedings. Until 2002, Danish law specified that beer and carbonated soft drinks could only be sold in refillable containers, and aluminium cans were not permitted in the country. As a result of the legal action against Denmark, the government removed the ban and introduced single-use packaging for beer and soft drinks on the market. The

foundations of the system were laid in 1995, and the privately owned company Danks Retursystem was established in 2000. The existing DRS has been extended to single-use packaging (Spasova, 2019). The framework is provided by the 2002 decree on deposits, which was last updated in 2020 (Tugran, 2023). The packaging of fruit juice, milk, cocoa, wine and spirits, as well as cardboard boxes larger than 20 litres and water bottles larger than 10 litres, are not included in the system. The Danish government announced in 2018 that the system would be extended to fruit juice bottles in 2020 (Spasova, 2019). Different deposit fees apply to different sizes of glass, tin and plastic bottles: DKK 1.00 (EUR 0.13) for glass bottles and aluminium cans smaller than 1 litre, DKK 1.50 (EUR 0.20) for plastic bottles smaller than 1 litre and DKK 3.00 (EUR 0.40) for all bottles and cans between 1 and 20 litres. Since 2020, fruit juice packaging has also been subject to DRS (Tugran, 2023).

### *3.1.6 Background to the introduction of DRS in Germany*

In Germany, waste management became a major political issue in the late 1980s. During this period, local authorities faced difficulties in financing new landfills and waste incinerators. The federal government wanted to introduce a mandatory deposit on single-use packaging and boost the availability of refillable packaging. The first packaging material manufacturer responsibility organisation was Duales System Deutschland (DSD). Several significant changes and optimisations were made to the initial system until May 2006, when the actual nationwide DRS was launched. The German Packaging Ordinance regulates and states that a deposit of at least EUR 0.25 must be charged on packaging. The deposit fee does not apply to environmentally friendly packaging, fruit and vegetable juices, milk drinks, baby and children's drinks, wines and liqueurs. The recycling targets are set out in the regulation that came into force in 2019 and must be met every year: 90% for glass, paper, cardboard, ferrous metals and aluminium, 80% for beverage cartons, 70% for composite packaging and 63% for plastic packaging (Spasova, 2019). The Packaging Act has been revised several times since 2019. These were primarily motivated by evolving EU regulations (e.g. the Single-Use Plastics Directive), the problem of 'free riders', the impact of the online retail sector and the challenges posed by excessive single-use packaging during the pandemic (Tugran, 2023). Deutsche Pfandsystem GmbH (DPG), the current operator of the DRS, was established in 2005 (Zhou et al., 2020). From January 2022, with the transposition of the EU directive on single-use plastics, the mandatory deposit fee will be extended to products previously exempt from the system (Tugran, 2023).

### *3.1.7 Comparison of the top 6 countries*

Table 2 summarizes the measures and systems in place prior to the introduction of the DRS.

**Table 2. Summary of measures taken prior to the introduction of the DRS**

| Country | Year of introduction | Tax | Previous system |
|---|---|---|---|
| Sweden | 1984 | No | DRS for single-use aluminium packaging from 1970s |
| Iceland | 1989 | No | No |
| Finland | 1996 | Tax on the packaging of alcoholic and non-alcoholic beverages (0.51 EUR) | Refillable bottles return system from 1950s |
| Norway | 1999 | Tax on beverage packaging (1974-1994) | Deposit system for refillable glass packaging from 1902 |
| Denmark | 2002 | No | DRS for reusable glass bottles from 1910 |
| Germany | 2003 | No | No |

*Source: Author's own contribution, 2025*

We can see in the table that in two countries (Finland and Norway), taxes were introduced prior to the DRS. This acted as a kind of incentive in both cases for the establishment of the current DRS. We can also see that, with the exception of two countries (Iceland and Germany), there was some kind of preventive system in place everywhere. In many cases, these are systems with a long history. The first country to introduce a nationwide system was Iceland, which had no previous system in place. In this case, no general conclusions about activities prior to the DRS can be drawn.

## 3.2 Experiences following the introduction of DRS in Hungary

In Hungary, the DRS was introduced on 1 January 2024 based on Government Decree 450/2023 (X. 4.) on the detailed rules for determining and applying the redemption fee and for distributing products subject to a redemption fee. The return fee is set at 50 HUF (0.12 EUR) for single-use packaging and 70 HUF (0.17 EUR) for multi-use packaging in the regulation. The decree also mandates that shops selling food with a sales area of more than 400 m2 must provide a return facility with a reverse vending machine for the return of non-reusable products subject to a mandatory return fee (Government Decree 450/2023. (X. 4.), 2023). The concessionaire is MOHU, which is responsible for

handling the collected bottles. Smaller shops with limited sales areas can also join the system on a voluntary basis as machine return points, provided that they accept the conditions for operating the automatic reverse vending machines. Thanks to this, there will be nearly 2,000 reverse vending machines at launch, and with the gradual addition of partners in the coming years, there are plans to have 4,000 to 5,000 machines in stores. Shops can also join the system as manual return points if they wish to offer manual returns with the support of a mobile app. During the return process, the consumer can choose how they want the return fee to be refunded. Voucher: The value of the returned bottles is printed on an automatic voucher, which can be redeemed or exchanged for cash at the store or chain of stores where it was issued. Bank account reference: using the barcode reader built into the machine, consumers registered in the app can identify themselves with their electronic customer code via their phone, and the refund will be automatically credited to the bank account specified in their customer profile. Charitable donation: The redemption fee can also be donated to a charitable organisation by selecting the option indicated on the ATM display. The amounts offered during a given period will be transferred to the beneficiary at the end of the period (MOHU, 2023). In their study, Boros et al. (2021) used a questionnaire survey to assess the needs of domestic consumers in relation to the system to be developed. Their findings show that consumers consider the location of redemption points, the type of redemption and the deposit fee to be important factors. Szűcs et al. (2024) conducted a large-scale questionnaire survey to assess consumers' expectations regarding the new system. Their findings show that the majority of respondents (8,225 people) are concerned and dismissive of the new system.

MOHU (DRS operator) prepared a report on the results of the last six months of the first year of implementation. Among other things, the report mentions that the highest number of bottles (49,196,439) were returned by residents in the 51st week of 2024. They also report on the distribution by part of the country and found that Eastern Hungary (9 county divisions) had the highest rate of bottle returns every week. The number of bottles returned per capita nationwide is 101. In terms of refund methods, store vouchers dominated with 82.99%, followed by bank transfers with 16.76% and charity donations with 0.25%. The types of beverage packaging were distributed as follows: 58% plastic, 37% metal, 5% glass. The recycling rates for these are: 63.9% plastic, 41.7% metal, 35.3% glass, totalling 55.3%. The following figure (*Figure 2*) shows the monthly breakdown of returned quantities by country, in 10,000 pieces per package (MOHU, 2025).

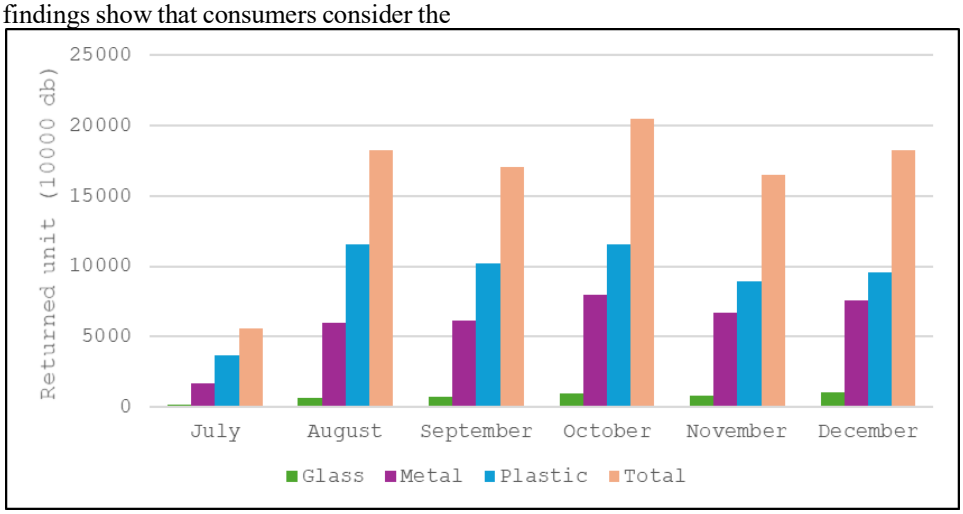


**Figure 2 The amount of packaging returned in Hungary in the second six months of 2024**

*Source: Author's own contribution based on MOHU (2025)*

We can see that during the six months presented, the number of glass returnable packaging increased steadily. In the case of metal packaging, a decline was observed in November, followed by an increase in December. Regarding plastic packaging, the trend appears to be constantly fluctuating. There was significant growth from July to August, followed by a slight decline, then slight growth again in October, a larger decline in November, and then slight growth once more. In total, the number of returned bottles exceeded 20,000,000 in October.

## 4 Comparative Analysis

In this chapter we show the analyses the amount of plastic packaging waste causing the most pollution and the amount recycled, followed by the recycling rate, based on statistical data from the six countries presented in the expamles chapter. Next, the cafe of two country recycling rates by packaging material was available, these cases are presented. We will then analyse the rates of return of deposit-based units by country, represent the number of collection points in proportion to the population, and analyse the average deposit fee ratio. Finally, we present the types of DRS and introduce the Hungarian system type.

### 4.1 Plastic packaging waste

The following table (*Table 3*) provides an overview of the quantities of plastic packaging material emitted and recycled over a 10-year period for the countries analysed (six countries reviewed and Hungary). Quantities are given in kg/capita.

**Table 3. Plastic packaging waste and recycled quantities by country (kg/capita)**

| Country | Plastic packaging waste | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sweden | Quantity | 22,43 | 22,44 | 23,18 | 23,55 | 23,57 | 24,03 | 23,93 | 24,17 | 23,9 | **24,03** | **39,11** |
| | *Recycled* | *7,65* | *7,83* | ***10,57*** | ***11,19*** | ***11,55*** | ***12,18*** | ***11,58*** | ***12,09*** | ***12,71*** | *8,05* | *9,31* |
| Iceland | Quantity | **35,81** | **37,34** | **44,73** | **43,14** | **44,98** | **46,04** | **46,74** | **47,55** | **48,51** | 39,42 | 44,55 |
| | *Recycled* | *14,86* | *15,27* | *11,85* | *11,56* | *16,64* | *19,11* | *13,51* | *13,93* | *11,64* | *12,14* | *12,30* |
| Finland | Quantity | 21,74 | 21,65 | 21,65 | 21,38 | 21,27 | 22,36 | 23,66 | 24,52 | 24,22 | **28,41** | **29,94** |
| | *Recycled* | *5,52* | *5,50* | *4,91* | *5,26* | *5,04* | *5,68* | *6,27* | *7,63* | *10,17* | *11,19* | *12,84* |
| Norway | Quantity | 30,71 | 31,49 | 33,79 | 32,15 | 35,49 | 36,91 | 41,81 | 41,74 | 44,86 | 46,12 | **47,52** |
| | *Recycled* | *11,55* | *12,00* | *13,11* | *11,61* | *13,17* | *14,51* | *15,43* | *15,15* | *14,89* | *12,87* | *13,45* |
| Denmark | Quantity | 33,8 | 32,85 | 33,85 | 33,22 | 34,67 | 37,46 | 34,81 | 42,88 | 39,8 | 39,27 | 38,8 |
| | *Recycled* | *7,54* | *8,51* | *9,85* | *10,20* | *10,57* | *13,52* | *14,55* | *13,42* | *14,89* | *8,99* | *9,00* |
| Germany | Quantity | 34,58 | 35,27 | 35,63 | 36,37 | 37,36 | 37,62 | 38,53 | 39,03 | 39,11 | 39,71 | 41,09 |
| | *Recycled* | ***11,96*** | ***12,44*** | ***12,69*** | ***13,23*** | ***13,96*** | ***14,15*** | ***14,85*** | ***15,23*** | ***15,30*** | ***15,77*** | ***16,88*** |
| Hungary | Quantity | 20,93 | 25,9 | 27,85 | 26,21 | 30,46 | 31,48 | 32,24 | 34,84 | 35,02 | **47,45** | |
| | *Recycled* | *4,69* | *7,20* | *8,58* | *9,65* | *8,35* | *9,88* | *10,32* | *10,45* | *11,56* | *11,82* | |

*Note: Recycled quantities are indicated in italics, and outstanding data is indicated in bold.*
*Source: Author's own contribution based on Eurostat databases (Eurostat, 2024a; Eurostat, 2024b)*

The table shows the amount recycled per capita in each country for each year. Iceland produced the most plastic packaging waste until 2019 but was overtaken by Hungary in 2020 and Norway in 2021. In terms of recycling, Sweden stands out between 2013 and 2019. The highest recycling rate will be achieved in 2019, at 53.2%, which is way above other countries in the period we looked at. Finland has the lowest overall waste generation, even though the amount of plastic packaging waste has increased significantly since 2020. Sweden was close behind, with the lowest amount in 2020, but in 2021, it went up to 15 kg per person. Germany is the only country to show steady growth in recycling. Over the past 10 years, the recycling rate has increased by 14%, which means that 16.88 kg of plastic per person is recycled compared to the starting year (7.72 kg per person). The following figure (Figure 3) shows the percentage distribution of plastic packaging waste generated and recycled by country.

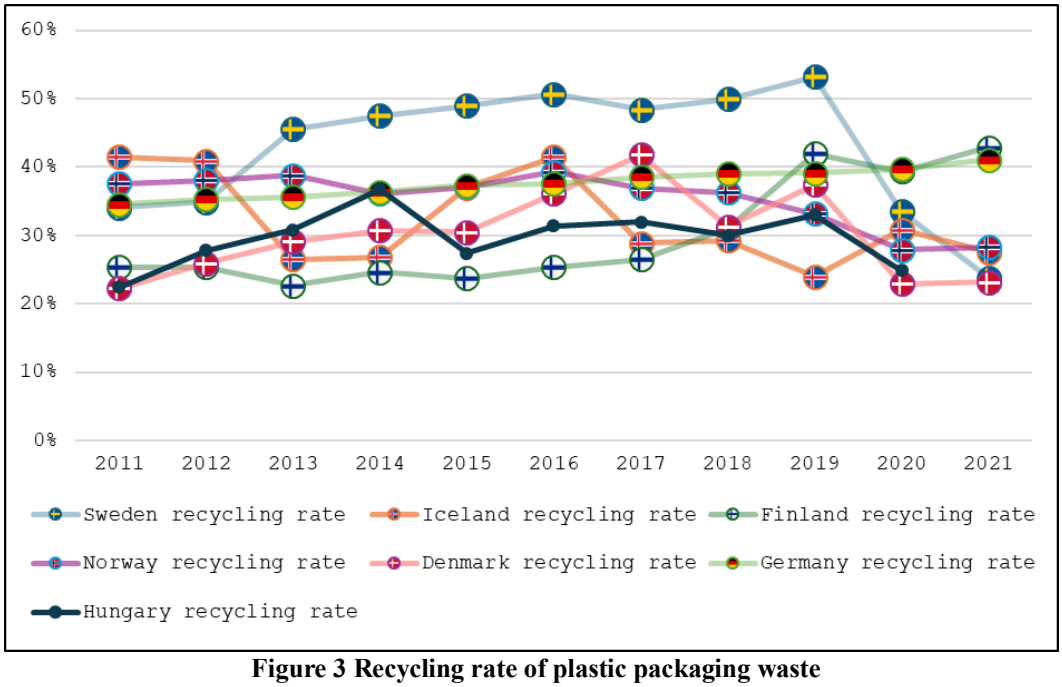


**Figure 3 Recycling rate of plastic packaging waste**

*Source: Author's own contribution based on Eurostat databases (Eurostat, 2024a; Eurostat, 2024b)*

In Sweden, the annual consumption of plastic packaging in 2017 was estimated at 325,000 tonnes (Lu et al., 2022). According to Eurostat data, nearly half (48.4%) of this was reused. The total amount of plastic packaging in Finland was estimated at 117,239 tonnes per year in 2012. The recycling target set for 2008 (22.5% of plastic packaging waste) was achieved and exceeded in 2012 with a recycling rate of 25%. In 2014, new targets were set (Government Decree 518/2014 on packaging and packaging waste), which set a target of 90% for deposit-refund systems for beverage packaging and 16% for non-deposit packaging by 2016 and 22% by 2020 (Dahlbo et al., 2018). These targets were achieved based on data available in the database (Eurostat, 2024a; Eurostat, 2024b), with plastic packaging waste recycling rates of 25.4% in 2016 and 39.4% in 2020. The recycling rate for plastic packaging waste is only rising towards 50% in Sweden (2016, 2019). Based on the data, we can say that Hungary is not lagging behind the reviewed countries by a significant margin. In 2022, Germany had the highest proportion of recycled plastic packaging (51.1%), followed by Finland (44.5%), Sweden (28.3%), Norway (28%), Hungary (27.5%), Denmark (23.5%) and finally Iceland (21.5%) (Eurostat, 2024b).

## 4.2 Recycling of packaging materials by type

Of the six countries discussed earlier, data covering a longer period was available for two (Sweden and Denmark). In addition to presenting these, we also provide any data available from other countries in the subchapter.

In Sweden, based on available data, the recycling rate for PET bottles and containers in the deposit refund system has fluctuated between 81% and 90% since 2012, with the PET recycling rate consistently lower, except for 2019 (Figure 4). Sweden is close to achieving its overall recycling target of 90%. In 2022, 3 billion DRS-obligated units were placed on the market, representing a 10% increase compared to the previous year. The collection rate is 87.8% for aluminium cans and 86.7% for PET. The total collection rate is 87.5% (Tugran, 2023).

.

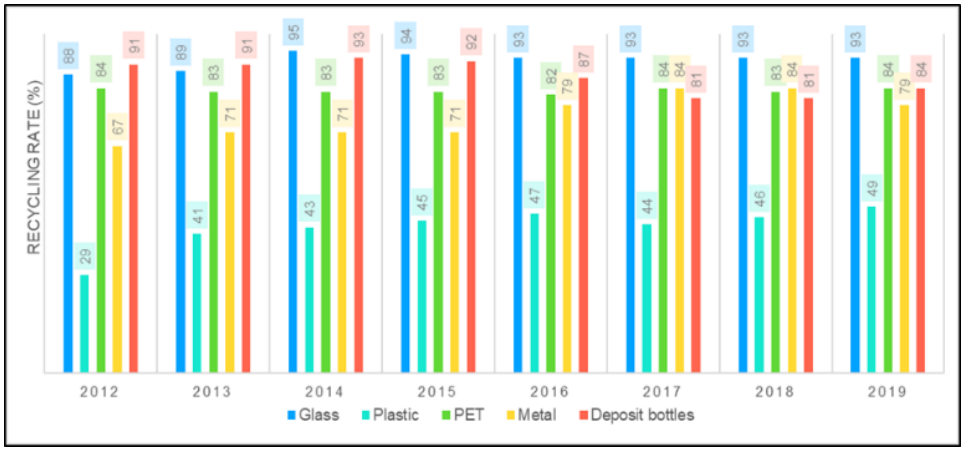


**Figure 4 Recycling rates by packaging category in Sweden**

*Source: Author's own contribution based on Swedish Environmental Protection Agency (2022)*

In terms of raw materials, plastic has the lowest share, but we must not forget deposit bottles, which have a very high share. The recycling rate for metal packaging has remained between 70% and 80% over the years. The Danes are excellent at returning empty bottles and cans (*Figure 5*).

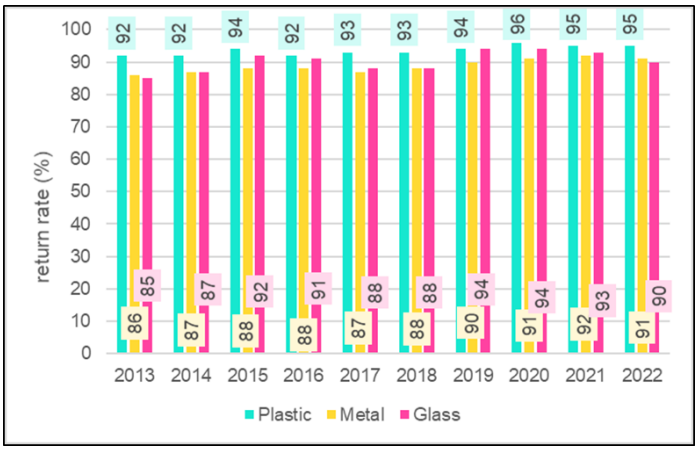


**Figure 5 Packaging return rate in Denmark**

*Source: Author's own contribution based on Dansk Retursystem (2024)*

We can see that the return rate for plastic packaging has remained stable at over 90% since 2013. Since 2019, neither metal nor glass has fallen below 90%. 92% of bottles and cans are returned to the system so that the aluminium, plastic and glass can be melted down and used to make new bottles and cans. Consumers, breweries and shops all contribute to the recycling of bottles and cans. Thanks to all the participants, the Danish deposit and return system is one of the best in the world, with 90% of empty bottles and cans being recycled. Manufacturers, importers and breweries contribute by selling reusable or recyclable bottles and cans. The Danes contribute by returning empty bottles and cans to the system instead of throwing them away. Shops, offices, cafés, restaurants and similar establishments contribute by accepting and storing empty bottles and cans until they are collected by Dansk Retursystem. Finally, Dansk Retursystem ensures that the bottles and cans are sorted and sent to special plants where they are melted down so that new bottles and cans can be made from the material. The deposit and return system is a well-oiled machine that ensures that bottles and cans can be reused over and over again (Danks Retursystem, 2024).

In Iceland, the recycling rates in 2014 were as follows: glass 83%, PET 87%, metal cans 90%, total 90%. In 2018, the figures were slightly lower: glass 80%, PET 83%, metal cans 85%. However, by 2019, we saw an overall improvement: glass 83.8%, PET 87.3%, metal cans 88.4%, for a total of 87.4% (Bottle Bill Resource Guide, 2023). In Finland, approximately 2 billion beverage containers are returned each year, with the following return rates: 95% glass, 92% PET, 98% metal in 2020; 98% glass, 90% PET, 97% metal in 2021; and 98% glass, 90% PET, and 99% metal in 2022 (Tugran, 2023). In Norway, the average collection rate for aluminium cans and PET bottles returned to retailers and collected for recycling in 2021 was 91.6% and 93.3%, respectively (Raadal et al., 2023). In Germany, the recycling rate for PET bottles was 94% in 2019, and 31.4% of PET bottles are made from recycled material (Tugran, 2023).

### 4.3 Return of packaging required by the DRS

The return rate for plastic bottles is shown in the following figure (*Figure 6*) for the year 2023. .

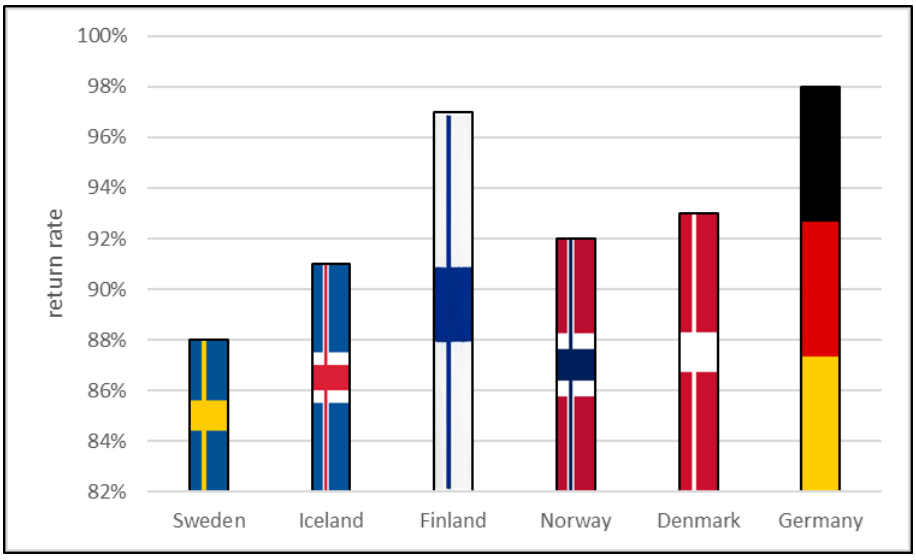


**Figure 6 The return rate of plastic packaging in 2023**

*Source: Author's own contribution based on SENSONEO (2024)*

In 2023, Germany will have the highest return rate (98%), followed by Finland (97%). Sweden has the lowest return rate among all countries (88%). In terms of deposit fees, the fee for metal cans has been increased several times, which has increased the return rate, whereas the fee for PET bottles has remained unchanged and the return rate has remained low. 80% of collected PET bottles are transparent, 70% of which are used to manufacture new bottles, while the rest are used to manufacture other products (Spasova, 2019). The recycling of plastic packaging has increased since the introduction of Extended Producer Responsibility (EPR) in the 1990s. In Sweden, however, the recycling rate is between 9% and 20%, despite the fact that a nominal rate of 44% was reportedly achieved in 2016. The current deposit refund system, which applies exclusively to PET beverage packaging, works better, with a return rate of 85.9% (Lu et al., 2022). Paper and metal recycling had a long tradition in Sweden even before waste legislation was introduced (Salmenperä, 2021). Swedish consumers were also accustomed to the system, as there was already a well-established glass return system in place before the introduction of the DRS, which made the single-use bottle system more acceptable. Consumer convenience is served by several factors, such as shops acting as return points and retailers accepting bottles even if they were not purchased from them (Spasova, 2019). In 2019, Finns recycled 90 per

cent of PET bottles (Reijonen et al., 2021). In their study, Abila and Kantola (2019) asked consumers about their return habits. Approximately half of the participants (45.5%) strongly agreed that recyclable materials should be placed at designated points because they believe in the benefits of recycling. Meanwhile, 61.8% of participants agreed that recyclable materials should be placed at designated points, taking into account the harmful environmental effects caused by failure to do so, while 44.7% agreed that recyclable materials should be placed at designated points in relation to the level of information provided. Based on this, it can be said that preventing harmful environmental impacts is the strongest motivator for Finnish consumers. The Norwegian system is successful, achieving a recovery rate of over 90% for both materials since 2020. Recycling rates are also very high, consistently above 95% for both materials (PET and metal) since 2016 (Tugran, 2023). Under the Danish deposit and return system, the return rate for beverage containers was 84% for single-use packaging and nearly 100% for refillable bottles in 2005 (Larsen et al., 2010). The bottle return rate was 102% in 2017, which may have been due to the declining market share of beverages sold in this type of packaging. This means that more bottles were returned to collection points than were put into circulation. Since 2002, the market share of single-use packaging has grown from 0% to 84% in 2016, while that of refillable packaging has fallen from 100% to 16%. The volume of aluminium cans and bottles purchased in Germany posed a problem, but in 2015, Danks Retursystem managed to secure parliamentary support. As a result, products purchased in shops near the border are exposed to either a German or Danish deposit, which can be refunded in both countries. According to surveys, 92% of consumers support the return system (Spasova, 2019). Germany has the world's largest and most successful deposit refund system, with a record refund rate of 98%. This is due to high deposit fees and a well-developed network of redemption points (TOMRA, 2023).

## 4.4 Distribution of collection points

We examined the available literature to determine how many people per return centre there are in these countries. Our findings are summarised in Table 4.

**Table 4 Number of residents per collection point in 2022**

| Country | Population (person) | Number of collection points (db) | Resident/collection point |
|---|---|---|---|
| Germany | 83 797 985 | 135 000 | 621 |
| Denmark | 5 903 037 | 15 500 | 381 |
| Norway | 5 457 127 | 15 400 | 354 |
| Finland | 5 556 106 | 18 500 | 300 |
| Iceland | 382 003 | 60 | 6 367 |
| Sweden | 1 048 6941 | 11 897 | 881 |

*Source: Author's own contribution based on data from Reloop (2022) and the World Bank (2024)*

Based on this data, we can say that Finland has the most vending machines per capita, while Iceland has the fewest. Denmark and Norway are not far behind Finland, followed by Germany with half as many collection points, and finally Sweden with 1.5 times fewer.

### *4.4.1 Structure of deposit refund systems in the countries examined*

In Sweden, Returpack is the only return system approved by the Swedish government. It is owned by breweries (50%), wholesale distributors (25%) and retailers (25%). In 2017, 96% of the total amount was collected through reverse vending machines (RVM). Consumers can choose between two options when returning the deposit: they can either redeem it in the store or receive it back via bank transfer. In addition, mobile collection stations are available at festivals for returning bottles (Spasova, 2019). In Iceland, the DRS operator is a limited liability company (Endurvinnslan) jointly operated by industry and the government. It is owned by the state, the Icelandic state alcohol and tobacco company, the Icelandic local authority, two metal processing companies, the Icelandic Scout Association, Icelandic merchants and two beverage companies. There is another option for returning packaging, namely taking it to collection organisations as a 'donation' (Spasova, 2019). In Finland, the DRS operator is PALPA, which is owned 50% by retailers and 50% by beverage manufacturers. PALPA employs a total of 13 people (Spasova, 2019). The recycling of beverage packaging involves numerous parties, from the design and manufacture of beverage packaging, through the sale of beverages, to the transport and recycling of empty packaging and the reuse of materials (PALPA, 2015). In Norway, in addition to collection points, there are 35 logistics hubs and five processing facilities (TOMRA, 2023). Retailers are obliged to take back bottles listed in the DRS. Consumers also have the option of returning bottles without a refund. The collaboration between Infinitum and Reg Dross is particularly noteworthy, with 1,000 collection points set up at tourist destinations to collect bottles. In addition, the partnership between Infinitum and Kolonoal.no (Norway's largest online grocery store) is also a great help to consumers, as bottles are collected directly from households (Spasova, 2019). In Denmark, the Danks Retursystem is regulated by the Ministry of the Environment and owned by breweries and Danish retailers and producers. The operator is conducting information campaigns about DRS in Denmark, highlighting the environmental benefits and emphasising that consumers will get back the deposit. There are 15,500 registered points, and temporary points can also be registered, such as festivals or sports competitions. Consumers also have the

option of using Pantstation, a return bank that offers only this service. In 2015, Copenhagen initiated the installation of 'deposit shelves' in public waste bins, an example that has since been adopted by several other countries (Spasova, 2019). In Germany, the deposit refund system follows the 'return-to-retail' model, and there are approximately 135,000 return points nationwide. Approximately 25% of these have automatic change machines, while the rest offer manual change. Shops with a floor space of 200 square metres or more are required to accept the return of at least the beverage packaging materials they sell, while smaller shops are required to accept the return of at least the packaging materials of the brands they sell. When the system was simplified and made it possible to return packages to any store nationwide, demand for automated returns increased significantly. In January 2022, the range of eligible packaging was expanded to include alcoholic beverages and fruit juices in single-use plastic bottles and cartons, as well as milk-based mixed drinks in cartons (TOMRA, 2023).

## 4.5 Comparison of average wage and deposit amount

The following table (*Table 5*) shows the average wages in the countries under review based on 2023 data, expressed in the countries' currencies and in euros, as well as the deposit fee in both currencies.

**Table 5 Average wage and deposit fee ratios in the seven countries analysed**

| Country | Average wage (2023) | Average wage (2023) EUR | DRS deposit | DRS deposit EUR | Rate (%) |
|---|---|---|---|---|---|
| Sweden | 8834 KR | 790,94 | 1-2 KR | 0,09-0,18 | 0,011 |
| Iceland | 153108 ISK | 1070,69 | 16 ISK | 0,11 | 0,010 |
| Norway | 12580 NOK | 1079 | 2-3 NOK | 0,17-0,26 | 0,015 |
| Denmark | 6525 DKK | 874,69 | 1-3 DKK | 0,13-0,27 | 0,014 |
| Finland | 837 EUR | 837 | 0,1-0,4 EUR | 0,1-0,4 | 0,011 |
| Germany | 737 EUR | 735 | 0,25 EUR | 0,25 | 0,034 |
| Hungary | 171484 HUF | 424,26 | 50 HUF | 0,12 | 0,028 |

*Source: Author's own contribution based on data from the International Monetary Fund (2024)*

Comparing average wages, Norway has the highest, followed by Iceland, while Hungary has the lowest. In terms of deposit fees, Germany ranks highest, followed by Norway. The order based on the percentages is as follows: Germany, Hungary, Norway, Denmark, Sweden and Finland are tied, followed by Iceland. This ratio shows the amount of the deposit fee in relation to the average wage. Germany has the highest value, meaning that the deposit fee they use is the highest in relation to the average wage. This is not surprising, as DPG proudly proclaims that its success is due to its high deposit fees. In Sweden, Iceland and Finland, the conversion fee is low compared to average wages, yet the programme can still be considered successful. This may be due to a high level of environmental awareness; in Finland, for example, environmental education begins in primary school (Abila and Kantola, 2019). Hungary has the second highest ratio of deposit fees to average wages. The impact of this incentive is discussed in detail in the following subchapter.

## 4.6 Types of deposit refund systems

There are four basic types of deposit refund systems, which represent different approaches (*Figure 7*). The first type is the operator-lock mode. In this case, the retailer purchases the product from the manufacturer and pays the deposit fee in addition to the price. When the consumer purchases the product from the retailer, they also pay the deposit fee. After consuming the product, the consumer returns the empty bottle to the retailer, at which point the deposit is refunded. The retailer returns the empty bottle to the DRS operator, who then refunds the deposit paid by the manufacturer to the operator. This type is used in Croatia, Estonia, Lithuania among European countries, and in Sweden, Denmark, Finland and Norway among the countries reviewed. The second type is the retailer-closure method. There are two main differences here: the process and the costs. One phase ends and the empty bottles remain with retailers, who are responsible for their transport and disposal/sale. This system is used in Germany. The third type is the producer lock-in model. There are two main differences: the process and the costs and revenues. Empty bottles are returned to manufacturers, who are responsible for collecting, disposing of and recycling them, or for outsourcing these tasks to third parties. In addition to the deposit fee, the retailer also pays an additional deposit to the DRS operator, which is only refunded if the empty bottle is returned to the manufacturer. This is applied in the Netherlands. The fourth type is the consumer-lock mode. Consumers return empty bottles directly to the collection/disposal facilities of the DRS operator. The DRS operator manages the deposits and the disposal/resale of empty bottles. This type is a closed system used in Iceland, which is possible due to the island nature of the country (Zhou et al., 2020; Calabrese et al., 2021). Based on this, we can say that practices optimized for local conditions are working well in these countries.

.

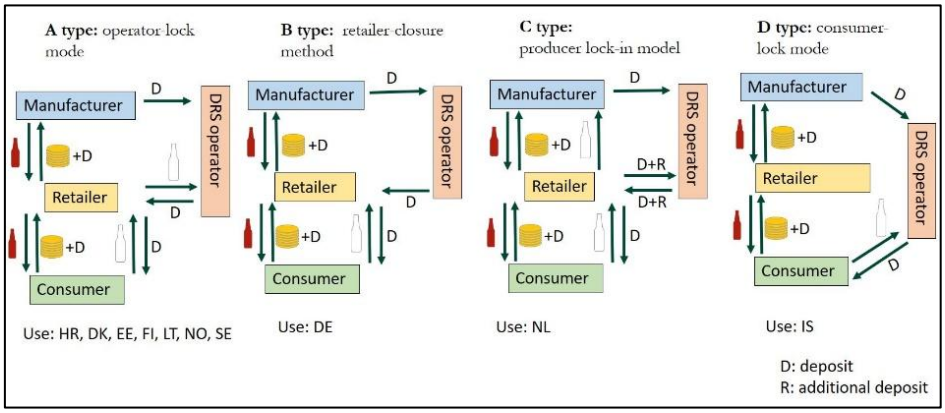


**Figure 7 Types of deposit refund systems**

*Source: Author's own contribution based on Calabrese et al. (2021)*

The system introduced in Hungary cannot be classified under any of these categories without reservation. The main differences are that the DRS operator operates the reverse vending machines and also pays a handling fee to the retailer. The manufacturer is obliged to pay the deposit fee corresponding to the number of bottles released to the DRS operator and to pay the retailer the deposit fee corresponding to the number of bottles returned to it. The returned bottles must be handled by the DRS operator. Based on this, the system can be visualised as shown in the following figure (*Figure 8*).

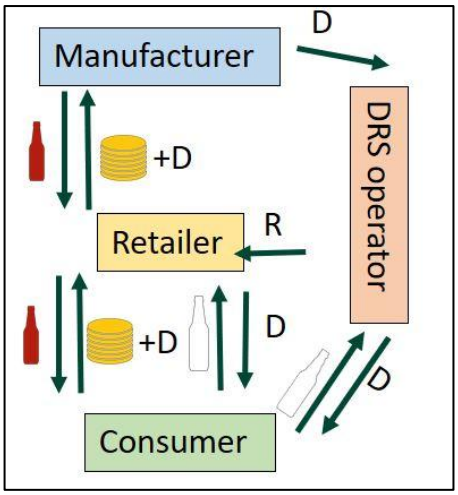


**Figure 8 The model of deposit refund system in Hungary**

*Source: Author's own contribution based on Government Decree No. 450/2023 (X. 4.)*

## 5. Discussion and Interpretation

### 5.1 Discussion

Based on the recycling rates for plastic packaging waste, we can conclude that Hungary did not fall significantly behind during the period under review (2011-2021). Sweden had the highest rates between 2013 and 2020 (around 50%). However, Finland performed below Hungary between 2012 and 2017. With the exception of a few outliers, the other countries analyzed showed recycling rates between 20% and 40% during these years. Even in 2022, Denmark and Iceland still ranked below Hungary.

In Sweden, data were available for a longer period on recycling rates by packaging material. Packages collected in the DRS system were also highlighted separately. Although we can see a decrease during this period, the rate did not fall below 80%. In Denmark, data on return rates were available for each type of packaging. None of the packaging materials can be said to have a low return rate.

In terms of plastic bottle return rates, all six countries exceeded 80% in 2023. Sweden achieved the lowest rate at 88%, while Germany achieved the highest at 98%. In terms of return points, Finland has the most return points per capita. Iceland has the fewest collection points, with only 60 in the entire country. However, as can be seen from the return rates, this does not seem to be a problem for residents. After examining deposit fees and average wages, we found that the highest rate is in Germany. This may be one explanation for why the country has the highest return rates. In Hungary, we can see that the deposit amount ranks in the middle range compared to other countries, while it is the second highest in relation to the average wage.

Fundamental differences can be observed in the operation of the system, which can be divided into four types. Operator-lock mode is the most commonly used mode. The other three types are used by individual countries, adapted to their specific circumstances. During our review of Hungarian legislation, we found differences compared to existing DRS types. Based on this, it was not possible to classify it into any of the types. In response to our second research question, we found the following differences and similarities. If we compare it with the four existing types, we can say that it uses types B and D simultaneously. However, a deposit fee is paid between the DRS operator and retailers, which is not typical of any of the types examined. Since it could not be classified or compared to anything else, we created the Hungarian DRS model.

Based on the systems examined, we have compiled the following best practices, which answer our first research question. The simple and easy-to-understand operation of reverse vending machines is advantageous, as it makes it easier for consumers to return bottles. In addition, it is advantageous to use machines that accept crumpled and damaged bottles, as this makes storage and transport easier for consumers, preventing these bottles from ending up in the natural environment. In terms of DRS operation, less complex, high-performance systems facilitate cooperation between the participants. The location of reverse vending machines is an important factor, as it can encourage consumers to return bottles, and the proximity of these points increases the return rate. The design of the bottles in the system can greatly contribute to easier recycling, so it is worth designing them for recycling from the outset. Based on the cases reviewed, it can be said that systems involving multiple parties in the process, rather than being controlled by a single operator, have proven to be more advantageous. As to deposit fees, no clear conclusion can be drawn as to whether low or very high amounts are appropriate, as there were positive examples in both cases. In several cases, the introduction of DRS was preceded and induced by an environmental tax. The tax can be considered successful and was an excellent incentive for the system. Proper communication with consumers is essential for the smooth operation of the system. This can also help to promote positive consumer habits and attitudes. Support from manufacturers is essential for the system to work, as the redemption system would be virtually impossible without their participation. A few other good practices that contributed to the success of the systems can also be highlighted. These included:

- In Germany, the fact that sustainable packaging was not initially subject to the deposit fee;
- In Sweden, retailers accepted bottles even if they were not purchased there;
- Setting up temporary collection points at festivals and sporting events in Sweden and Denmark;
- Collection points set up at tourist sites and households in Norway as part of a partnership programme;
- In Finland, conscious environmental education begins in childhood;
- and acceptance of crushed packaging in Iceland.

## 5.2 Interpretation

We developed scenarios based on the examined operational efficiency (redemption rate, number of machines, coverage), environmental impact (recycling rate), economic incentives (deposit amount and ratio to average wage), consumer acceptance (convenience, communication, trust in the system), and institutional and stakeholder cooperation (one or more stakeholders, logistics). Based on these, we present three scenarios: a reference scenario, an optimistic scenario, and a pessimistic scenario (*Table 6*).

**Table 6 Scenario analysis**

| Scenario criteria | Reference (HU 2024) | Optimistic (good practices) | Pessimistic (in case of risks) |
|---|---|---|---|
| Return rate (%) | 55-60% | 90-98% | 40-50% |
| Recycling rate (%) | 55,3% | >85% | <40% |
| Consumer acceptance | mixed (distrust, use) | high (strong communication, education, trust) | low (distrust, no communication) |
| Economic incentives (deposit fee/average wage ratio) | 2,8% | 3–3.5% (high deposit fee ratio) | <2% (weak incentive) |
| Institutional cooperation | one stakeholder (MOHU) | more stakeholder, transparent operation | more stakeholder, no coordination |
| Comfort aspects | Medium (2000+RVM, but not available everywhere) | High (mobile collection points, festivals, convenient access) | Weak (few RVM, malfunctions, lack of coverage in rural areas) |

*Source: Author's own contribution based on own research, 2025*

Of the good practices listed above, and based on the scenario analysis, we make the following recommendations. The first of these considerations is the **convenient location and smooth operation** of reverse vending machines, which was also highlighted in previous studies. This may act as an incentive for consumers, as they are more likely to return an RVM if it is located close to their home. Smooth operation can also help maintain consumer motivation, as a glitch or machine downtime can discourage them from returning. The next good practice is **communication with consumers**, which includes information campaigns in the media and communication at return points. This practice is perhaps one of the most important, as consumers often suffer from a lack of information, so eliminating this is essential for the system to work. These information campaigns are essential at the start of the system, but they must be maintained and developed to ensure smooth operation. In order to ensure communication with consumers at return points, it is necessary to train employees. In several cases, it was mentioned as good practice that the **involvement of multiple actors** is essential for the smooth functioning of the system. Although there are cases where one actor controls the system, in most cases these roles are shared. Currently, the Hungarian DRS is linked to one actor, but shared leadership and the involvement of multiple actors would facilitate the operation of the system. In addition, it would be worthwhile to adopt good practices such as the use of **mobile collection points** at festivals and sporting events. Since there is no collection option at such events, most consumers will dispose of these bottles incorrectly. The

introduction of these good practices can improve the current system in Hungary.

## 6. Conclusion

In this study, we examined what good practices can be gathered from countries that have been using deposit refund systems for a long time for the system recently introduced in Hungary. To this end, we first identified which countries have been using them the longest, assuming that they have the most experience. We then reviewed their example, which explored the activities that preceded implementation. In this case, we did not find any factors that were uniformly characteristic of all six countries. In the comparative analysis, we examined the amount of plastic waste and its recycling rate, the recycling and recovery rates (where data was available for each type of packaging material), the return rates in 2023, the number of return points per capita, the deposit fee and average wage rates, and the types of systems. In terms of plastic waste and recycling rates, we found that between 2011 and 2021, Hungary was not far behind the countries examined, and in some cases even outperformed them. In 2022, however, two countries performed below Hungary. Recycling rates by packaging material were available for Sweden, reaching over 80% for packaging subject to the DRS. In the case of Denmark, detailed data on the return rate by packaging material was available. In all cases, we can talk about a rate of over 85%. In 2023, we were able to report return rates exceeding 80% in all six countries. This also proves that these are well-functioning systems. In terms of return points per capita, Finland has the most return points per capita, while Iceland has the fewest. After examining the average wages and deposit fees, we found that Germany has the highest rate, while Hungary ranks second. In terms of system types, there were four types, which were used differently across the six countries surveyed. Denmark, Finland, Norway, and Sweden use "Type A," Germany uses "Type B," and Iceland uses "Type D". However, the Hungarian system could not be classified into any of these types, which is why we created the Hungarian system model. Finally, after gathering all the good practices, we considered the following to be worth adapting to the current Hungarian system: convenient location and smooth operation, communication with consumers, involvement of multiple actors, and mobile collection points. By incorporating these into the system, we believe that the recently introduced system can be improved.

## References

Abejón, R., Laso, J., Margallo, M., Aldaco, R., Blanca-Alcubilla, G., Bala, A., & Fullana-i-Palmer, P. (2020). Environmental impact assessment of the implementation of a deposit-refund system for packaging waste in spain: A solution or an additional problem? *Science of the Total Environment*, 721, 137744
DOI: 10.1016/j.scitotenv.2020.137744

Abila, B., & Kantola, J. (2019). The perceived role of financial incentives in promoting waste Recycling—Empirical evidence from finland. *Recycling, 4*(4)
DOI: 10.3390/recycling4010004

Boros, A., Kurdi, R., Lukács, Z. P., Sarkady, A., & Banász, Z. (2021). Opinion of the Hungarian population on the reform of beverage packaging deposit-refund system. *Sustainability, 13*(11)
DOI: 10.3390/su13116373

Bottle Bill Resource Guide. (2023). Iceland.
Retrieved from: https://www.bottlebill.org/index.php/current-and-proposed-laws/worldwide/iceland
Accessed on 10.07.2025.

Bragadóttir, H., Danielsson, C. v. U., Magnusson, R., Seppänen, S., Stefansdotter, A., & Sundén, D. (2014). The use of economic instruments: In Nordic environmental policy 2010-2013.(549)
DOI: 10.6027/TN2014-549

Buzzoni, L. (2023) Deposit & return: The plastic recycling success opposed by southern Europe.
Retrieved from: https://www.investigate-europe.eu/en/posts/deposit-return-the-plastic-recycling-success-opposed-by-southern-europe
Accessed on 07.06.2025.

Cabot, C. (2024). EU's deposit refund scheme a 'false solution' for plastic pollution.
Retrieved from:
https://www.france24.com/en/environment/20240318-activists-say-eu-s-proposed-deposit-refund-schemes-are-false-solution-to-plastic-pollution
Accessed on 26.04.2025.

Calabrese, A., Costa, R., Levialdi Ghiron, N., Menichini, T., Miscoli, V., & Tiburzi, L. (2021). Operating modes and cost burdens for the European deposit-refund systems: A systematic approach for their analysis and design. *Journal of Cleaner Production, 288*, 125600
DOI: 10.1016/j.jclepro.2020.125600

Callewaert, P., Lerche Raadal, H., & Lyng, K. (2023). How to achieve ambitious recycling targets for plastic packaging waste? the environmental impact of increased waste separation and sorting in Norway. *Waste Management, 171*, 218–226
DOI: 10.1016/j.wasman.2023.08.037

Council of the, EU. (2023). Packaging and packaging waste: Council adopts its negotiating position on new rules for more sustainable packaging in the EU.
Retrieved from: https://www.consilium.europa.eu/en/press/press-releases/2023/12/18/packaging-and-packaging-waste-council-adopts-its-negotiating-position-on-new-rules-for-more-sustainable-packaging-in-the-eu/
Accessed on 11.12.2025.

Dahlbo, H., Poliakova, V., Mylläri, V., Sahimaa, O., & Anderson, R. (2018). Recycling potential of post-consumer plastic packaging waste in Finland. *Waste Management, 71*, 52–61
DOI: 10.1016/j.wasman.2017.10.033

Dansk Retursystem. (2024). About us.

Retrieved from: https://danskretursystem.dk/en/about-us/
Accessed on 10.07.2024.

Directive 2008/98/EC of the European parliament and of the council of 19 November 2008 on waste and repealing certain directives, (2008).
Retrieved from: https://eur-lex.europa.eu/legal-content/HU/TXT/?uri=celex:32008L0098
Accessed on 02.12.2025.

Directive (EU) 2018/851 of the European parliament and of the council of 30 may 2018 amending directive 2008/98/EC on waste, (2018). Retrieved from:
https://eur-lex.europa.eu/legal-content/HU/TXT/?uri=celex%3A32018L0851
Accessed on 02.12.2025.

Directive (EU) 2019/904 of the European parliament and of the council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment, (2019).
Retrieved from:
https://eur-lex.europa.eu/legal-content/HU/TXT/?uri=CELEX%3A32019L0904
Accessed on 02.12.2025.

Directive (EU) 94/62/EC: Packaging and packaging waste, (2020).
Retrieved from:
https://eur-lex.europa.eu/HU/legal-content/summary/packaging-and-packaging-waste.html
Accessed on 02.12.2025.

Ettlinger, S. (2016) Deposit Refund System (and Packaging Tax) in Finland
Retrieved from:
https://ieep.eu/wp-content/uploads/2022/12/FI-Deposit-Refund-Scheme-final.pdf
Accessed on 25.06.2025.

European Commission (2020) Action Plan for the Circular Economy. (in Hungarian)
Retrieved from:
https://ec.europa.eu/commission/presscorner/api/files/attachment/863170/EU_Greendeal_Circular_economy_hu.pdf.pdf
Accessed on 02.12.2025.

European Commission (2022). Impact assessment report.
Retrieved from:
https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=SWD%3A2022%3A384%3AFIN&utm_source=chatgpt.com
Accessed on 02.12.2024.

Eurostat. (2024a). Generation of plastic packaging waste per capita.
DOI: 10.2908/CEI_PC050
Retrieved from:
https://ec.europa.eu/eurostat/databrowser/view/cei_pc050/default/table?lang=en
Accessed on 01.07.2025.

Eurostat. (2024b). Recycling rate of packaging waste by type of packaging.
DOI: 10.2908/CEI_WM020
Retrieved from:
https://ec.europa.eu/eurostat/databrowser/view/cei_wm020/default/table?lang=en
Accessed on 01.07.2025.

International Monetary Fund. (2024). Download world economic outlook database: October 2023.
Retrieved from: https://www.imf.org/en/Publications/WEO/weo-database/2023/October/weo-report?c=512
Accessed on 25.06.2025.

Larsen, A. W., Merrild, H., Møller, J., & Christensen, T. H. (2010). Waste collection systems for recyclables: An environmental and economic assessment for the municipality of Aarhus (Denmark). *Waste Management, 30*(5), 744–754
DOI: 10.1016/j.wasman.2009.10.021

Lorang, S., Yang, Z., Zhang, H., Lü, F., & He, P. (2022). Achievements and policy trends of extended producer responsibility for plastic packaging waste in Europe. *Waste Disposal & Sustainable Energy, 4*, 91–103
DOI: 10.1007/s42768-022-00098-z

Lu, Z., Hasselström, L., Finnveden, G., & Johansson, N. (2022). Cost-benefit analysis of two possible deposit-refund systems for reuse and recycling of plastic packaging in Sweden. *Cleaner Waste Systems, 3*, 100048
DOI: 10.1016/j.clwas.2022.100048

Mager, M., Traxler, I., Fischer, J., & Finger, D. C. (2022). Potential Analysis of the Plastics Value Chain for Enhanced Recycling Rates: A Case Study in Iceland. *Recycling*, 7(5), 73
DOI: 10.3390/recycling7050073

MOHU. (2023). From January 1, 2024, a new beverage container return system will be introduced in Hungary. (in Hungarian)
Retrieved from: https://mohu.hu/hu
Accessed on 17.07.2025.

MOHU. (2025). Results achieved by the mandatory redemption system in 2024. (in Hungarian)
Retrieved from: https://repont.hu/hu
Accessed on 28.02.2025.

Government Decree 450/2023 (X. 4.) on the detailed rules for determining and applying redemption fees and for distributing products subject to redemption fees (2023). (in Hungarian)
Retrieved from: https://njt.hu/jogszabaly/2023-450-20-22
Accessed on 15.02.2025.

PALPA. (2015). Deposit-based system.
Retrieved from: https://www.palpa.fi/beverage-container-recycling/deposit-refund-system/
Accessed on 17.07.2025.

Raadal, H. L., SaxegÅrd, S. A., & Modahl, I. S. (2023). Life cycle assessment of the current recycling system and an alternative reuse system for bottles in Norway. Infinitum.
Retrieved from: https://infinitum.no/media/tn3p5jvl/report-lca-of-single-use-and-reuse-systems_or2723.pdf
Accessed on 02.07.2025.

Reijonen, H., Bellman, S., Murphy, J., & Kokkonen, H. (2021). Factors related to recycling plastic packaging in Finland's new waste management scheme. *Waste Management, 131*, 88–97
DOI: 10.1016/j.wasman.2021.05.034

Reloop. (2022). Global deposit book 2022 an overview of deposit return systems for single-use beverage containers.
Retrieved from:

https://www.reloopplatform.org/wp-content/uploads/2022/11/RELOOP_Global_Deposit_Book_11I2022_P1.pdf
Accessed on 30.01.2025.

Salmenperä, H. (2021). Different pathways to a recycling society – comparison of the transitions in Austria, Sweden and Finland. *Journal of Cleaner Production, 292*, 125986
DOI: 10.1016/j.jclepro.2021.125986

SENSONEO. (2024) Detailed overview and results of the current deposit return scheme implementations in Europe.
Retrieved from:
https://sensoneo.com/waste-library/deposit-return-schemes-overview-europe/
Accessed on 02.07.2025.

Spasova, B. (2019). Deposit-refund systems in Europe., 121. Retrieved from: https://www.acrplus.org/en/
Accessed on 17.02.2025.

Suter (2019) Beyond PET: an extended Deposit-Return System for plastic packaging in Sweden. Master Thesis KTH, ABS, SEED, (Stockholm)

Sutton, T., 2018. Exploring the Norwegian Model [online]. Packaging Europe.
Retrieved from:
https://packagingeurope.com/api/content/8b04d138-0cbb-11e8-8e53-121bebc5777e/
Accessed on 03.07.2025.

Swedish Environmental Protection Agency. (2022). Total amount of packaging put on the market and recycled broken down by packaging types, observations and year.
Retrieved from:
https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__MI__MI0307/MI0307T1/
Accessed on 16.07.2025.

Szucs, R. S., Foldi, K., Feher, A., Kiss, V. A., & Kiss, M. (2024). Preliminary opinion of consumers on the new deposit-refund system in Hungary. *Ecocycles, 10*(2), 97–113
DOI: 10.19040/ecocycles.v10i2.492

TOMRA. (2023). Deposit return scheme in Germany: The world's highest-performing drink container recycling system.
Retrieved from:
https://www.tomra.com/reverse-vending/media-center/feature-articles/germany-deposit-return-scheme
Accessed on 03.07.2025.

Tugran, T. (2023). Deposit refund systems in the EU. ACRplus. Retrieved from
https://www.acrplus.org/media/origin/images/technical-reports/2023_ACR_Deposit_Refund_Systems_EU_Report.pdf
Accessed on 05.07.2024.

WorldBank. (2024). Population, total. Retrieved from https://data.worldbank.org/indicator/SP.POP.TOTL?end=2024&start=2024&view=bar&year=2022
Accessed on 15.04.2025.

ZeroWasteEurope. (2019). Deposit return systems (DRS) manifesto.
Retrieved from: https://zerowasteeurope.eu/wp-content/uploads/2019/12/2019_12_10_zwe_drs_manifesto.pdf
Accessed on 27.08.2025.

Zhou, G., Gu, Y., Wu, Y., Gong, Y., Mu, X., Han, H., & Chang, T. (2020). A systematic review of the deposit-refund system for beverage packaging: Operating mode, key parameter and development trend. *Journal of Cleaner Production, 251*, 119660
DOI: 10.1016/j.jclepro.2019.119660