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Deposit-refund systems and the interplay with additional mandatory extended producer responsibility policies

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Abstract

Despite decades of experience with Deposit Refund Systems (DRS) in some countries and sub-national markets, there are only a few instances where DRS is complemented by additional mandatory EPR policy instruments within the same sector. In light of increasingly ambitious collection and recycling targets, countries and sub-national governments are considering the use of a DRS for specific products in combination with other mandatory EPR policy instruments, such as product take-back requirements or advance disposal fees (ADFs) for other products in the same sector.

This interplay of a DRS and other mandatory EPR policy instruments can lead to synergies, as it can improve the quality and quantity of recycling, enable reuse systems and incentivise eco-design. DRS also helps to address littering and influence consumer behaviour, which is difficult to address with other mandatory EPR policy instruments. However, there are also issues and conflicts that can arise from the combination, such as financial implications through losses of economies of scale or unintended substitution effects. This report identifies key insights that can guide the design and implementation of a DRS and its role in a broader policy mix including other mandatory EPR policies.

Keywords: Circular economy, waste management, deposit refund system, extended producer responsibility, product stewardship, resource efficiency, sustainable consumption

JEL Classification :

L15, O14, Q53, Q56, Q58

Résumé

Malgré des décennies d'expérience avec les systèmes de consigne dans certains pays et marchés infranationaux, il n'y a que quelques cas où les systèmes de consigne sont complétés par des instruments politiques de responsabilité élargie des producteurs (REP) obligatoires supplémentaires dans le même secteur. Compte tenu des objectifs de plus en plus ambitieux en matière de collecte et de recyclage, certains pays et des gouvernements infranationaux envisagent d'utiliser un système de consigne pour des produits spécifiques en combinaison avec d'autres instruments politiques obligatoires de REP, tels que des exigences de reprise des produits ou des frais d'élimination préalables pour d'autres produits du même secteur.

Cette interaction entre le système de consigne et d'autres instruments obligatoires de la REP peut créer des synergies, car elle peut améliorer la qualité et la quantité du recyclage, permettre la mise en place de systèmes de réutilisation et encourager l'éco-conception. Les systèmes de consigne permettent également de lutter contre les déchets sauvages et d'influencer le comportement des consommateurs, ce qui est difficile à faire avec d'autres instruments politiques obligatoires de la REP. Cependant, la combinaison de ces deux instruments peut également entraîner des problèmes et des conflits, tels que des implications financières dues à des pertes d'économie d'échelle ou des effets de substitution involontaires. Ce rapport identifie les principaux éléments qui peuvent guider la conception et la mise en œuvre d'un système de consigne et son rôle dans un ensemble de politiques plus large comprenant d'autres politiques obligatoires de la REP.

Mots clés : Économie circulaire, gestion des déchets, système de remboursement des consignes, systèmes de consigne, responsabilité élargie des producteurs, utilisation efficace des ressources, consommation durable

Classification JEL :

L15, O14, Q53, Q56, Q58

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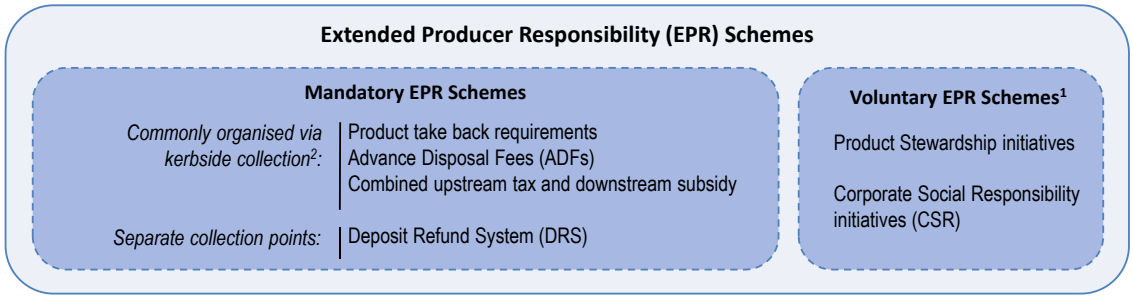
Executive Summary

Public expectations of management for end-of-life (EoL) products have evolved over time and collection and recycled content targets are becoming increasingly ambitious. For instance, the European Single-Use Plastic Directive will require Member States to collect 90% of single-use plastic bottles by 2029 and to meet a 30% recycled content target for PET bottles. California (United States) will require a minimum share of 50% recycled content in plastic beverage containers by 2030. Moreover, as the public concern around littering grows, policy makers are looking for instruments that are able to address this issue. Indeed, the issue of plastic leakage to the environment has captured the public attention and has led to international commitments such as the Osaka Blue Ocean Vision, where G20 countries agreed to reduce additional plastic pollution by marine plastic litter to net zero by 2050. In addition, countries agreed at the fifth session of the UN Environment Assembly to develop a legally binding instrument to reduce plastic pollution.

Extended Producer Responsibility (EPR) policy instruments will play an important role to meet these goals, reduce plastic pollution and increase material circularity. Different EPR policy instruments exist to shift financial, and sometimes physical, responsibility of waste management from the public sector to producers. Commonly used mandatory EPR policy instruments to finance or organise kerbside collection of end-of-life products include product take-back requirements, Advance Disposal Fees (ADF) and upstream product taxes combined with downstream subsidies for waste management. In some markets, where mandatory EPR policy instruments do not exist, producers commit to taking responsibility through voluntary product stewardship or Corporate Social Responsibility (CSR) initiatives (Figure 1).

Figure 1. DRS in the context of other mandatory and voluntary EPR schemes



[1] Voluntary and industry-led initiatives are not part of the scope of this report but are included in the broader definition of EPR.
[2] Kerbside collection includes door-to-door collection from properties, as well collection via communal waste containers placed on streets.

A Deposit Refund System (DRS) is an EPR policy instrument when producers are made responsible to finance and operate the system. In a DRS, customers pay a deposit when purchasing a product that is refunded at its return to a collection point. The instrument has proven effective in increasing collection rates and reducing littering of products such as beverage containers. Placing a value on returning products helps operators to collect more and higher-quality materials for purposes of reuse, recycling or environmentally sound disposal.

Deposit refund systems have been an important instrument in waste management in various OECD jurisdictions for several decades, most prominently for reusable or single-use beverage containers (e.g. aluminium cans and glass, PET and sometimes HDPE bottles), but also for other items, such as reusable pallets, gas cylinders or lead-acid batteries. Some jurisdictions with a DRS achieve collection rates of more than 90% for targeted products and items subject to deposit are observed to be reduced by between 40 to 90% in litter surveys.

Several OECD member countries have implemented or are considering the use of a DRS for specific products in combination with other mandatory EPR policy instruments, such as product take-back requirements or ADFs for other products in the sector. For example, Germany, Lithuania and Norway have a DRS alongside a take back requirement for packaging and Spain, South Korea and France are considering the use of a DRS for beverage containers or disposable cups alongside their existing EPR schemes for packaging. Alternatively, some markets, particularly in the United States (e.g. Maine and Oregon), have long-running DRSs for beverage containers that will soon operate in conjunction with a new take back requirement for packaging.

This interplay of DRSs and other mandatory EPR policy instruments can lead to synergies, as it can improve the quality and quantity of recycling, enable reuse systems and incentivise eco-design. DRS also helps to address littering and influence consumer behaviour, which is difficult to address with other mandatory EPR policy instruments. However, there are also issues and conflicts that can arise from the combination of a DRS and other mandatory EPR policies, such as unintended substitution effects or financial implications through losses of economies of scale.

This report outlines the current state of knowledge of the use and impact of DRSs, drawing upon available literature, and analyses the interaction of a DRS with additional mandatory EPR policy instruments.

Policy insights from analysing the implementation of deposit refund systems

- Regulation should define the responsibility for producers and the role of other actors including clearing service providers and retailers. Targets are needed to ensure that the system works towards high collection rates. If the DRS is implemented in the form of an EPR, producers are responsible for covering the full cost of the system, whilst meeting established targets. The public sector has a role in monitoring and enforcing these obligations and, if necessary, in sanctioning non-compliance.
- Whilst a DRS can achieve higher collection rates than kerbside collection, the marginal cost of collection is usually higher. Increased revenues through material sales in most cases only partially cover the increased costs, meaning that DRS programmes typically require financial support through producer fees or from the public sector. A DRS, however, can also lead to substantial non-market benefits, such as reduced littering and a cleaner environment or job creation, which should be considered when assessing the costs and benefits of DRS implementation.
    - Costs arise from setting up the collection infrastructure (e.g. purchase or lease of reverse vending machines) and operating the system (e.g. labour of collection and transport, and the clearing of financial transactions between stakeholders). Temporary storage and time to return products can also add inconveniences for consumers.
    - Revenues are generated from the sale of collected material and from unredeemed deposits. In most cases these revenues do not cover the costs of a DRS. It is only for certain high-value materials that the revenues can lead to a net-profit. This is for instance the case for aluminium cans in Norway.
- Unredeemed deposits can be a large revenue source of a DRS, but the use of this revenue is subject to policy design:

  - Unredeemed deposits can partially offset the costs of operating the DRS. However, complementary policies, such as collection targets or a tax tied to collection rates should be considered to incentivise collectors to strive for high return rates and not excessively rely on financing from unclaimed deposits. For example, Norway charges a tax on beverage containers, which reduces as the collection rate increases, successfully incentivising collection.
  - Products that are unreturned can cause externalities when they are littered or disposed of in general household waste. Public authorities can fully or partially claim revenues from unredeemed deposits and earmark the income to cover costs associated with these externalities, such as financing clean-up of littered items or contributing to the costs of sorting and treating residual waste.
- Finally, information campaigns and other soft approaches can help to "nudge" consumers and increase DRS participation.

Issues at the interplay of deposit-refund systems and kerbside collection organised by extended producer responsibility

- A DRS often targets high-value material and isolates this from the remaining waste stream. In jurisdictions with an existing EPR for kerbside collection, this has financial implications for the incumbent producer responsibility organisation (PROs) that loses recycling revenues to the DRS operators and may incur higher marginal operating costs due to reduced economies of scale. As well, the PRO may still be responsible for the costs of unreturned items that end up in mixed waste or are being littered. These issues can downgrade the support of stakeholders for the adoption of DRS policy. DRS policy should establish methods for arbitration between producers, DRS operators, and PROs, to address instances of overlap or compensation for services rendered.
- Regulation should clearly define the scope of a DRS in the context of other EPR instruments and establish which products are subject to which programme, to avoid potential "double coverage" or unintended substitution effects. Policies that define the scope of a DRS based on certain materials leave more opportunity for producers to change materials in product design to avoid participation. Policies that instead specify the scope based on product groups may be better suited to avoiding possible substitution effects.
- DRS can be helpful for enabling reuse of packaging by giving consumers an incentive to return products, thus facilitating the necessary physical movement between consumers and producers. However, the strong emphasis of recycling in most kerbside EPR programmes can conflict with opportunities for reuse. Complementary policies, such as taxes on single-use packaging or reusability quotas are likely needed to reverse the general shift towards single-use packaging. Nonetheless, policies should only promote reusable packaging, where this is the environmentally preferable option.
- DRS and other EPR policy instruments can work towards sustainable product design. Modulation of EPR fees based on product design criteria provides an economic incentive for producers to design for recycling. Similarly, operators of DRS can consider modulating producer fees based on design criteria that facilitate recycling or reuse. In markets, where DRS participation is optional, operators can also define exclusion criteria.

1 Introduction

Extended Producer Responsibility (EPR) is an environmental policy approach in which a producer's responsibility is extended to the end-of-life stage of a product. The approach sets obligations for producers to shift financial, and sometimes physical, responsibility of waste management from the public sector to producers (OECD, 2016[1]). Moreover, EPR contributes to improving recycling and material recovery.

A deposit-refund system (DRS) is a system in which an initial payment (deposit) is made by a customer at the point of purchase that is then refunded if the product or packaging is physically returned by the customer to the collection scheme (OECD, 2016[1]). Refunds provide consumers with an incentive to return items through appropriate channels for separate collection[1] rather than littering or discarding them in general waste. A DRS can generate a high rate of return[2], but requires substantial investment in physical and financial infrastructure and usually incurs higher operational costs than other waste collection methods. As well, not all product groups are well suited for DRS collection. Nonetheless, the instrument has been an important element of waste management policy for several waste streams (in particular for beverage containers) in various markets for several decades. DRS policy typically specifies the scope of the system either by identifying a type of product and detailing exemptions for particular product types (e.g. dairy products are excluded in Lithuania's DRS), or by specifying types of material (e.g. single-use bottles made of PET are included, but HDPE is excluded in Scotland's forthcoming DRS).

A DRS is one EPR policy instrument to shift the responsibility for waste management from the public sector to producers. Other mandatory EPR policy instruments that are commonly used include product take-back requirements, advance disposal fees (ADFs) and combined upstream taxes and downstream subsidies.

Increasingly ambitious targets for recycling, recycled content, and litter prevention will likely require a combination of different mandatory EPR policy instruments that include DRSs. Several OECD member countries have implemented or are considering the use of a DRS for specific products in combination with product take-back requirements or ADFs for other products in the sector to meet targets. For example, Spain and France are each considering the use of a DRS for beverage containers alongside an existing EPR take back requirement for packaging. Alternatively, some markets have long-running DRS for beverage containers that will soon operate in conjunction with a new EPR scheme for packaging. For instance, the US states Oregon and Maine (United States) have recently enacted mandatory EPR laws in the form of product take-back requirements with an ADF for general packaging and both states currently have a DRS for beverage containers in place that will continue to operate in the new framework (Maine legislature, 2021[2]; Oregon State Legislature, 2021[3]). More US states are considering similar EPR legislation for broader packaging waste streams on top of existing DRS.

This report outlines the current state of knowledge on DRSs and considers the interaction of a DRS with additional mandatory EPR policy instruments.

[1] *Collection* refers to the total end-of-life material collected for recovery and environmentally sound management through various means including kerbside collection, material banks and returns via DRS.

[2] *Return rate* is the share of material sold that is collected through returns via the DRS (i.e. redeemed), whereas the *collection rate* comprises collection through all means, including items redeemed via DRS, as well as items collected via kerbside collection and material banks.

2 Extended Producer Responsibility

An EPR scheme consists of several policy instrument options that in their combination make producers responsible for their products at end-of-life. Whilst EPR schemes can also include voluntary or industry-led product stewardship or CSR initiatives, the majority of EPR policy instruments are mandatory or include mandatory recycling or collection targets to define producer's responsibilities (Box 2.1).

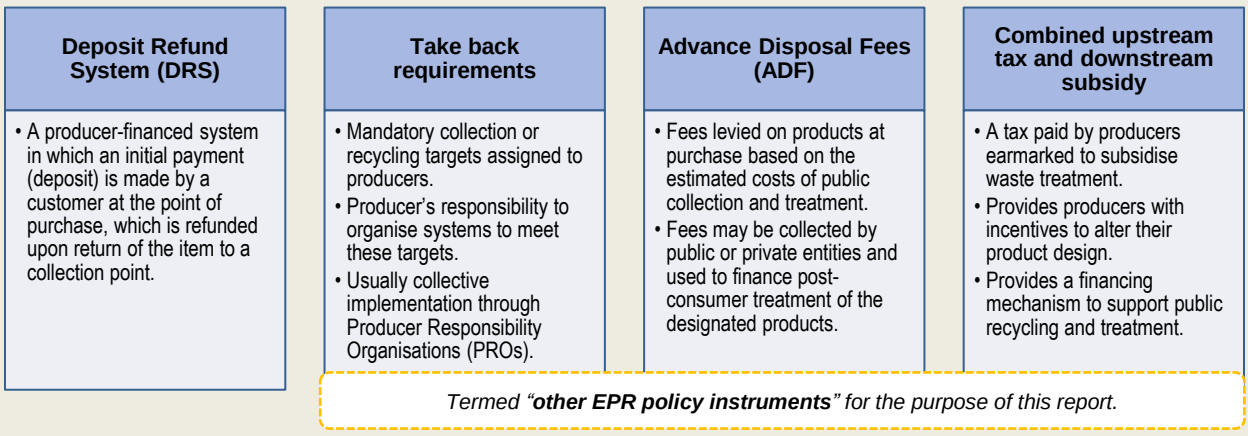
Box 2.1. DRS versus other EPR policy instruments

A deposit refund system is a type of EPR scheme, when the costs of operating the system are assigned to producers. Other mandatory EPR policies include take back requirements, advance disposal fees (ADFs) or combined upstream taxes with downstream subsidies. Voluntary, or industry-led initiatives, often known as "product stewardship", can also be considered EPR, but the focus of this report lies on *mandatory* EPR policy instruments (Figure 2.1).

Different EPR policy instruments are suited for different purposes. DRS is usually applied to specific products such as beverage containers and requires specific collection infrastructure such as in-shop collection points. Take-back requirements or ADFs can be applied to broader product categories such as packaging and often finance and organise kerbside collection (either door-to-door or via communal waste containers on streets) for a broader group of recyclables such as all recyclable packaging plastics. Combined upstream taxes with downstream subsidies make producers financially responsible, whilst the public sector remains in control of waste management operations.

DRS can coexist with other mandatory EPR policy instruments. For instance, glass and aluminium beverage containers can fall under a DRS, whilst general packaging waste is subject to an ADF.

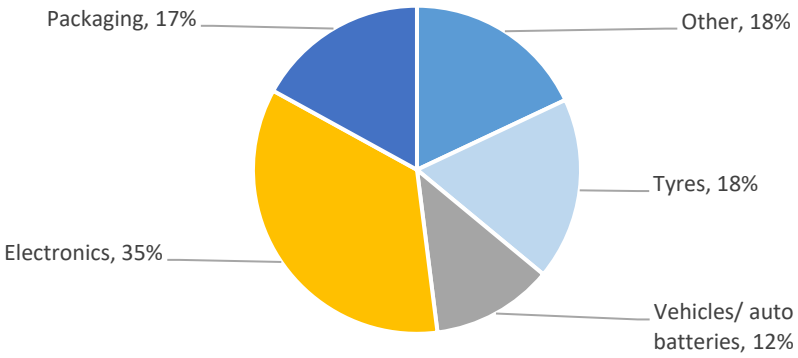
Figure 2.1. Mandatory EPR policy instruments



Source: (OECD, 2016[1])

In the last three decades, the principle of EPR has been increasingly implemented in waste policy (OECD, 2001[4]). Now more than 400 schemes are in place worldwide, up from about 30 in 1990 (OECD, 2016[1]). EPR schemes have been implemented in a diverse set of product types, including electronics, vehicles, batteries, tyres, and packaging (Figure 2.2).

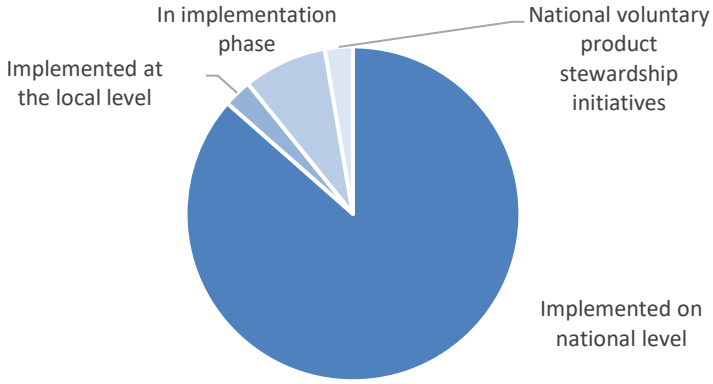
Figure 2.2. EPR by product type, worldwide



Source: (OECD, 2016[1])

Across the OECD Membership, EPR schemes for packaging are either implemented or in the implementation phase at national or sub-national levels (Figure 2.3). The form of implementation varies from one country to the next, ranging from mandatory regulations at the national or local level to voluntary product stewardship initiatives. Also stringency can vary, for example, whether producers are required to cover the full cost of their end-of-life products or only part of the cost.

Figure 2.3. Implementation of packaging EPR in OECD Member Countries



Source: Authors own, based on data from (OECD, 2022[5])

EPR is effective as a means to shift the waste management costs from all taxpayers to the producers and consumers of the waste generating products, in line with the polluter pays principle (OECD, 2016[1]). It also aims at improving Design for Environment (DfE), yet there is only limited evidence that this has occurred

so far (OECD, 2016[1]; Kunz, Mayers and Van Wassenhove, 2018[6]). Owing to economies of scale, most EPR schemes for packaging are typically organised in an industry-wide way with producers funding a Producer Responsibility Organisation (PRO). Often, the modulation of these EPR producer fees provides only a limited link between product design and fee charges per product (Laubinger et al., 2021[7]; OECD, 2016[8]).

Several organisations representing industry have recently re-emphasised support for EPR as a means to increase recycling. For example, the Consumer Goods Forum, a group of 28 leaders in the manufacturing and retailing of packaged goods, and the Ellen MacArthur Foundation each publicly released strong statements from more than 100 major businesses in the packaging value chain supporting EPR, in the form of product take-back requirements, for packaging (The Consumer Goods Forum, 2020[9]; Ellen MacArthur Foundation, 2021[10]). The support of such stakeholders stresses the potential of EPR for the circular use of materials and indicates the readiness of many producers to further expand the ambitions and geographic coverage of EPR.

3 Deposit refund systems

A deposit refund system gives an economic value to products or packaging by requiring consumers to pay a deposit on the item at the point of sale. When the customer returns the item or packaging to a collection point, they receive a refund of the deposit. As such, a DRS provides consumers with an economic incentive for returning a product or packaging in a high-quality condition to collection points instead of disposing of in mixed municipal solid waste, fly-tipping[3] or littering.

Deposit refund systems are widely used around the world for various items. Most commonly, it is used for beverage containers and an estimated 290 million people in Europe, North America, and Australia currently live in a jurisdiction with a DRS for beverage containers (Reloop, 2020[11]). Deposit systems also exist for other products, such as lead-acid batteries and reusable pallets, gas bottles, kegs, crates and boxes (Conseil national de l'emballage, 2016[12]; Battery Council International, 2022[13]).[4] The *OECD Recommendation of the Council concerning the Re-Use and Recycling of Beverage Containers* mentions DRS as one of the measures, which can be considered to implement the recommendation.

This chapter reviews research into the benefits and costs of DRSs, in particular applied to beverage containers, and describes key considerations for the design of effective deposit-refund systems.

3.1. Objectives of deposit refund systems

Deposit refund systems aim to improve collection of end-of-life products or packaging and to improve the quality collected material. There are several objectives that can motivate the implementation of a DRS: (1) to provide incentives against littering; (2) to collect hazardous materials in order to ensure their safe and environmentally sound end-of-life treatment; or to collect high-value material for (3) recycling, or (4) reuse (Table 3.1).

[3] Fly-tipping is the illegal dumping of waste, instead of using an authorised method such as kerbside collection or authorised dumpsites.

[4] Whilst this report acknowledges the use and usefulness of a DRS for various product groups, the focus lies on DRSs for packaging and in particular beverage containers.

Table 3.1. Different objectives can motivate a DRS

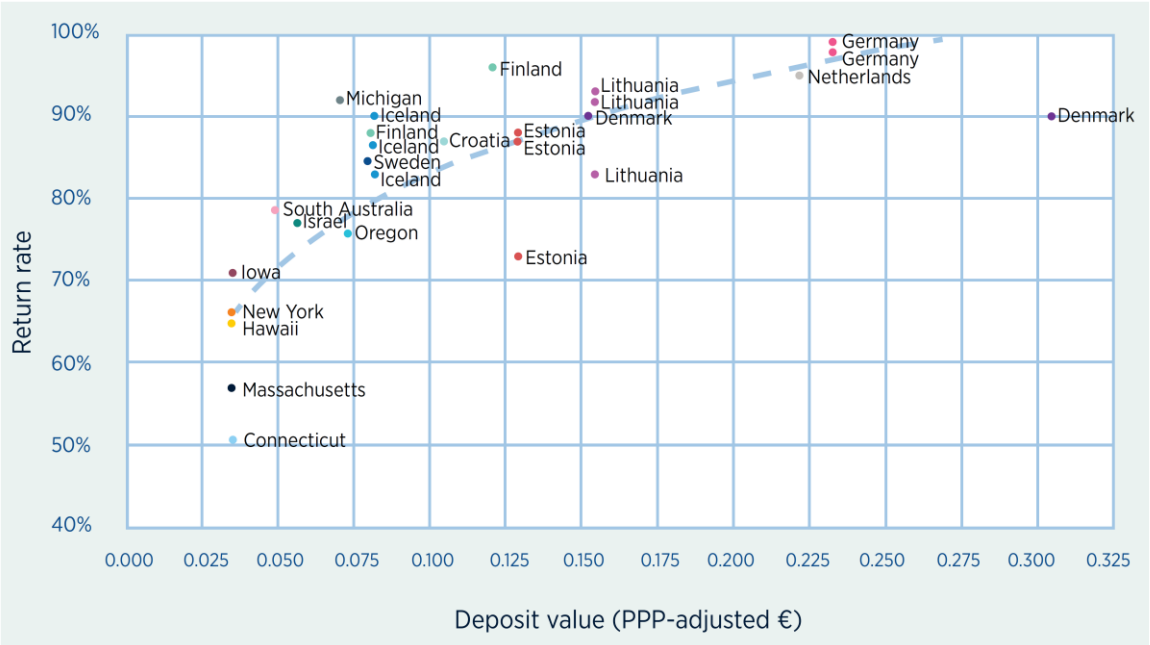
Objective	Impact of improved collection rate	Impact of improved quality of collected material	Example(s) of relevant waste flows
Strengthen incentives **against littering**	A deposit strengthens incentives against littering and illegal dumping in line with the polluter pays principle. It also provides an economic incentive for clean-up.		Beverage containers
Collect hazardous materials for **safe and environmentally sound treatment**	Reduces the risk of hazardous waste being improperly disposed of (flushed or mixed in municipal waste) and not being treated appropriately.		Batteries
Collect materials for **recycling**	Increases the supply of high-value recyclable material that is insufficiently collected under market conditions.	Reduces the cost of sorting and allows more material to meet food-grade recycling standards.	Plastic bottles
Collect valuable products/packaging for **reuse**	High-value items can be collected for reuse or another commercialisation (e.g. repurpose).	Improves reverse logistics to enable reuse or strengthen repurpose business models.	Crates, kegs, pallets, gas cylinders

3.2. Benefits of deposit refund systems for beverage containers

Evidence shows that a DRS can be effective in increasing collection rates of the targeted product or waste material. Countries and sub-national markets with a DRS for beverage containers can achieve collection rates of more than 90% for targeted materials. The size of the deposit fee drives incentives for consumers to participate in the programme and correlates with higher return rates (Figure 3.1).

Figure 3.1. Higher minimum deposit fees correlate with higher return rates

Rate of return vs. Purchasing Power Parity-adjusted minimum deposit values (in PPP 2018 EUR)



Note: Return rate is defined by TOMRA as the percentage of beverage containers sold with a deposit that are returned for recycling in exchange for the deposit refund. Markets with disaggregated data for return rate by material are represented with multiple bullet points.
Source: (TOMRA, 2021[14])

The high collection rates that DRS can achieve can generate substantial benefits. These can be in the form of direct economic gains and revenues (e.g. increased scrap income), indirect economic gains for other actors in the economy (e.g. reduced litter clean-up by public authorities or job creations), or non-market benefits (e.g. a cleaner environment).

Scrap income from recovered materials is a revenue stream that can help finance the costs of the DRS. DRS can increase scrap income by increasing the quantity of collection, as well as ensuring a high quality of collected material, by tying eligibility for a refund to quality criteria. For example, in Germany glass recovered though the DRS exhibited rejection rates between 1-4%, whereas glass recovered through bottle banks exhibited rejection rates between 18-26% due to higher contamination (Lee and Baker, 2018[15]). For some high-value materials, scrap income collected through the DRS can even lead to a net-profit for operators (e.g. aluminium cans in Norway). For most lower-value materials, however, recovery of more scrap material does not cover the full costs of operating a DRS.

For reuse systems, DRS can be attractive as it saves producers the costs of producing a new container. Reusable glass bottles have an average lifetime of 50 cycles and reusable PET bottles can be reused for up to 25 cycles (NABU, 2022[16]).

Table 3.2. Evidence of DRS increasing collection and improving recycling

Country	Description of evidence	Source
United States	In California, the implementation of the bottle deposit law led to an estimated net increase in recycled material of 36 to 51 percent.	(Ashenmiller, 2009[17])
	States with a DRS for beverage containers exhibit significantly higher collection rates[5] than states without such systems in place.	(Gitlitz, 2013[18])
	According to the Container Recycling Institute, PET scrap collected through DRS in US states obtains 40% higher prices than PET scrap collected through kerbside collection.	(TOMRA, 2021[14])
Canada	Provinces with DRS reach an average collection rate of 82% of all one-way beverage containers sold. This rate compares favourably to other provinces with kerbside collection, for example a 70% collection rate in Manitoba (2016) and 46% in Ontario, where non-alcoholic beverage containers are recovered through municipal kerbside collection and only alcoholic beverage containers are subject to DRS collection.	(Reloop, 2021[19]; CBCRA, 2017[20])

DRS is effective in reducing littering and improper disposal of targeted products. Empirical studies show that the inclusion of a product in a DRS reduces the observation of this product in littering surveys by 40-90% (Table 3.3). Attaching a deposit value to a waste material or reusable item not only disincentives improper disposal and littering, but also provides an incentive for collection and clean up. Reductions in littering can lead to lower public spending to clean up litter and reduced environmental damages.

Table 3.3. Evidence of DRS reducing littering

Country	Description of evidence	Source
Australia & the United States	In coastal debris surveys in the US and Australia the proportion of beverage containers littered on the coasts was found 40% lower in states with a DRS legislation for these containers than in states without a DRS.	(Schuyler et al., 2018[21])
Estonia	After the introduction of a DRS for beverage containers, the share of beverage containers amongst littered items along roadsides dropped from 80% to below 10%.	(Reloop, 2021[22])
Germany	The share of beverage containers amongst total litter dropped from 20% (in 1998) to "almost zero" two years after the introduction of a DRS on one-way beverage containers in 2005.	(PWC, 2011[23])

[5] Collection rates in the study are based on total weight of PET material collected in the US and purchased by domestic processors (re-claimers) or sold to export markets divided by the total weight of resin used in bottles in the United States (NAPCOR, n.d.[121]).

United States	In Maine, litter of containers subject to the bottle bill declined by 96% after two years of implementation. In Michigan, litter of beverage containers subject to a deposit fell by 80% after introduction of the bottle bill.	(US GAO, 1980[24])
	Beverage containers were an estimated 2.5 times more likely to be littered in Virginia than in states with bottle bills.	(Clean Virginia Waterways, 2020[25])
	Across the United States, substantially less per-capita litter was found in bottle bill states as compared to non-bottle bill states. Particularly, items subject to a deposit were found to be littered 50% less. The amount of litter items not subject to a deposit was still found to be 30% less in bottle bill states.	(Burns McDonnell, 2021[26])
	Beverage containers comprise a smaller share in NOAA debris collection survey data from states with container deposit laws (California, Hawaii, and Oregon) than states without (Alaska, Texas, Virginia, and Washington.	(Hardesty et al., 2017[27])
Denmark	Prior to 2018, imported beverage cans purchased in Germany were exempt from deposits as compared to beverage cans purchased in Denmark. Litter surveys and sales figures in 2017 showed that imported beverage cans (without deposit) are 3.3 times more likely to be littered than domestically purchased cans (with deposit).	(CE Delft, 2017[28])

Note: Studies use different methodologies to quantify litter and are thus not directly comparable to one another. See Reloop (2021[22]) "*Fact Sheet: Deposit Return Systems Reduce Litter"* for a more comprehensive review of existing evidence.

Unredeemed deposits of items that were not returned provide another revenue stream for a DRS. These revenues can be used to partially offset operating costs. However, heavily relying on unclaimed deposits for financing can lead to perverse incentives for collection (Box 3.1).

Box 3.1. The fate of unclaimed deposits

When a consumer does not return an item for a refund, the deposit fee is considered unclaimed or unredeemed. Redemption rates vary widely depending on a number of factors, primarily the deposit amount and the convenience to return the item. A certain share is also not returned due to damages to the item. Particularly in the first years after introduction of a new DRS, redemption rates can still be low as stakeholders adjust, resulting in a substantial amount of revenues from unredeemed deposits. For instance, in Lithuania revenues from unclaimed deposits amounted to 14.4 million EUR in the first year of implementation but decreased to 4.7 and then 4 million EUR in the following years as return rates increased (ACR+, 2019[29]). In Germany revenues from unclaimed deposits are estimated to amount to 180 million EUR per year (NABU, 2017[30]).

Unredeemed deposits can serve to offset operating costs of the DRS, to compensate the externalities caused by unreturned items, or a combination of both:

Offset operating costs of the DRS: Unredeemed deposits can be used to finance costs of operating the DRS. Heavily relying on financing from unclaimed deposits, however, can lead to perverse incentives, where optimal return rates lie below 100% from the perspective of the operator. Ambitious collection goals, together with effective deposit values and a convenient redemption infrastructure should thus help ensure that the system works towards maximum material recovery. In well-functioning systems with high return rates, unredeemed deposits generally cover less than 50% of operating costs (see Figure 3.2). Additional financial gains from unredeemed deposits can be reinvested to finance further improvements to the system. The Swedish clearing organisation for beverage containers, Returpak, is an example of a DRS operator that reinvests any net-profits to improve overall efficiency (Innowo, 2020[31]).

Fund government to compensate externalities: Public authorities can fully or partially assume ownership over the funds from unredeemed deposits as a source of public income. This income can be earmarked to cover costs associated with externalities caused by unreturned products that are being littered or disposed of in household waste (e.g. by contributing to public or PRO-run kerbside collection or by funding litter clean-up or prevention). Most "bottle states" in the United States escheat between 75-100% of unclaimed deposits. The revenue stream is commonly used to fund waste management, recycling or clean-up activities, or for environmental programmes (Bottle Bill Resource Guide, 2021[32]).

A DRS can also lead to indirect benefits to other actors in the economy and non-market benefits. For instance, it can reduce costs of clean-up for municipalities (Reloop, 2021[33]), lead to job creation (Morris and Morawski, 2011[34]), or provide bottle-collectors with an added income. Non-market benefits include a cleaner environment and avoided ecosystem impacts of littered items.

3.3. Costs of deposit refund systems for beverage containers

A DRS requires a financial system to manage deposits and distribute financial flows (i.e. a clearing system) and a physical infrastructure that includes collection points and the means for transporting and processing collected materials or products. Setting up the infrastructure involves significant one-off investment costs. Running the system incurs operational costs that are specific to different actors, including producers, distributors, retailers, and consumers. An important factor for these costs is the density of collection points and the type of collection, whether through manual collection (e.g. at retailers) or automated reverse vending machines (RVMs) (Box 3.2). Transport costs will be higher in DRS for reuse than DRS for recycling, due to heaver and more bulky material. DRS for recycling can greatly reduce transport costs if the DRS operates RVMs that compact collected material at source.

Box 3.2. Reverse vending machines – an important cost factor of a DRS

RVMs require significant capital investment, but have low operational costs and increase the ability to remotely monitor DRS data and generate automated reports that reduce risks of fraud (Zhou et al., 2020[35]). Manual collection on the other hand requires less capital investment, but has higher operational costs such as labour wages for manual counting, sorting and issuing refunds.

Previous estimates for the installation cost per RVM range from 30-41 thousand USD, but the cost can vary depending greatly on its functionalities (DEFRA, 2019[36]; CE Delft, 2017[28]). Leasing can be an option to avoid high upfront capital investment. For instance, in Lithuania, Latvia, and New South Wales (Australia), the DRS operator opted for a leasing contract, where the RVM company finances the system's RVM infrastructure and recuperates its investment through a "throughput" fee charged per container collected (Dundon, 2018[37]). In European countries with a DRS for one-way bottles, approximately 620 RVMs are in use per million inhabitants, though the density varies between countries (Table 3.4). Manual collection often complements RVM collection in more rural areas with less throughput. For instance, Norway operates around 11 400 manual collection points in addition to their 3 600 RVMs (Infinitum, 2018[38]).

Table 3.4. Reverse vending machines for beverage containers in selected OECD countries

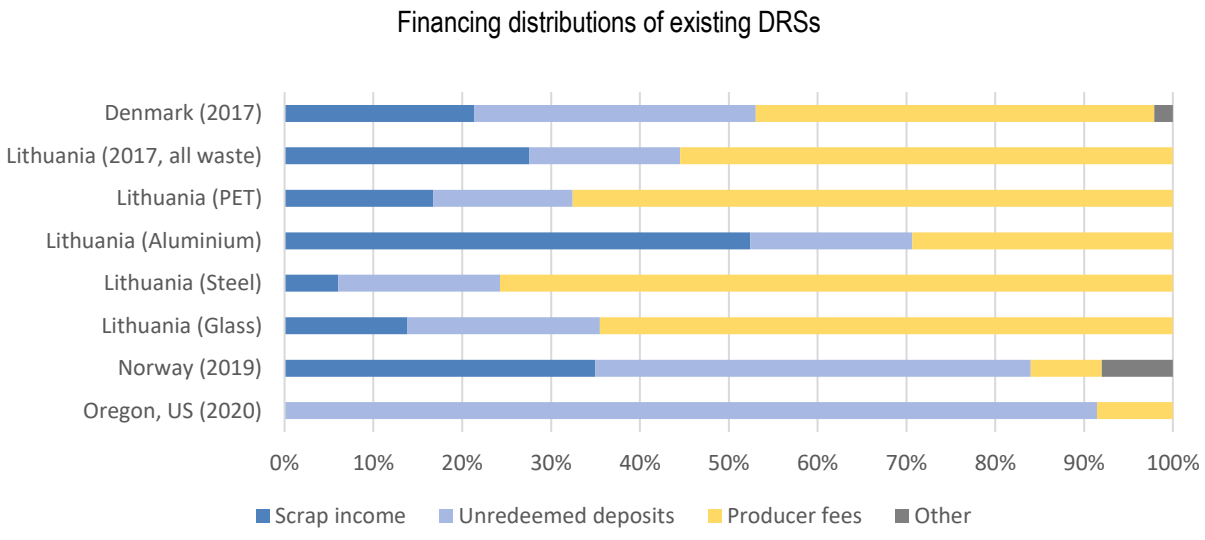
	Collection points overall	Automated collection point	Manual collection point	Number of RVMs	Inhabitants per RVM	Average Return rate (2019)	Automated return	Manual return
Norway	15 000	3 500	11 500	3 900	1 379	89%	93%	7%
Finland	4 600	3 000	1 600	4 000	1 383	93%	97%	3%
Germany	130 000	30 000	100 000	44 000	1 892	98%	90%	10%
Estonia	820	700	120	700	1 901	92%	94%	6%
Denmark		2 900		3 000	1 944	92%		
Sweden	12 600	3 100	9 500	5 100	2 029	85%		
Lithuania	2 500	800	1 700	1 100	2 540	92%	89%	11%
The Netherlands				4 200	4 152	95%		
Oregon (US)				717	5 883	86%	53%	47%

Sources: (OBRC, 2021[39]; Infinitum, 2021[40]) and presentations by System operators.

3.3.1. Distributional impacts for stakeholders

Where revenues from material sales and unredeemed deposits are insufficient to finance the full operating costs, remaining costs can be covered by producer fees in the form of an EPR, customer provision (through an additional non-refundable charge added to the product price), or public provision (Figure 3.2).

Figure 3.2. Operating fees help to cover costs of DRS



Note: "Other" covers, among others, revenues from interest.
Source: Data sources (ACR+, 2019[29]; Infinitum, 2021[40])

Implementing a DRS has distributional impacts for stakeholders (Table 3.5). Costs from unclaimed refunds are shouldered by the customer, but may serve as revenue to help pay for DRS provision or litter clean-up (Box 3.1). Producers incur costs to fund the operation of the DRS in the form of producer fees and these

may be higher than producer fees of other mandatory EPR instruments that would finance kerbside collection[6]. If producer fees are (partially) passed on through increased product prices they may also affect consumers. Producers that sell their products in multiple markets with DRS jurisdiction are likely impacted disproportionally, as DRS often require individual product labelling, and adjusting labels comes with additional costs.

Table 3.5. Costs and revenues associated with setting up a DRS

Stakeholder	Costs	Benefits, revenues or avoided costs
Producers	One-off: Costs to adjust production for new labelling requirement(s) Ongoing: Contributions to operating costs of clearing organisations and retailer handling fees*	Savings through improved reuse of products or better access to high quality secondary materials for recycled content
Retailers*	One-off: Installation of physical infrastructure; potential refits Ongoing: Lost retail space (space requirements likely higher for reuse); Handling deposit-bearing containers (emptying RVMs or manual take-back, reimbursing deposits, facilitating pick-up of collected material)	Handling fees*; Increased customer traffic in store
Clearing Operator	One-off: Setting up of central system; communicating the new system to the public Ongoing: Administering the system (distribution of financial flows, leasing of RVMs, transport logistics from collection points and retailers to recovery or treatment point)	Material sales revenues; Producer fees*; Revenues from unclaimed deposits; Interest earned on "float" (short-term returns from deposits in-hand)
Municipalities/ Taxpayer	One-off: Designing DRS policy Ongoing: If running costs are borne by producers, costs for municipalities should be minimal; Monitoring and enforcement; Foregone revenues in material sales of high-value waste stream (if waste is owned by municipalities).	Reduced litter clean-up and cleaner public spaces; Reduced load of waste collection, disposal, alternative treatment; Escheats of unclaimed deposits
Consumers	Ongoing: Unclaimed deposits; space requirements for temporary storage; lost time and costs for returning items	Litter-free environment; Income from collected bottles (canning)

Note: * In case of return to retail format. Handling fees can compensate costs incurred by retailers.
Source: Authors own

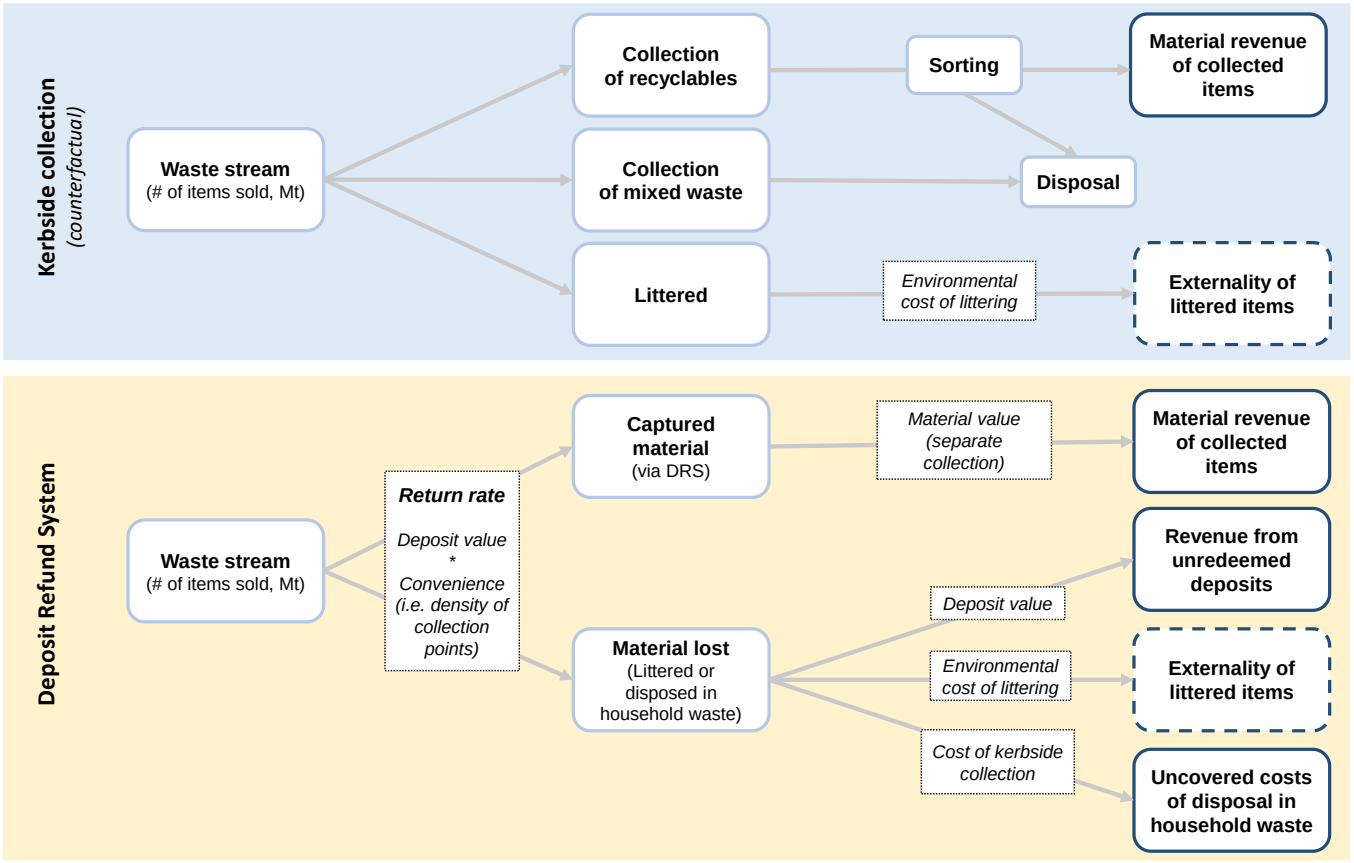
3.3.2. Ex-ante costing studies for establishing a DRS

Researchers, governments, and consulting firms have conducted numerous ex-ante studies to estimate the financial benefits and costs of establishing a DRS for beverage containers in particular locations (i.e. a specific municipality, region, or country) (Table 3.6).

These studies vary in scope, with some focusing on the financial costs and benefits for the public sector in municipalities, and others estimating all costs, including the costs to consumers and producers or clearing organisations. The degree to which non-market benefits and costs are considered in the analysis also varies. Figure 3.3 provides an overview of the different assumptions in key factors and variables that can influence results. Sensitivity analyses around some of these assumptions would help to better understand possible cost and benefit ranges.

[6] See Section 4.2.1 for a discussion on producer fees in PRO-run kerbside collection systems and DRSs.

Figure 3.3. Factors influencing the cost-effectiveness of a DRS



Note: Bold blue boxes depict market benefits/costs, dotted boxes depict non-market benefits/costs of setting up a DRS.
Source: Authors' own elaboration

Most of prospective studies conclude with net costs for producers for DRS implementation and operation, after revenues from unredeemed deposits and material sales are considered. These vary by material.

Several studies assess these added costs to producers against additional benefits to society resulting from DRS implementation and consequent higher return rates compared to other collection options. In a *total cost approach*, DRS implementation can be net positive for society if it leads to substantial reductions in littering that generate environmental and social benefits. However, establishing a monetary value for non-market benefits, such as reduced ecosystem impacts or an overall cleaner environment is challenging (Reloop, 2021[22]). One of the indirect but measurable financial benefits of reduced littering are avoided costs of litter removal incurred by Municipalities. Reloop (2021[33]) and Eunomia (2017[41]) provide an overview of studies that have aimed to quantify these to provide for a more informed policy decision for DRS implementation.

The recently introduced requirement at EU level for member states to pay 0.8 EUR per kilogram of non-recycled plastic packaging waste may result in further financial incentives to set up new policy instruments such as DRS (European Council, 2020[42]).

Table 3.6. Operating cost projections from different costing studies

Country/ Region	Currency	Description	Gross costs	Revenue material sales	Average revenue of unclaimed deposits	Net costs for producers	Source
Per-container costing studies							
Canada (Ontario)	CAD	Addition of DRS for non-alcoholic beverages and reduction in kerbside collection	0.0442	0.0168	0.0182	0.0091	(Edwards et al., 2019[43])
Czech Republic	EUR	DRS for beverage containers with 90% return rate	0.0216 (PET) 0.01835 (metal)	0.0125 (PET) 0.022 (metal)	0.0013 (PET) 0.00155 (metal)	0.0078 (PET) -0.0052 (metal)	(Cordle et al., 2019[44])
Ireland	EUR	90% return rate, PET bottles and aluminium cans	0.0384	0.009	0.018	0.0114	(Woods et al., 2019[45])
Netherlands	EUR	DRS for plastic bottles and aluminium cans (10-25 cents deposit)	0.015 – 0.037	0.008 – 0.01		0.004 – 0.029	(CE Delft, 2017[28])
New Zealand	NZD	Beverage containers; assumption of 79% return rate				10 million annually or 0.05 per container	(Envision, 2015[46])
Sweden	EUR		0.039	0.013		0.024	(CE Delft, 2017[28])
Scotland	GBP	10p deposit, 85% collection	0.025	0.008	0.015	0.0024	(Eunomia, 2015[47])
		20p deposit, 95% collection	0.027	0.009	0.01	0.0071	(Eunomia, 2015[47])
Slovak Republic	EUR	90% collection	0.025	0.012 (metal) 0.009 (PET)	0.012	0.015 (PET bottles) -0.005 (metal cans)	(Dráb and Slučiaková, 2018[48])
Spain	EUR	0.2 EUR deposit, 89% return rate	0.042	0.009	0.02	0.013 (0.007 if avoided EPR fees are subtracted) 0.004 (aluminium) 0.019 (steel) 0.014 (plastic) 0.023 (carton) 0.020 (glass)	(Fletcher, von Eye and Elliot, 2012[49])
Spain (Catalonia)	EUR	DRS for beverage containers (glass, plastic aluminium, steel, glass), 10c deposit, 86% return rate	0.0261	0.0069	0.0105	0.0087	(Eunomia, ENT Environment and Jimenez Parga, 2017[50])
United Kingdom	GBP	DRS for all beverage containers 0.15 deposit, 85% return rate	0.034	0.007	0.022	0.004	(DEFRA, 2019[36])
United Kingdom	GBP	DRS only for on-the-go beverage containers 0.15 deposit, 85% return rate	0.043	0.005	0.022	0.016	(DEFRA, 2019[36])
United States (Minnesota)	USD	Beverage containers, target of 80% return rate	0.1227	0.0162	0.1002	0.0062	(Gjerde, Hickle and Sandhei, 2014[51])

Country/ Region	Currency	Description	Gross costs	Revenue material sales	Average revenue of unclaimed deposits	Net costs for producers	Source
Absolute value costing studies							
Australia (Australian Capital Territory)	AUD	Cost-benefit appraisal FY2018-2037 for roughly 217 million containers	50.2 million				(ACT Government, 2017[52])
Australia (New South Wales)	AUD	Cost-benefit analysis for 20-year period 2016 to 2036 for 4.2 billion containers	857 million	104 million			(NSW EPA, 2017[53])
Australia (Tasmania)	AUD	Cost-benefit analysis for 20-year period for beverage containers				78 million	(Marsden Jacob Associates, 2014[54])
New Zealand (Auckland)	NZD	10 cent deposit for roughly 80% manual collection of beverage containers alongside kerbside collection, NPV over 5 years	313 - 912 million	7.9 - 18.5 million annualised			(Davies, 2017[55])
United Kingdom	GBP	DRS for all beverage containers 0.15 deposit, 85% return rate Units: 23,779,545,079	818 million	176.6 million	535 million	106 million	(DEFRA, 2019[36])
United Kingdom	GBP	DRS only for on-the-go beverage containers 0.15 deposit, 85% return rate Units: 7,414,578,826	321 million	37 million	166,8 million	284 million	(DEFRA, 2019[36])
United States (New York)	USD	Expansion of current DRS to additional beverages and increase in deposit fee from 0.05 to 0.1	250 million total handling costs (increase 40%)	22 million increase (40%)	45 million increase (34%)		(Edwards, Kelly and Grushack, 2019[56])
United States (Vermont)	USD	Expansion of beverage containers DRS to water, juice and sports drinks.			1.27 million additional revenues	0.035 handling fee per container	(CM Consulting, 2012[57])
United States (Washington State)	USD	10 cents on bottles and cans. Estimated 90% return rate	95.8 million	28.1 million	36.4 million		(Morris, 2005[58])

Note: Net-costs assume that revenues from material sales and from unclaimed deposits are fully used to offset gross costs of the DRS. The remaining net costs are assumed to be borne by producers.

3.4. Considerations for the design of a DRS

3.4.1. Voluntary or mandated by regulation

The drivers for implementing a DRS include:

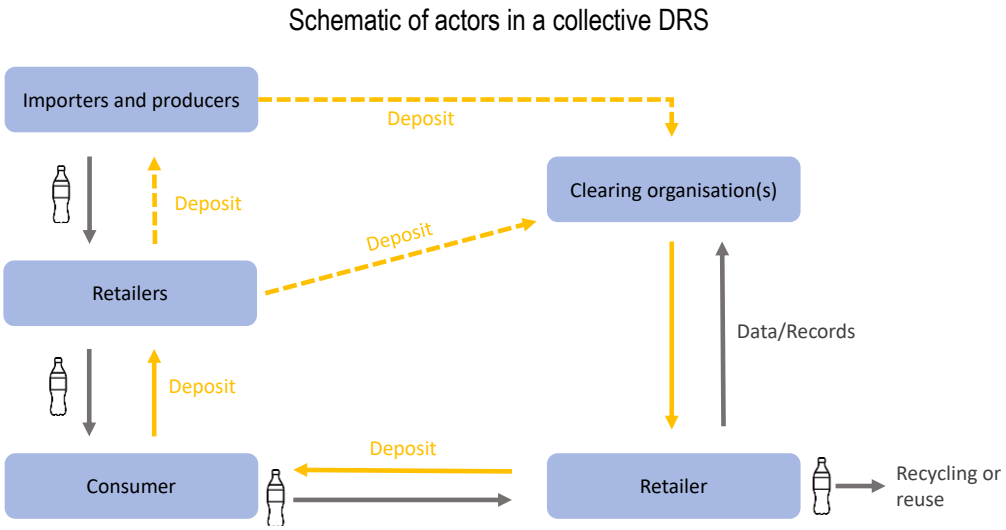
- Business model: If the value of an item or material is high, there can be sufficient incentive for producers to set up a DRS voluntarily to recover products or packaging for reuse or recycling. For example, Soda Stream and various propane and butane gas suppliers set up a DRS for their reusable gas bottles (EMF, 2019[59]; Conseil national de l'emballage, 2016[12]). As well, many DRS for reusable beverage containers are voluntary systems set up by industry.
- Direct public intervention: There is a need for policy intervention where there is an important and identified reason for separate recovery of items that would not otherwise happen on a commercial basis. For instance, a DRS for purposes of avoiding littering of low-value materials or ensuring the collection of hazardous waste streams creates a common good but is unlikely to have a viable business case as the market-value of the recovered waste material is relatively low. In these cases, regulation can mandate a DRS to ensure an optimal outcome for society.
- Indirect public intervention: Mandatory targets on environmentally sound management of waste, collection or recycling rates or recycled content can push industry to implement a DRS in order to meet these targets. For example, the European Single-Use Plastic Directive will require Member States to collect 77% of SUP bottles by 2025 and 90% by 2029. The directive also includes a 30% PET recycled content target for 2025. Beverage producer associations have urged the EU to acknowledge the role of a DRS to ensure such a quantity of high-quality recycled material and develop guidance for new DRS implementation in Member States (UNESDA, 2021[60]). Producers may also wish to implement a DRS voluntarily to pre-empt legislation or to avoid liability to other producer responsibility schemes or participation in other EPR schemes (e.g. kerbside collection). In Norway the beverage industry implemented a DRS voluntarily to reduce liability to an environmental tax on products that exhibit a low collection rate (see Box 4.5). Also in Finland exemptions from beverage packaging taxes incentivise DRS participation (Palpa, 2022[61]).

3.4.2. An individual firm system or a collective deposit refund system

In their most simple form, DRS are based on direct relations between a consumer and an individual producer or retailer. The customer both pays a deposit and receives a refund from the same producer or retailer in exchange for returning the item for reuse, refurbishment or specific material recovery. An individual DRS gives a producer flexibility in management of the programme, but the constraint to return items to the specific point of sale requires efforts by the customer and may lead to lower return rates (OECD, 2015[62]).

In a collective DRS with multiple producers and retailers, the consumer is not limited to a point of sale, but can return the EoL item at any participating retailer or collection point. A clearing organisation handles the financial flows of deposits and redemptions and is responsible for administrative and organisational aspects (Figure 3.4). A visual marking indicates which products are covered by the DRS (Box 3.3). There can be one central clearing operator (e.g. in Norway's DRS for beverage containers), or a decentralised system with multiple clearing organisations (e.g. Germany's DRS for beverage containers). The clearing can also be entirely state-run (e.g. Croatia's or California's DRS for beverage containers).

Figure 3.4. A collective DRS includes a clearing organisation to organise financial transactions between multiple actors



Note: Different DRS models exist, with deposits being charged either directly to retailers, or to importers and producers.
Source: Authors' own elaboration, adapted from (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 2018[63])

Box 3.3. Visual marking and labelling in a DRS

Visual marking and labelling is an important element of a DRS, as it indicates to consumers, retailers and RVMs the eligibility of an item for refund and helps to define the scope of a DRS. Visual marking increases customer awareness about a DRS and helps to minimise fraudulent activities (Alpizar et al., 2020[64]).

3.4.3. Deposit fee structure

A DRS requires the customer to pay a deposit at the point of purchase. Generally, the higher the level of the deposit, the higher the incentive for the customer to return the product after its use. Some beverage container DRSs set different fee schedules for different materials (i.e. glass, metal, or plastic) or for different sizes. Increased granularity helps to adjust incentives, but complicates the clearing or deposits. Too high a deposit and refund can give incentives for consumers to avoid covered material (i.e. substituting toward products with lower or no deposits) and for fraudulently returning material (Eunomia, 2021[65]).

The deposit fees should create a sufficiently strong price signal for users to return the item. Purchasing power leads to variation of deposit values between countries. To keep pace with inflation and to mitigate erosion of incentives over time, fee schedulers should update charges periodically.

Depending on the system design, the deposit rate can be inspired by the forgone benefit of capturing the material/item or the external costs that are associated with the impacts that the waste/item generates if not collected and disposed of improperly:

- The deposit fee can compare with the lost anticipated value of reuse or recycling revenue. For example, the value that could have been recovered from refurbishing an EEE product for reuse, from re-using a reusable container, or the value of the secondary material from recyclables that would otherwise not be recovered.

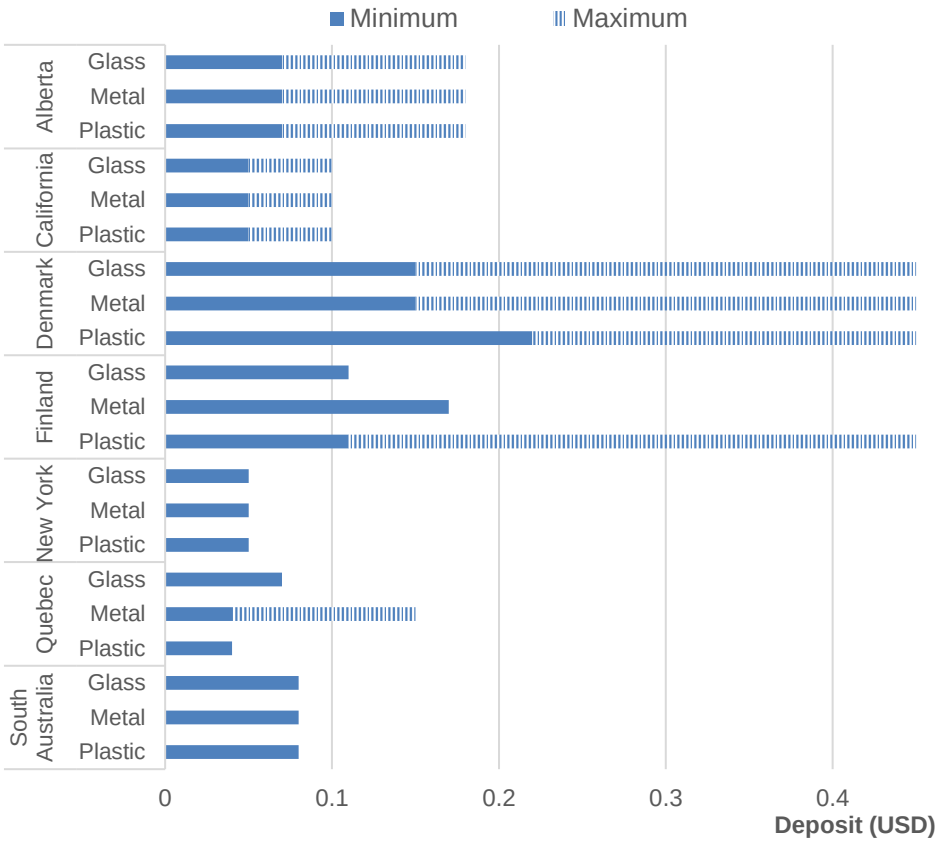
- The deposit fee can also compare with the environmental or health costs that the item or waste stream generates when handled improperly (e.g. entering regular waste streams), littered, or fly-tipped (OECD, 2015[62]). For instance, a deposit could amount to the cost of improper disposal of hazardous waste (e.g. batteries) in municipal solid waste, or the cost of beverage containers when littered.

Different approaches can result in different deposit fees. Based on the first approach, a larger PET bottle would receive a higher deposit value than a smaller one, whereas based on the second approach a smaller container could arguably receive a higher deposit if one assumes that it is more likely to be consumed on-the-go and littered. Figure 3.5 shows different country approaches, with some adjusting deposit fees based on material type (e.g. Finland and Denmark) and others on product size (e.g. Alberta and California). Other governments have opted for simpler, more harmonised rates, with no differentiation by material or size (e.g. New York and South Australia).

Deposit fees can also vary between deposit charges for recycling and reuse. For instance in Germany and the Netherlands, DRS for reusable bottles is a voluntary system and the deposit is set by producers, corresponding to the production value of the bottle, whereas the DRS for recycling is mandatory and the fee is set by public authorities.

Figure 3.5. Deposit fees vary by size and material in beverage container DRSs

Minimum and maximum deposit fees by material and container size for select countries or sub-national markets

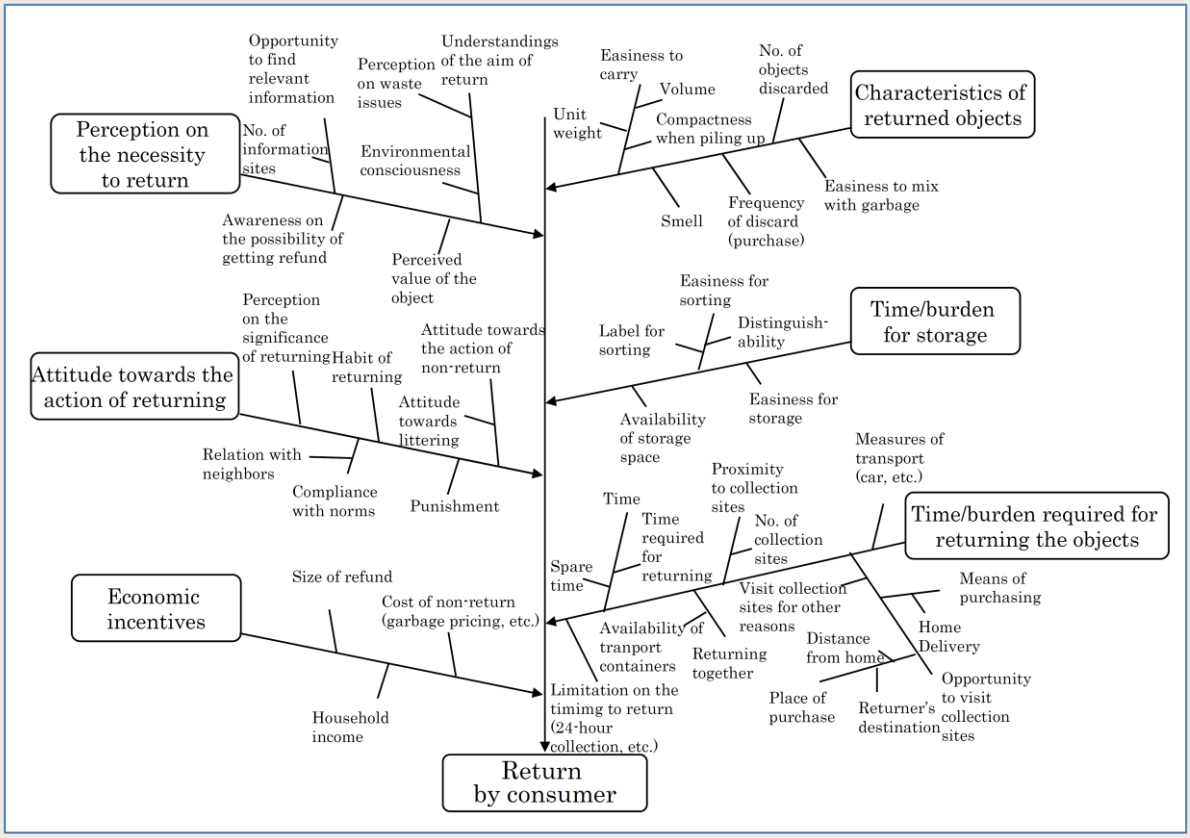


Note: Deposit amount depicts the lowest/minimum and highest/maximum fee value
Source: Author's own based on (Reloop, 2020[11])

Box 3.4. Additional "soft" factors influence return rates in DRS

Besides the deposit value, several "soft" factors further influence consumer return rates, such as the time and effort required for returning the object, the perception on the necessity to return, attitudes towards the action of returning, characteristics of returned objects, cleaning and the time or inconvenience of temporary storage and cleaning items (Tasaki et al., 2010[66]).

Figure 3.6. Factors influencing consumer return rates



Source: (Tasaki et al., 2010[66])

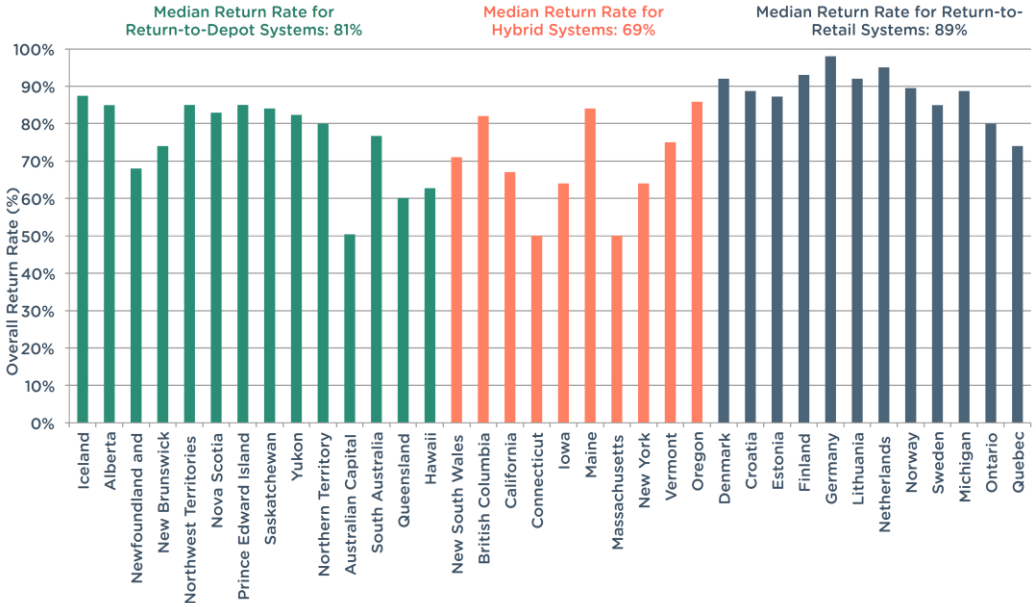
3.4.4. Type and amount of collection points

Collection points are where consumers return items and receive their refund. Collection points are responsible for reporting return data and collected material to the clearing organisation. Often, the collector receives a handling fee as compensation for the cost incurred or is able to keep some of the revenue from scrap sales or unredeemed deposits (Box 3.5).

Different redemption systems exist: return-to-retail models, where retailers are obliged to collect containers, or return-to-depot models, where consumers return items to separate redemption centres. Variations of the return-to-retail model are frequently in use in Europe, regularly achieving high return rates of 90% or more as they offer a convenient redemption option without additional trips required. Return-to-depot models are more common in the US and Canada. Return rates in return-to-depot models depend

on the density of depots, which tends to be lower than in return-to-retail systems (Figure 3.7) (Reloop, 2020[11]).

Figure 3.7. Return rates by redemption system in different markets



Note: DRS coverage of products and materials varies by jurisdiction.
Source: (Reloop, 2021[19])

Box 3.5. Handling fees for collectors

Handling fees help ensure an efficiently running DRS, in particular in jurisdictions, where retailers do not face legal obligations to take back containers. Handling fees are intended to act as compensation for the costs associated with collecting and sorting container returns, such as those related to extra labour (for manual collection), the purchasing or leasing of RVMs (for automated collection) and space requirements for storage of collected material.

Handling fees are a per unit compensation, that is ideally modulated depending on the mode of collection, to accurately reflect cost implications. For instance, handling fees for RVMs with compaction should be higher than manual collection to reflect higher capital costs and the benefit of reduced transport costs of compacted containers to clearing operators. This is the case in most European countries, such as Norway, Sweden, Lithuania or Estonia.

Handling fees should be dynamic and updated regularly to reflect true costs, and to incentivise cost efficiency improvements. If handling fees are static, the compensation value risks losing its connection to the actual costs incurred over time, reducing incentives for retailers to participate. For instance in Connecticut, US, fees were defined by legislation in 1983 and not updated since, which lead to more and more redemption centres struggling to cover costs and closing down. An additional concern of fixed handling fees that are defined in legislation is that fee updates can be a lengthy legislative process through which legislators are subject to political lobbying.

Note: See (Reloop, 2021[67]) for best practices of modulating handling fees.

3.4.5. Transboundary movement and redemption

Considerations of transboundary movements and redemptions are particularly important in federal countries and regional markets with varying DRS policies in place or large cross-border flows.

Differences in refund values within a country or region can incentivise illicit redemptions and costs to DRS operators if items are not marked properly. For example, in 2018, Californian law enforcement authorities detected a criminal operation to traffic containers from Arizona (a state without a DRS) to California that was estimated to have fraudulently redeemed 16 million USD over a period of three years (Staub, 2018[68]). In 2012, government officials estimated losses due to fraudulent out-of-state redemption activities in California at 40 million USD per year (Garrison, 2012[69]). Similar activities likely occur in other US "bottle sates", such as Oregon's border with Washington (United States), where the Oregon Beverage Recycling Cooperative (OBRC) estimates illegal redemption to amount to 10 million USD per year, 5% of Oregon's total redemptions (Oregon Audits Division, 2020[70]). An analysis of Vermont's Bottle Bill estimated that 10% of its redemptions were purchased outside the state (Beverage Association of Vermont, 2006[71]).

Visual marking and digital technologies, such as bar codes or RFID codes can help to prevent fraudulent or inappropriate redemptions, as these technologies enable storage of information about the point of purchase (see Box 3.3). However, changing the product design for specific regions within a uniform market is costly for producers, such that operators and producers in the United States have so far opted for other measures to combat fraudulent activities. For example, Oregon's clearing organisation limits the number of containers that can be redeemed per person per day to 350 (Oregon.gov, 2021[72]).

Large cross-border flows of products can also have financial implications for the importing country's waste management system (Hogg et al., 2011[73]). The case of cross-border trade of alcoholic beverages between Germany and Denmark and Sweden and Norway illustrates how these markets adopted measures to address pressures on waste management systems (Box 3.6).

Box 3.6. Cross-border DRS adjustments – the case of Denmark, Germany and Norway

An estimated 600 to 700 million cans of alcoholic beverages are purchased in Germany and brought to Denmark for personal consumption annually. Beverage cans bought for consumption abroad have traditionally been exempt from German deposit fees and are also not subject to a refund in Denmark. Litter surveys in Denmark have found that beverage cans purchased abroad were 3-4 times more likely to be littered than cans purchased domestically. Similar transboundary flows of alcoholic beverages exist from Germany to other Nordic countries and from Sweden to Norway. Whilst exemption of deposit fees for beverages consumed abroad is not always the norm, DRS participation remains an issue as containers are often not eligible for a refund abroad.

Denmark and Germany agreed in 2015 to adopt an arrangement whereby customers can select whether to pay a Danish or German deposit charge on the bottles or cans they buy in German border shops. The customers will be able to return the cans or bottles for a refund in either of the two countries. However, the start date for the cross-border deposit system remains to be determined. Norway and Sweden are likely to join this agreement in the future.

The Norwegian deposit system Infinitum started to accept Swedish beverage cans, but without paying refunds, with the intention to keep these cans from entering the general household waste stream.

Source: (ACR+, 2019[29]).

3.4.6. Complementary information and nudges to increase DRS participation

Awareness campaigns can help increase DRS participation by consumers. For example, New South Wales accompanied the introduction of its DRS with its “return and earn” campaign to encourage participation by consumers (Return and Earn NSW, 2021[74]). Lithuania’s deposit legislation specifies that 1% of the annual turnover of the clearing organisation should be spent on public education and communications (TOMRA, 2021[14]). The initiative “Every bottle helps” (“Pfand gehört daneben”) encourages consumers to place deposit beverage packaging they decide not to redeem next to the bin, which allows others to collect and return the items and prevents them from entering mixed waste (Every Bottle Helps, n.d.[75]).

Small adjustments to the physical surroundings can also prevent deposit items from entering mixed waste. For example, some municipalities in Denmark, Germany and The Netherlands have installed “Deposit-rings” on public waste bins, which can hold deposit bottles that consumers decide not to redeem. These can then be picked up by bottle collectors (Doneerring, 2021[76]).

Gamification of DRS participation can further promote recycling habits. The Swedish DRS operator Pantamera offers a competition for primary school children to recycle the most beverage containers. School classes compete for a prize. The winner is the class which can travel the farthest by train per person with the energy saved from the recycled materials. The initiative engages over 100 000 students per year (Pantamera, 2021[77]). Charitable donations can also encourage returns and several deposit refund programs offer the opportunity to raise funds for donations.

4 The interplay of DRS and other mandatory EPR instruments

DRS and other mandatory EPR policy instruments, such as product take-back requirements or an ADF, can complement each other in achieving resource efficiency and circular economy goals. This chapter discusses possible synergies and considerations between DRS and other EPR policies. Most relevant examples are appearing for DRS for beverage containers, but insights from this chapter are also applicable to other items subject to a potential DRS within a broader EPR framework.

Public authorities and PROs in numerous markets are considering how best to combine DRS for specific products and other EPR policies for a sector to meet their waste management goals. Some European markets have product take-back requirements without a DRS in place (e.g. France for packaging). In these markets, DRS for beverage containers is being considered as a means to increase collection rates. On the other hand, several states in the United States and provinces in Canada have a DRS policy for one-way bottles, but do not have other EPR policy instruments for general packaging. Oregon and Maine (United States) have recently enacted laws that will require EPR in the form of product take-back requirement for general packaging in the near future and more US states are considering similar EPR legislation. Both, Oregon and Maine are “bottle states”, with a DRS for beverage containers that will continue to operate in the new framework.

4.1. Synergies of DRS and other EPR instruments

4.1.1. A DRS for products within an EPR approach for a sector can improve the quality and the quantity of recycling

A DRS can improve the quantity and quality of collected material, facilitating producers’ ability to meet increasingly ambitious EPR obligations for recycling (Table 4.1). Whilst kerbside collection used to be sufficient to meet EPR obligations, some industry observers now consider DRSs to be necessary for producers to meet more ambitious public collection and recycling targets.

Table 4.1. A DRS and other EPR instruments can together improve quality and quantity of recycling

	Quality of recycling	Quantity of recycling
DRS	• Separate collection of targeted materials • Incentives to design for recycling • Incentives to implement reuse systems	• Increased return rates by consumers
EPR	• Separate collection infrastructure • Awareness campaigns • Take back requirements can increase collection sites • Incentives for design for recycling	• Recycling targets push supply • Recycled content requirements pull demand

Source: Authors own

The European Single-Use Plastic Directive aims at a collection rate of 90% of single-use plastic (SUP) bottles by 2029. A study by Collectif Boissons for the French market concludes that the 90% collection goal for PET beverage containers can only be reached with a DRS in place (Collectif Boissons, 2019[78]). A study by the French Environmental Agency concludes that it would be ambitious (but not impossible) to meet the 90% collection target without a DRS, but a DRS would be more cost-effective (Collet, 2021[79]). The United Kingdom has proposed to introduce a DRS for beverage containers in conjunction with an adaptation of its EPR scheme in the near future (see Box 4.1). Outside of the packaging sector, the European Commission has awarded a contract for a study to assess the possibility of a DRS for batteries to increase collection rates of the current battery EPR (European Commission, 2020[80]).

As well, increasingly ambitious recycled content requirements (e.g. in the EU and California)[7] will bolster demand for high-quality secondary material. DRS can help to meet the increased demand with bolstered supply of high-quality secondary materials.

As well, a DRS can help to meet recycling targets for food-grade applications. In Europe, the European Food Safety Authority (EFSA) requires that no more than 5% of the plastic waste input used for food-grade secondary materials comes from non-food-contact applications (EFSA, 2012[81]). DRS facilitates the production of food-grade secondary material, by isolating food-grade packaging through separate collection. Most PET collected through a bottle DRS is used in bottle-to-bottle applications, whilst food-grade packaging collected kerbside risks being co-mingled with non-food grade material, which jeopardises its use for food-grade applications.

Box 4.1. Packaging case study United Kingdom: Introducing a DRS and adapting its existing EPR framework for packaging

Governments in the United Kingdom have committed to introducing a DRS for one-way beverage containers as part of their efforts to increase resource productivity. The UK Department for Environment, Food and Rural Affairs (DEFRA) conducted impact assessments of several options for a DRS in England, Wales, and Northern Ireland (DEFRA, 2021[82]). In parallel, DEFRA also assesses the possibility to update its kerbside collection EPR for packaging waste, which would supersede the current permit and trade system. It is planned to include full financial responsibility for producers including payments for management of litter, mandatory recycling targets and incentives for design change. Modulated fees and labelling requirements are also considered (DEFRA, 2021[83]) (DEFRA, 2021[84]). The revised EPR scheme is implemented in a phased approach starting from first payments to local authorities in 2023. It would cover packaging waste other than what is covered by the DRS (Zero Waste Scotland, n.d.[85]).

Scotland is planning to implement its own DRS for beverage containers in August 2023, with a target collection rate of 90% (Zero Waste Scotland, n.d.[86]). Scotland will also be part of the UK-wide approach to adapt to a new EPR scheme for packaging.

The efforts to implement a DRS and adapt the existing EPR scheme for the packaging sector are meant to be complementary. To avoid double-coverage products covered under the DRS will not be liable to other EPR payments. However, whilst beverage containers subject to DRS are excluded, the accompanying packaging, such as multi-pack wrappers, will be covered by the kerbside EPR (Zero Waste Scotland, n.d.[85]).

[7] The EU Single-Use Plastics Directive requires plastic bottles to be made of at least 25% recycled content by 2025 and 30% recycled content by 2030 (European Parliament, 2019[119]). Starting in 2022, California's Assembly Bill No. AB-793 will require a minimum share (up to 50% in 2030) of post-consumer recycled plastic for plastic beverage containers (California Legislative Information, 2020[120]).

Evidence shows, that introducing a DRS for specific products into a market where this product was previously covered by a kerbside collection EPR can lead to a significant increase in collection rates. For example, Lithuania introduced a DRS for one-way bottles and cans in an already existing EPR scheme for general packaging. After implementation of the DRS, collection rates for bottles and cans increased from 34% in 2016 to 92% within two years (Enviro30, 2020[87]).

Box 4.2. Packaging case study France: Complementing the existing EPR with a DRS

France currently has an EPR scheme in place for packaging and paper products. The largest producer responsibility organisation (PRO) operating in the sector is CITEO. The EPR policy requires producers to take financial responsibility for their end-of-life products by financially supporting the municipalities that remain in charge of the physical management of paper and packaging waste. France currently has a collection rate of roughly 55% of plastic bottles, which will need to increase to 90% by 2029 to meet requirements of the EU SUP Directive.

The French public sector at the national and municipal level and CITEO are considering the introduction of a DRS for beverage containers as a means for increasing the collection rate. One key consideration regards the physical responsibility of material collected via a possible DRS. France currently runs a financial EPR, in which ownership of waste and revenues from secondary material sales remain with municipalities. The conflict over the ownership of collected waste has temporarily halted plans for implementation of a DRS for one-way bottles. Whilst previous discussions have been focused on plastic bottles, future decisions may seek to include cans in a larger programme for beverage containers.

Meanwhile, CITEO is developing a DRS in the overseas territory Guadeloupe, to improve lower than average collection rates and to reduce high littering rates of plastic packaging on the island. The DRS in Guadeloupe is considered a pilot project for a possible nation-wide DRS (Plan Climat, n.d.[88]).

4.1.2. A DRS can enable reuse systems

Most current EPR schemes are focused on increasing recycling and measured by recycling or collection targets. As governments aim to increase reuse rates, DRSs will be a key addition to the existing EPR policy landscape, as it helps to facilitate the necessary physical movement of returnable packaging between consumers and producers. It is important to note that reuse systems are not in all cases preferable from an environmental, cost or innovation perspective (Coelho, Corona and Worrell, 2020[89]).

Barriers to reusable systems include transport distances, return rates, ease of sorting and cleaning (handling), and performance in protecting the product (Coelho et al., 2020[90]). The handling costs of DRS for reuse are likely higher than the ones of DRS for single-use containers since reusable containers cannot be shredded or compacted and thus require more space for storage and transportation. There is a strong incentive to standardise containers in DRS for reuse to one harmonised packaging pool shared by producers to keep operational costs low and to minimise the complexity and costs of sorting, transportation and logistics (Coelho et al., 2020[90]). A DRS that involves long transport distances (of relatively heavier packaging) for returning refillable containers to specific producers may result in higher lifecycle environmental impacts than single-use DRSs. Pooled reuse systems with minimised transport routes can be more environmental and cost efficient, but can create barriers for packaging innovation.

Most existing DRS for reuse are industry-specific and voluntary schemes run by producers. Reuse DRS are most common for refillable beer bottles, mineral water and lemonades, milk bottles and yoghurt containers. For example, Oregon has initiated a programme with craft beer breweries in the state (see Box 4.3) and similar reuse DRS for beer and other refillable beverage container exist in many other countries, like Germany, Austria, Denmark or the Netherlands (Bottle Bill Resource Guide, 2022[91]).

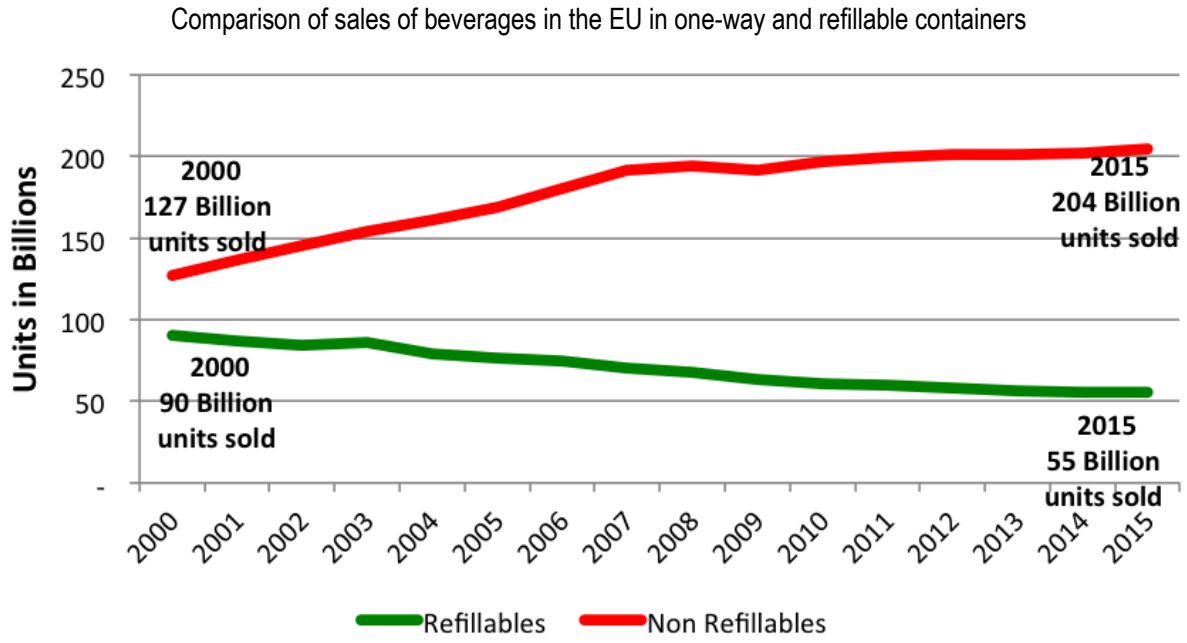
Box 4.3. Refillable bottles: Oregon's BottleDrop programme

Oregon's BottleDrop Refillable Bottles programme is currently the only state-wide refillable bottle programme operating in the United States. A collection of ten brewing companies participates in the programme by offering their customers their products in refillable bottles. The bottles are subject to the same deposit fee and redemption rate as one-way bottles. After use, customers can return the bottles at the same locations as one-way bottles and may even co-mingle the bottles. Refillable bottles are distinguishable due to their unique conical shape and several markings at wear points (OI, 2018[92]). The programme has just under one million refillable bottles in circulation (OBRC, 2021[39]).

Source: (BottleDrop, n.d.[93])

Cheap prices for virgin material, notably plastics, combined with the importance of brand image and convenience, have led to a gradual replacement of reusable beverage containers with single-use containers. From 2000 to 2015, annual sales of one-way beverage containers in Europe grew by roughly 60%, while sales of refillable beverage container declined by approximately 39% (Figure 4.1).

Figure 4.1. Sales of beverages in one-way containers outpaced those in refillables



Source: (Reloop, 2016[94])

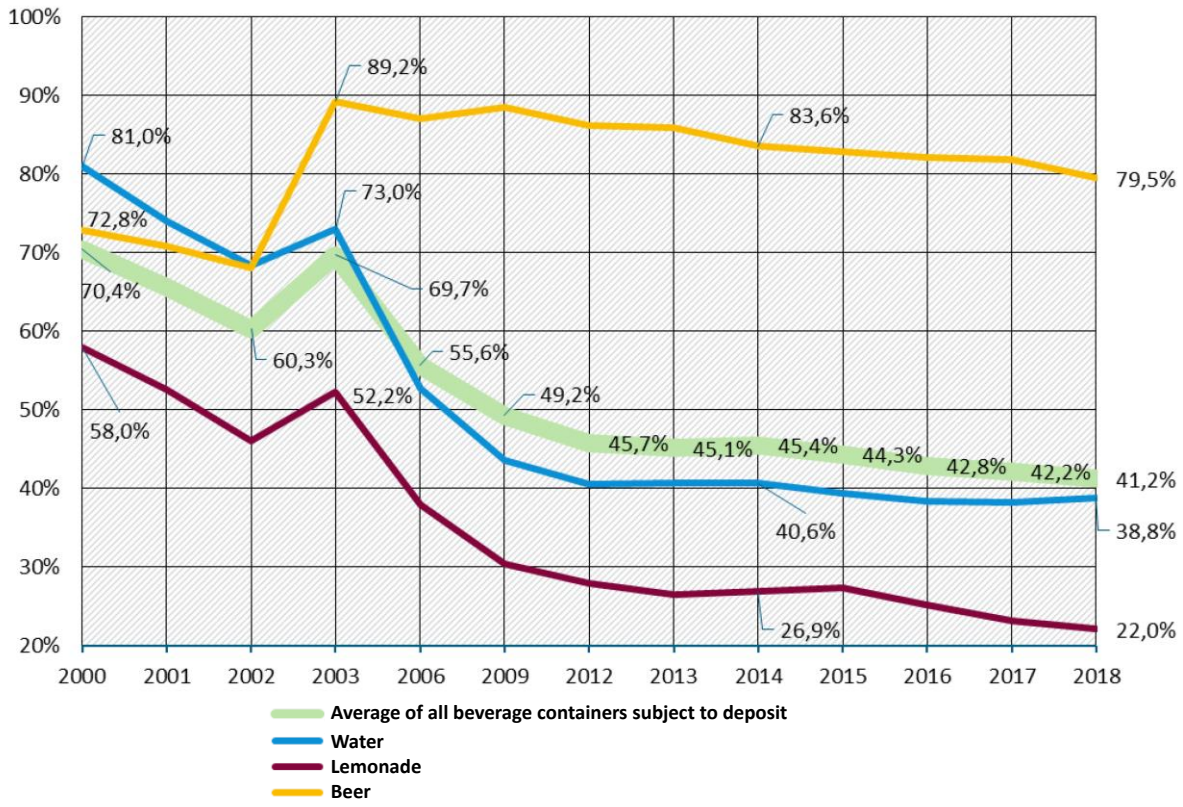
Several countries have implemented policy measures such as taxes or mandatory DRS on single-use containers to encourage reuse, but many of these seem to have failed. In Germany, for instance, a mandatory DRS for single-use beverage containers was introduced in 2002 with the aim to increase the relative attractiveness of reusable containers and help level the playing field. But the policy had only limited effect: the decline in the share of reusable beverage containers of the product categories subject to a DRS[8]

[8] Some product groups are excluded from the mandatory DRS in Germany based on the current stand of the Packaging Law (VerpackG), most notably dairy products, juices and wine.

halted temporarily but continued in the following years. Beer bottles were the only type of beverage container in which the share of refillable beverage containers remained high, likely due to consumer preferences (Figure 4.2).

Figure 4.2. The share of refillable beverage containers decreased in nearly all sectors

Market share of refillables for key product groups covered by the single-use DRS in Germany 2000-2018



Source: (Umweltbundesamt, 2020[95])

In recent years, there have been initiatives to promote reusable packaging but these programmes have not yet reversed the general decline in the use of refillable containers. Well enforced reuse targets are likely needed to work towards higher reuse shares. The current emphasis on recycling targets in existing EPR schemes can conflict with achieving reuse targets and EPR performance targets would need to be adjusted to also include a reuse component where this is deemed environmentally preferable (see Section 4.2.2).

4.1.3. DRS is more effective in addressing littering than other EPR instruments

Littering strongly depends on consumer behaviour, an externality that consumers can only limitedly influence. As such, it is challenging to incorporate it in EPR fee structures of ADFs or product take back requirements implemented collectively through PROs (Laubinger et al., 2021[7]). A deposit works as an effective incentive for consumers to return the material, whilst a forgone deposit can act as a payment for clean-up of littered items, in line with the polluter pays principle. A producer-financed DRS is thus an effective way to incorporate littering externalities in EPR.

4.1.4. DRS can provide incentives for eco-design

EPR policy instruments such as ADFs and take back requirements have been effective in increasing recycling rates and providing financial support for waste management services. However, there is little evidence to suggest that these instruments have instigated Design for Environment (DfE). More and more countries are currently exploring options of eco-modulation of EPR fees to provide a stronger economic incentive for DfE (Laubinger et al., 2021[7]).

A DRS that is implemented in the form of an EPR makes producers pay an administration fee to recover operating costs and eco-modulation of these fees can provide eco-design incentives for producers. When DRS participation is optional, the DRS can define criteria for participation, such as in Norway. When DRS participation is mandatory, a modulated producer fee can incentivise design changes, such as in Sweden or Croatia (Box 4.4).

Box 4.4. Examples of eco-design incentives in DRS

The operating company of the **Swedish** bottle DRS Pantamera modulates fees charged to producers based on recyclability. Whilst the administration fee is charged based on the capacity of the container, an additional sorting fee is charged for coloured PET bottles, bottles made of other plastics and steel cans (Innowo, 2020[31]).

The **Norwegian** DRS requires approval of a bottle design prior to participation. Only certain designs are allowed and producer fees of accepted bottle designs are modulated based on recyclability. Supplementary producer fees are charged for less-recyclable bottle designs, such as coloured bottles or coloured sleeves that cover 75% of the packaging (Infinitum, 2021[96]).

The state-run **Croatian** DRS charges a fee to encourage producers to switch to reusable options. It is paid until the producer sells a target share of reusable items. The fee amounts to 0.045 – 0.15 USD per container depending on size and material type and is charged on top of other participation fees (Bottle Bill Resource Guide, 2022[97]).

4.1.5. Digital technologies can improve the functioning of DRS and other policies

Item-specific DRS labels or barcodes can facilitate the collection of valuable information, such as material flows, the point of sale and collection, the return rates of specific product groups, or the length the item was in use. Automated RVMs that collect and process this data in real-time allow DRS operators to further optimise the system and provide useful insights on customer behaviour. For instance, it enables to analyse return-rates based on products, regions and seasons and allows to launch more targeted awareness campaigns and optimise collection schedules and routes. It also enables more detailed reporting of collection and recycling data by clearing operators and producers. As well, item-specific barcodes can enable flexible deposit rates, whilst lowering risks of fraud.

RVMs connected via Internet of Things platforms can provide opportunities for customisation by the clearing operator. For instance, during the 2019 drought in Australia, a donation campaign was launched in bottle-deposit states that allowed consumers to donate redemption values for a rural aid charity. The Internet of Things platform enabled the RVM provider to centrally launch the nation-wide campaign for a specific time frame (TOMRA, 2020[98]).

Blockchain technology, combined with RVMs or scanner-equipped tills can also enable new applications of DRS. Blockchain technology can simplify the financial transaction of deposits and refunds, by automating the clearing process and using an electronic payment that does not burden the cash register of collection points. In such systems a deposit label would be activated through a blockchain transaction

at the check-out and the electronic deposit transferred to a deposit pool. It would be refunded electronically upon return of the item to a certified drop-off point. The decentralised architecture of blockchain technology allows the clearing to occur without the need of a clearing organisation and with low risks of fraud. It enables the application of DRS to various products, such as cell phones or other electronic equipment, using different deposit values, whilst using the same collection and clearing infrastructure (Mertens and Munz, 2018[99]).

4.2. Key issues and conflicts of combining a DRS with other EPR instruments

4.2.1. DRS disrupts incumbent EPR schemes

Markets that operate both a DRS and other EPR policies typically have mechanisms in place to prevent double payment by producers. The introduction of a DRS into a market with an incumbent EPR scheme for kerbside collection will shift producer payments and reduce waste streams in kerbside collection EPR systems, leading to financial implications for producer responsibility organisations (PROs) and producers (Table 4.2).

Table 4.2. Costs and revenues of setting up a DRS in jurisdiction with incumbent EPR scheme

Stakeholder	Costs	Benefits, revenues or avoided costs
Producers	One-off: - Costs to adjust production for new labelling requirement(s) Ongoing: - Contributions to clearing organisation's costs	- Avoided EPR kerbside collection fees from products covered by DRS - Improved data and reporting
PROs of kerbside collection EPR schemes	- Reduced volume of (high-value) recyclables recovered by PROs (i.e. reduced revenues) - Loss of economies of scale - Cost of managing items subject to deposit that are unreturned and end up in solid waste streams	- Reduced operating costs due to reduced volumes

Note: Additional costs and revenues incurred by the implementation of a DRS in a jurisdiction with an incumbent EPR scheme for kerbside collection. These impacts are to be seen in conjunction with impacts to other actors depicted in Table 3.5.
Source: Authors own

Financial implications for the PRO of incumbent kerbside collection EPR schemes

Introducing a DRS for beverage containers into a market with an existing packaging EPR for kerbside collection will mean that a portion of beverage containers is no longer collected by the EPR, which impacts PROs in several ways:

- Forgone revenues from diverted high-value material: A DRS often targets high-value material that is useful to the collectors for reuse or that generates recycling revenue. In EPR systems with limited fee modulation, high-value materials partially cross-subsidise low-value materials so that the fees for the remaining low-value materials will have to increase substantially if the high-value materials are separately collected by a DRS. PROs that employ a more granular fee modulation and already have lower fees for products with high-value materials, should be less impacted (DEFRA, 2019[36]).
- Exemption of EPR fees and loss of economies of scale: Reduced waste volumes deprive PROs of revenue and reduce economies of scale, whilst costs are mostly fixed. This would lead to increases in marginal costs and EPR fees for the remaining waste (Umweltbundesamt, 2010[100]).
- Managing DRS items ending up in waste stream: The return rate in a DRS is unlikely to reach 100% and a share will inevitably end up in municipal solid waste or be littered. Collecting unreturned waste via kerbside collection creates costs for PROs that are not covered by EPR fees.

Clean-up costs of littered items may also lead to costs for PROs if littering impacts are included in producer fees. However, if PROs are able to sort collected items with deposit value, these could be returned to the DRS in exchange of the deposit, which would cover some of the cost of the services provided.

Table 4.3. Estimates of financial implications to PROs

Country	Description	Source
Germany	One year after implementation (2002 to 2003), the DRS for beverage containers deprived the existing dual system for commercial packaging of 400.000 tonnes of recyclable material and PRO licensing revenues declined by 13% (EUR 250 million p.a.).	(Roland Berger, 2008[101])
Germany	The PROs annually spend an estimated 9 million EUR* to manage unreturned, DRS-covered beverage containers that were exempted from EPR fees.	(NABU, 2017[30])
Spain (Catalonia)	A modelling study for potential implementation of a DRS for beverage containers in Catalonia, Spain, estimated that a DRS would deprive incumbent PROs for packaging waste (Ecoembes and Ecovidrio) of 13.7 million EUR in revenues per year.	(Eunomia, ENT Environment and Jimenez Parga, 2017[50])

*Note:** This estimate is based on a 96% return rate, 410 000 tonnes PET bottle production (in 2015) and 500-600 EUR/t EPR fees.

Financial implications for producers

Financial implications for producers will depend on the changes and differences in net operating costs of EPR schemes for kerbside collection and DRS. In most cases, fees for DRS will exceed EPR fees for kerbside collection. This is especially true for products with low-material value. If producer fees for a DRS are lower than producer fees paid previously to PROs, it can lead to a net cost reduction for producers[9]. An ex-post study on the implementation of the German beverage container DRS estimates that producer fees per beverage container have increased by a factor of 2.5 for the targeted fractions (5.3 Euro cent per beverage container for DRS collection vs. 2.2 Euro cent for kerbside collection) (Umweltbundesamt, 2010[100]).

Costs to producers will also depend on the extent that littering externalities are accounted for in EPR fees. There is an ongoing debate about whether the responsibility for the costs and/or clean-up of littering should be assigned to the producer (OECD, forthcoming[102]). Norway is an example, where littering is indirectly incorporated through an environmental fee charged to producers based on collection rates. With DRS achieving higher collection rates than kerbside collection, it incentivises producers to participate in the DRS (Box 4.5).

[9] Note that many producers will likely continue to pay a reduced PRO fee that covers some portion of their packaging or product line (e.g. a beverage can be subject to DRS, whilst hi-cones or cartons remain subject to ADFs).

Box 4.5. Additional policies can help to internalise external benefits of the DRS to encourage producer participation in a DRS where this is voluntary

Norway: Environmental tax

In Norway, participation in its beverage containers DRS is not mandatory. However, producers that cannot ensure a high collection rate of their end-of-life beverage containers are required to pay an additional environmental tax of NOK 6.2 (0.7 USD) per can or glass bottle and NOK 3.75 (0.4 USD) per plastic bottle. The environmental fee declines depending on the collection rate of a product:

- If the return and recycling rate of the used beverage containers is below 25%, the producer or importer will receive no reduction in the environmental fee.
- If the return rate is above 95%, the environmental fee is reduced to zero.
- If the return and recycling rate is between 25% and 95%, the environmental fee is reduced proportionally (The Norwegian Tax Administration, n.d.[103]).

This tax incentivises producers and importers to participate in the DRS that achieves significantly higher collection rates than the kerbside collection programme (Infinitum, n.d.[104]). The sum of environmental fees and (higher) DRS producer fees results in less overall costs, than signing up for the (cheaper) EPR kerbside collection and paying higher environmental fees. As a result, almost all producers sign up to the DRS. The environmental fee does not only incentivise DRS participation, but it also provides a dynamic incentive for the system to work towards higher collection rates.

Finland: Beverage Packaging Tax

Finland applies a packaging tax of 0.51 EUR (0.56 USD) per litre for beverage packaging. Beverage packaging that participates in an approved and operational return system or producers that organise a new return system are exempted from the tax, as long as the return system meets recycling or reuse objectives (at least 90% by weight) and applies minimum deposit values. In practice, most beverage manufacturers and importers are members of the DRS managed by Suomen Palautuspakkaus Oy (i.e. Palpa) to avoid the tax (Palpa, 2022[61]).

Sweden: Juices and smoothies

At the introduction of its DRS for plastic bottles and beverage cans, Sweden exempted juices and smoothies. Since 2018, juice and smoothie producers can opt-in to the DRS for beverage containers. Producers have joined the DRS to date either to increase brand reception by customers or to meet other regulatory requirements (INNOWO, 2020[105]). The DRS is more expensive for producers than their previous obligations under other EPR policy instruments, but participation is beneficial in part due to better access to high quality secondary material. Currently, roughly 80-90% of juices sold in Sweden are connected to DRS and the programme has a recovery rate of approximately 83%.

Oregon (United States): interest in expansion of the beverage container DRS

Oregon's DRS requires a 0.1 USD deposit at purchase of any beverage, except for liquor, wine, milk and infant formula (Oregon DEQ, 2021[106]). Products covered by its bottle bill will be exempt from responsibilities in the forthcoming EPR scheme for packaging. With the incoming EPR, some stakeholders have expressed a desire to expand the DRS to cover wine and spirits, as DRS participation fees are likely to be lower than future PRO fees, due to both revenues from collected material and unredeemed deposits. Whilst producers do not have an option to select to participate in the DRS, a future adaptation of the state's 'bottle' bill will provide industry stakeholders with an opportunity to collaborate on a possible expansion of the DRS to include additional beverage products that would otherwise be a part of the overall EPR scheme for packaging.

If there are large differences in producer fees for participating in DRS or EPR for kerbside collection, it will be important for policy to clearly determine the responsibilities for producers and the scope of each programme, to avoid unwanted substitution effects (Box 4.6).

Box 4.6. Defining the scope of DRS based on material can cause unintended substitution effects

DRS policy typically specifies which products or types of material must or can participate in a DRS.

Often DRS policy identifies a *type of product* (e.g. for beverage containers) and details exemptions for particular types of this product category. For instance, Germany's policy for its beverage container DRS defines specific product groups (including beer, mineral water, lemonade and alcoholic mixed beverages) that are subject to the DRS. It also defines products, such as dairy products filled in single use plastic bottles or cans[10] that are excluded from participation (VerpackG, 2022[107]). Milk and dairy products, alcoholic beverages such as spirits, and juices are frequently excluded, but exclusion criteria differ extensively from market to market.

Other DRSs specify *types of material* that are covered by a DRS. For example, the forthcoming beverage container DRS in Scotland defines the scope based on material type, where it includes all single-use beverage containers of PET, metal and glass, but excludes HDPE polymer beverage containers (legislation.gov.uk, 2020[108]). Some markets also exclude glass from the DRS system.

DRS policies that define the scope based on certain materials leave opportunity for producers to substitute towards the material with lower producer fees (e.g. substitute away from a DRS-covered material to a kerbside EPR-covered material to attain cheaper producer fees or vice versa). Product exclusions may be better suited to avoid these substitution effects. Ideally the policy defines the scope based on product type, material type and size. To minimise confusion and create a level playing field, exceptions should only be made where there is a clear reason for these items to be exempted from DRS participation.

4.2.2. Emphasis on recycling in EPR can conflict with opportunities for reuse

The emphasis on collection for recycling in conventional EPR schemes can conflict with opportunities for reuse or repair that a DRS enables. EPR schemes commonly have targets for recycling, but only a few jurisdictions oblige producers to meet separate reuse targets (Box 4.7). Consequently, much waste that has reuse potential is being directly recycled by PROs and producers are incentivised to design for recyclability, rather than reusability. EPR schemes can help to foster reuse programmes by (partially) exempting reusable items from fees and responsibilities of the EPR.

Whilst reusable packaging is not in all cases environmentally preferable to one-way packaging products, there are opportunities for environmentally efficient local reuse cycles (Coelho, Corona and Worrell, 2020[89]). A "pool" of standardised reusable packaging is an important criteria for economically efficient and environmentally preferable reuse systems as it helps to minimise transport costs. Local voluntary reuse systems as seen for beer containers (e.g. reusable bottle system by local breweries) or on-the-go coffee cups (e.g. the German ReCup system) are good examples of such systems.

[10] As of 1 January 2024, all dairy products filled in single use plastic bottles or cans will be part of the scope of the German DRS.

Box 4.7. Only a few jurisdictions have set reuse targets for producers

France has set a target of 10% reuse for packaging placed on the market by 2027 and 50% reduction in single-use plastic beverage bottles by 2030. If by 2023 performance metrics are not on track (i.e. 5% reuse achieved), the government, together with stakeholders, will consider implementing one or more deposit refund systems for recycling and reuse (Écologique, 2020[109]) (Legifrance, 2020[110]). These reuse systems will likely be local DRS initiatives for specific products, rather than a nationwide DRS.

Austria set mandatory quotas for retailers to offer refillable beverage container in their assortment. By 2024 retailers must offer 60% of beer, 20% of mineral water, 10% of fruit juice, lemonades and milk in refillable containers (Republik Österreich, 2021[111]).

In **Germany**, the Packaging Law (VerpackG) includes a target for 70% refillables for beverage containers, however no penalties are in place for missing the target and the share in 2018 stood at only 41% (VerpackG, 2022[107]).

4.2.3. DRS programmes with competitive clearing systems require clear rules and oversight

In some countries, DRS policy allows multiple clearing service providers to act in competition. Competition incentivises cost-efficiency and can expand collection infrastructure. However, it also requires appropriate framework conditions and standards for all actors involved to avoid organisational duplication, poaching of competitors' material, and confusion for consumers:

- In a DRS with multiple competing clearing service providers a separate clearing house is needed to coordinate physical and financial aspects of individual clearing service providers and to define rules for poaching material.
- As well, a standard setting organisation needs to standardise and harmonise marking, deposit labels and reporting and oversee compliance. For example, the German "Deutsche Pfandsystem GmbH" defines a standardised label and manages a national standardised database for deposit clearing of competing clearing systems in Germany (Deutsche Pfandsystem GmbH, 2022[112]).

A central not-for-profit authority with policy setting and oversight responsibilities adds to administration and operating costs of the DRS, but ensures transparency, traceability and accountability.

4.2.4. There are other policy instruments to increase collection rates and DRS may not always be the optimal tool

Setting up and operating a DRS comes with significant infrastructure investments and operational costs, which need to be evaluated against its benefits (see Section 3.3). Alternative policy instruments (e.g. pay-as-you-throw schemes) can also be effective in increasing separate collection rates in combination with EPR for kerbside collection (see Box 4.8).

An additional consideration is that DRS is not appropriate for all products. For instance, products without possibility of visual inspection (e.g. label), that are frequently reconfigured, subdivided or transformed during usage would require other instruments to increase collection rates.

Box 4.8. The combination of EPR instruments with PAYT can help improve separate collection

As an alternative to a DRS, other policies can be combined with a mandatory EPR for kerbside collection to provide customers with incentives to separate target materials for collection. For example, separate collection of recyclable material combined with a weight-based charge for collection of residual waste (Pay-As-You-Throw or PAYT) can also be effective to incentivise separation of recyclables. PAYT schemes for residual household waste are in place at the municipal level, such as in Belgium, the Netherlands and Luxembourg, and at the national level for example in South Korea (Card and Schweitzer, 2016[113]; Broom, 2019[114]). This combination does not require a complex financial clearing system for deposits and refunds and can effectively separate materials with increased convenience for customers if recyclables are collected kerbside. PAYT schemes can also impact a larger segment of waste, as they typically cover all household waste, as opposed to DRS targeting specific product groups.

However, PAYT has less flexibility in pricing the recovery of particular materials or items, as prices are set for avoiding weight-based charges of mixed residual waste, rather than properly disposing specific recyclables. Receiving a deposit refund may also more effectively nudge customers in returning items, than the prospect of avoiding a waste fee. Most importantly, PAYT does not provide an incentive to avoid littering or to clean up littered material. It is also not effective to incentivise separation of on-the-go consumption, but only addresses waste occurring in households. If PAYT charges are set too high, there is a risk of fly-tipping or contaminating waste streams to reduce the weight of the payable stream.

5 Other policies that can help strengthen DRS

The previous chapter discussed the interplay of DRS with other mandatory EPR policy instruments. If implemented properly, DRS and other EPR policy instruments combined can be effective in achieving high collection and recycling rates, whilst reducing littering. Other policies can further strengthen the effectiveness of DRS and create a policy mix that ensures a cohesive set of incentives for sustainable production and consumption. Targets for collection, recycling, or reuse can incentivise DRS implementation and ensure its high performance. Design criteria, bans on unwanted substances or eco-design incentives can help ensure that products are designed for more circularity and compatible with DRS, whilst information campaigns and nudges can help increase DRS participation (Table 5.1).

Table 5.1. Several policies can support implementation and operation of DRS

Complementary policy	Description	Aims	Connection to a DRS	Example(s)
Regulatory instruments				
Collection targets	Requirements for a share of products placed on the market to be collected	Increase collection	Can incentivise DRS to enable high collection	EU SUP Directive
Return rate targets	Requirements for a DRS to ensure that a share of products placed on the market is redeemed	Ensure performance in mandatory DRS	Ensures high performance of DRS	Various DRS include performance targets (e.g. Oregon, Lithuania).
Recycling targets	Requirements for a share of products placed on the market to be recycled	Increase recycling	Ambitious recycling targets can make a DRS an interesting option for producers or PROs	EU SUP Directive
Recycled content requirements	Requirements for a minimum share of recycled content in a product design	Design for environment (DfE), increase recycling rates	DRS can enable high-quality supply of secondary material to meet the requirements	EU SUP Directive; California recycled content for plastic bottles
Reuse requirements	Requirements that a share of product (packaging) in a market are designed and collected for reuse	Increase reuse rates, DfE	DRS can enable reuse systems through high collection rates	France reuse target for packaging; Austria refillable bottles target; Germany
Economic instruments				
Fee modulation	Fees paid by producers for DRS are modulated by criteria for DfE	DfE	DRS operators can modulate fees paid by participating producers to incentivise DfE	Norway, Sweden (for DRS fees); Belgium, Italy, Portugal (for kerbside EPR fees)
Tax on single-use packaging	A tax on single-use packaging placed on the market	Design for the environment	Incentivises reuse systems and participation in DRS for reuse	Norway base tax on single-use packaging
Tax on low collection rates	A tax on products placed on the market that diminishes as the collection rate increases	Increase collection rates	Can incentivise DRS operators to aim for high return rates (despite a loss of revenues from unredeemed deposits)	Norway environmental tax on packaging

Taxes to encourage broad materials management	Virgin material taxes or waste disposal taxes	Increase resource efficiency and recycling rates	Incentivises using secondary over primary materials. DRS can help to access these materials.	EU assessment fee on non-recycled plastic waste
Information & nudges	*(discussed in Section 3.4.6)*			
Labels, product information, and consumer awareness strategies	Information about disposal instructions	Increase return or reuse rates	Identifies which products are subject to DRS and encourages participation.	New South Wales (Australia): 'Return and earn' programme
	Information about product composition	Inform consumer choices	Labelling on single-use or reusability can strengthen reuse systems.	Germany: Mandatory labelling of single-use and reusable bottles (Bundesanzeiger, 2017[115]).
Behavioural strategies: physical infrastructure and gamification	Strategies that aim to impact the decision framework for customers to encourage DRS participation	Increase return rates	Nudges aim to encourage DRS participation	Physical: deposit rings on public bins Gamification: Pantamera recycling game

Source: Author's own

5.1. Complementary regulatory policies and targets

Performance targets in a DRS help to set the goals of the overall programme and incentivise operators to work towards a well-functioning DRS. Without targets or economic incentives for high return rates, revenues from unredeemed deposits may incentivise operators to strive for lower than optimal return rates. Lithuania and the Netherlands, for example, have both set a return rate target of 90% by 2022 for each's DRS.

Other quotas or mandatory targets can indirectly require high return rates and make DRS an interesting option for producers and PROs to achieve these targets. These include:

- Ambitious targets for separate collection. As part of the Single Use Plastic Directive, the EU has set a separate collection target of 77% for plastic bottles by 2025 and 90% by 2029. Whilst the collection target is independent of the means of collection (e.g. kerbside, DRS or bottle banks), the high return rates that can be achieved through a DRS make DRS an interesting option.
- Ambitious targets for the recycling of specific materials.
- Minimum recycled content requirements, such as the EU Single Use Plastic Directive and the Californian (United States) minimum share of recycled content in plastic beverage containers. A DRS can help to secure supply of secondary material.
- Reuse requirements or quotas on the assortment offered in reusable containers. So far only a few countries have adopted mandatory reuse targets (see Box 4.7). These targets can help shift the emphasis of EPR programmes from recycling to more reuse, with DRS being a key enabler.

5.2. Complementary economic incentives

Policy can tie taxation to collection rates of targeted products. This incentivises operators and producers to aim for high return rates, where revenues from unredeemed deposits may work against striving for the highest return possible. Norway's environmental tax on single-use packaging is an example of a dynamic tax, with a tax rate based on the collection rate of the DRS (see Box 4.5). Revenues can help to fund externalities of unreturned products, such as litter clean-up.

Modulation of producer fees based on product design criteria can provide an economic incentive for producers to design for the environment. Operators of DRS could consider modulating producer fees

based on design criteria that facilitate recycling or reuse. This is the case in Sweden, Norway and Croatia (see Box 4.4).

Economic incentives can also help level the playing field between single-use products and more costly reusable options. For example, Norway has a base tax on single-use packaging of 1.27 NOK (0.15 USD) per unit (The Norwegian Tax Administration, 2022[116]). Markets with a DRS for reusable packaging can adopt these policies to incentivise customers and producers to participate in these programmes. Such economic incentives should only be applied, where reusable packaging is environmentally preferable. Finland's experience shows what can happen when such incentives are removed. In 2008, its packaging tax (EUR 0.17 per litre) on recyclable beverage packaging that participate in a DRS was removed, eliminating the tax difference between single use and tax exempted refillable packaging. This change has been credited as a driver for the shift from refillable to single-use containers (Ettlinger, 2016[117]). Finland continues to apply a beverage packaging tax of 0.51 EUR (0.56 USD) for beverage containers not collected via a DRS, to stimulate DRS participation. However, the differentiated tax of refillable and single-use containers participating in DRS was removed in 2008.

Taxes can also serve as a means of broad materials management, for example by increasing the cost of primary (virgin) materials or the disposal of waste with value. For example, the EU requires a national contribution of 0.8 EUR per kg of its Member States for non-recycled plastic waste (European Commission, n.d.[118]). This may result in further financial incentives to set up new policy instruments such as DRS to reduce the disposal of plastic waste.

6 Key policy insights

As the public sector's ambitions for waste management evolve to ever-higher targets for resource efficiency and materials recovery, EPR policies will play an important role. DRS is one EPR policy that, by itself or in combination with other EPR policies can be effective in increasing collection as well as recycling rates, can lead to better quality recyclates and can enable reuse systems.

The following policy insights arise from the analysis for the implementation of a DRS:

- Regulation should define the obligations of impacted actors, including producers, distributors/importers, retailers, consumers and the public sector. The public sector also has a role in monitoring and enforcing these obligations and targets, and, if necessary, sanctioning non-compliance.
- DRS can enable environmental, social and economic benefits, such as increased collection and recycling rates as well as reduced improper disposal and littering. However, the programmes typically do not pay for themselves in revenues alone, requiring financial support in the form of producer fees or from public funds. In order to make a full cost-benefit analysis, market as well as non-market benefits and costs of implementing a DRS should be considered.
- Unredeemed deposits can be a large revenue source for the operator of a DRS, but the use of this revenue should be determined by regulation:
    - Unredeemed deposits can partially offset the costs of operating the DRS. However, complementary policies, such as return rate targets or a tax tied to collection rates, should be considered to incentivise collectors to strive for high return rates and not excessively rely on financing from unclaimed deposits. For example, Norway charges a tax on beverage containers, which reduces as the collection rate increases.
    - Public authorities can fully or partially claim revenues from unredeemed deposits and earmark the income to cover costs associated with externalities caused by unreturned products that are littered or disposed of in household waste.
- Retailers are a common and effective collection point in DRS. However, retailers incur costs in the form of loss of retail space for RVMs, maintenance and electricity or labour for manual collection. Handling fees, paid by producers, are an option for compensation, which can help to get buy-in from retailers for DRS.

The introduction of a DRS impacts producers and the incumbent waste management operators. The interplay of DRS for specific products and other EPR policies for a larger waste sector requires careful policy consideration:

- An incumbent PRO risks losing revenues to the future DRS operators. A PRO may also incur higher marginal operating costs due to reduced economies of scale and still be responsible for the costs of unreturned items that end up in mixed waste or are being littered. These issues can be a political barrier to adoption of DRS policies. Regulation should establish methods for arbitration between producers, DRS operators and PROs to address instances of overlap or compensation for services rendered.
- There is a potential for 'double coverage' of some products that are subject to a DRS but also fall within the scope of other mandatory EPR policies covering a larger waste sector. Policy should

clearly define the scope of a DRS in the context of other EPR instruments and establish which products are subject to which programme to avoid double coverage or unintended substitution effects[11].

- DRS can enable reuse of packaging, but complementary policies, such as taxes on single-use packaging or reusability quotas are likely needed to reverse the general trend towards single-use packaging. Policies should only promote reusable packaging where this is the environmentally preferable option.
- Additional policies are needed to complement a DRS to create a cohesive set of incentives for sustainable production and consumption. These policies can include regulations, such as collection targets or recycled content mandates, bans of hazardous substances to ensure sustainable product designs, or economic incentives, such as taxes on low collection rates. Information campaigns and other soft approaches can also help to "nudge" consumers and increase DRS participation.

[11] Policies that define the scope of a DRS based on certain materials leave more opportunity for producers to change materials in product design to avoid participation. Policies that instead specify the scope based on product groups may be better suited to avoiding possible substitution effects.

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