TOMRA

UNLOCKING CIRCULARITY

Insights from the World's Highest Performing Deposit Return Systems

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CHAPTER 1

EXECUTIVE SUMMARY

A series of trends are disrupting recycling and waste management conversations worldwide.

The first is a growing awareness that plastic waste is polluting even the far reaches of our planet. Scientists have determined that plastic waste including litter is leaking into the oceans at a rate of a garbage truck per minute and forecast there will be more plastic in the ocean than fish by 2050 (by weight).[1] This has led researchers to review how much plastic has actually been recycled given current recycling systems in place. Scientists have determined that of all the plastic ever produced, only 9% has been recycled,[2] and only 2% of plastic packaging was recycled in a closed loop.[3]

The second trend is concerns raised by the Basel Convention* and the associated rising costs of collection, processing and recycling for parts of the world that used to rely on China, India, and other Asian countries to buy and sort through mixed recyclables. These cost disruptions have, for example, in North A merica since led to further adoption of Extended Producer Responsibility policies that task producers of packaging to cover the end-of-life costs of packaging.

A third trend is a growing aspiration to shift the industrial model away from “take-make-waste” to a “circular economy”, where resources are captured and utilized at their highest material value for as long as possible. This is most evident in the European Union’s Circular Economy Package, which established legally - binding collection and recycling targets for common materials. Motivated by this confluence of trends, policymakers, environmental organizations and businesses are actively evaluating solutions such as a deposit return system (DRS) for the sustainable management of single-use beverage containers and even reusable beverage containers.**

Deposit return systems add a small but meaningful deposit to the sale of each beverage, which is repaid when consumers return the empty containers for recycling. DRSs are typically established through legislation passed by state/province or national governments. The policy is known for its effectiveness, with leading systems routinely recovering in excess of 90% of deposit containers sold.[4]

*During the United Nations Conference of the Parties in Basel, Switzerland in May 2019, the UN agreed to require consent from importing countries before exporting of mixed, unrecyclable and contaminated plastic waste can proceed.
**Deposit return systems are also known as container deposit schemes, “bottle bills”, container deposit legislation, or beverage container deposit and refund programs.

Figure 1: Principles and elements of high-performing deposit return systems

CIRCULARITY
1. Accurate definitions of recycling
2. Recycled content requirements and producer access to material

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3. Return-rate target
4. Broad scope of beverages and containers
5. Meaningful deposit value

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7. Separately charged and fully refundable deposits
8. Container deposit markings for consumers and manual returns, barcodes for accurate accounting

All of the elements – when applied together – will address global waste challenges and advance a circular economy.

PRODUCER RESPONSIBILITY
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10. Reinvestment of unredeemed deposits and material revenue
11. Whether centralized or decentralized, roles and responsibilities are clearly defined

SYSTEM INTEGRITY
12. Fraud protections
13. Government reporting and consumer communication
14. Government enforcement

Deposit systems are growing in popularity as the world comes to terms with the waste management and plastic pollution challenge. In 2024, the European Union adopted its Packaging & Packaging Waste Regulation, explicitly requiring member states to implement a deposit return system in order to reach a 90% collection rate for plastic beverage containers by 2029. While new systems are launching in Europe each year to fulfill this mandate, other long-standing systems in Europe and beyond are optimizing their programs to increase consumer participation and redemption rates. In 2024, at least nine US states proposed adopting new deposit systems[5] and most of the existing 10 states with deposit systems saw legislation filed to update their programs in some way. It is projected that by the end of 2027, there will be more than 70 jurisdictions globally with operational DRS programs for single-use beverage containers, up from at least 56 today.[6]

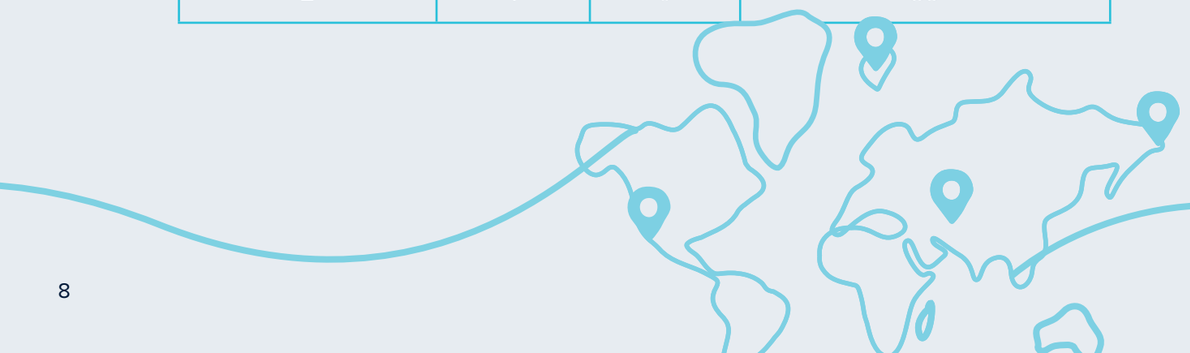
Figure 2: New deposit return systems introduced per decade

1970-79	1980-89	1990-99	2000-09	2010-19	2020-
8	8	9	12	11	11

Figure 3: Number of deposit return systems per region

Canada	US	Australia	EU&EFTA	Middle East	Oceania
11	10	8	19	1	7

Latin America & Carribean region	Africa	Asia	Total
2	1	0	**59**



TOMRA has over 50 years of experience working in deposit return systems, today working in over 60 voluntary and legislated deposit markets, in every part of the value chain.

TOMRA has unique first-hand insights based on its global experience in the field. Now is the right time to understand what makes some programs more successful than others. After analyzing global deposit systems and reflecting on its experience in those markets, TOMRA identified a series of “best practices”.

Principles of High-Performing Deposit Return Systems

Circularity: A structure is in place to ensure material is collected and recycled or reused as many times as possible back into the same product or product of similar high quality.

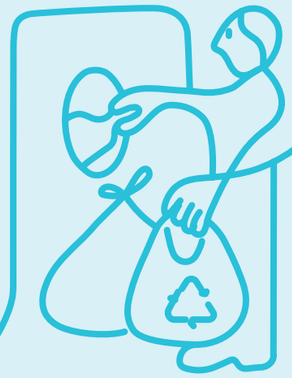
Performance: Of utmost importance, the system is focused on meaningfully increasing recycling and/or reuse rates.

Convenience: The redemption system is easy, accessible and fair for everyone.

Producer Responsibility: Producers manage the end of life of their packaging within a framework set by the government and reinvest the system’s revenue to continuously improve the system’s performance.

System Integrity: The system works reliably through a mix of fraud protections, transparency, and oversight.

In practice, these design principles are brought to life through 14 key policy or program elements. All of the elements – when applied together – will address global waste challenges and advance a circular economy. Prioritizing one but not the other will disrupt a deposit system’s performance and cost effectiveness. As with all policies, local culture, infrastructure, and politics need to be factored in to shape the system that works best for each market.



All of the elements - when applied together - will address global waste challenges and advance a circular economy.

The 14 key elements of high-performing deposit return systems include:

CIRCULARITY

1. Accurate definitions of recycling: The performance of a deposit system is gauged by its “redemption rate”, calculated as the number of deposit containers returned for a refund divided by the number of deposit containers sold. Due to the differences in material quality produced by curbside or alternative collections systems, containers collected through these channels are not counted towards redemption rate performance targets. For recycling rate targets, “recycling” is defined as the amount of material that is used as an “input to final recycling”. In the EU for example, previously, “recycling” referred to the amount of material collected for recycling, but this included material that was not ultimately used by manufacturers due to contamination or process losses. Subsequent reforms now properly define recycling as the amount of material used for inputs to final recycling. “Recycling rate” is defined as the amount of material used as input to final recycling divided by the amount of material sold (also known as “put on the market” or POM).

2. Recycled content requirements and producer access to material: High and stable commodity values for redeemed container material reduce overall system costs in the deposit systems, which allows producers or a Central System Administrator (CSA) to retain the revenue from material sales. Like many commodities, recycled materials experience volatile market prices, which creates risk for investments in collection, processing and recycling. For example, in January 2018 the price of food-grade recycled PET (rPET) in the US was 7% cheaper than virgin PET, but remains at a significant premium in 2024.[7] Many brand owners are repeating past patterns of setting voluntary commitments to use more recycled content, then setting new lower targets or dropping them entirely.[8] Mandates for beverage producers to use recovered materials, such as Washington state’s requirement for plastic bottles to contain 50% recycled content by 2031, has correlated with a rise in the value of recycled PET plastic.[9] Many high-performing systems also ensure producers have access to their share of collected containers (known as the “right of first refusal”), which fosters closed-loop recycling by increasing the probability that the recycled materials will go back into the same packaging again, as opposed to other markets and products.

PERFORMANCE

3. Return-rate target: Setting a collection target establishes the policy's objective right from the start, which aligns producers to set incentives and provide convenient redemption options. Regulators then measure performance and enforce provisions. (See Key Element #13 - Government enforcement). Setting expectations through targets also grants a license for businesses to design the program with flexibility and responsiveness in mind. For example, Oregon’s stakeholders agreed to incorporate a performance target in a 2011 legislative update. By 2016, the return rate had fallen below the target of 80% for two consecutive years and triggered an automatic increase in the deposit value in April 2017 from 5 to 10 cents. The return rate rose from 64% in 2016 to 86% in 2019.[10]

4. Broad scope of beverages and containers: The legislation clearly defines which beverages, material types and sizes will be included in the program. Leaving out one beverage category could mean millions of recyclable cans or bottles are wasted and potentially littered. Modern deposit systems include all beverage categories packaged in the same material type, with minimal exceptions e.g. infant formula. The Netherlands, a system which previously covered only large plastic bottles, expanded the scope of its DRS to include small PET bottles (<1L) in 2021 and aluminum cans in 2023, adding 3.7 billion more containers to the scheme (from 550 million to 4.25 billion), a 410% increase. As of April 2025, the collection rate for PET bottles and cans is approximately 77%.[11] In addition, including more beverage types reduces consumer confusion at the redemption point, and leads to better economies of scale for the system.

For the purposes of this paper, “producer” means the company first selling the deposit container in the market (e.g. producer, importer or distributor). If a brand owner is not located in the jurisdiction, the obligated entity becomes the distributor or importer located in the jurisdiction. In some instances, an out-of-jurisdiction brand owner may make a private arrangement with the in-jurisdiction distributor to cover DRS costs.

5. Meaningful deposit value: Providing a financial incentive to recycle is what separates deposit return systems from other collection programs. Decades of redemption data show that meaningful deposit levels effectively drive more containers into the program. For example, prior to adopting a deposit system, Lithuania achieved a 34% beverage container recycling rate through its Extended Producer Responsibility-funded curbside collection system. Once the country introduced a €0.10 (US$0.12) deposit, the container recycling rate increased to 92% in two years.[12] By contrast, Massachusetts' 5-cent deposit has not changed since 1978, when it was an engaging value. Adjusted for inflation, this is equivalent to 26 cents today (€0.22). The return rate has dropped from 88% in 2002 to 35% in 2024, making it the lowest return rate in the world.[13] High-performing systems establish a minimum deposit value at a meaningful level and allow producers to raise it as needed to reach performance targets.

CONVENIENCE

6. Convenient redemption system for consumers: High-performing deposit systems make redemption easy for the consumer. Consumers have a right to easily recoup their deposit money, and producers have an obligation to make that possible. High-volume redeemers and the informal economy also should be accommodated in the design of the redemption network. The most common and effective redemption model is known as "return to retail", where retailers who sell beverages must take back the empty containers. Nine out of 10 of the world's best-performing deposit return systems employ some form of return-to-retail collection, achieving an average return rate of 92%.[14] Some markets have expanded to a "hybrid redemption model" that incorporates both retailers and standalone return locations known as "depots" or "redemption centers". When bolstered with a meaningful deposit value and enforced return rate target, hybrid redemption models have reached high performance, meaning achieving return rates of 85% or higher.

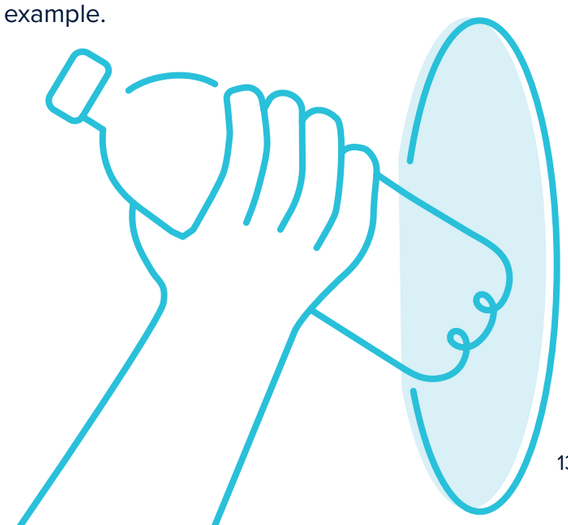
7. Separately charged and fully refundable deposits: Effective deposit systems label the deposit value separately on receipts and store shelves, and ensure deposits are fully refundable. A true "deposit", in any context, is designed to be returned in full when the payor completes a given action. This maintains the strong financial incentive and delivers higher return rates than those with partial refunds (known as "half-back" models). The top-five performing deposit systems in the world (Finland, Germany, Denmark, Norway and Lithuania) all offer fully refundable deposits. Together they average a 94% return rate.[15] Listing the deposit value separately from the sales price on both the store shelf and receipt helps educate the consumer and avoids unnecessary confusion.

8. Container deposit markings for consumers and manual returns, barcodes for accurate accounting: For consumers to easily identify containers eligible for a deposit, high-performing systems require standard text or a logo to be printed on each beverage container. A visual marking also allows redemption locations that process containers manually to easily recognize containers eligible for deposit. Barcodes serve a similar purpose in that they enable automated redemption technology to recognize and count each deposit container. This provides accurate payments to consumers, a baseline level of security, and fair, transparent financial accounting by keeping track of each brand. Unique deposit marks and market-specific barcodes can help to prevent fraudulent redemption of non-deposit containers and reduce losses. Before the deposit system was launched in New South Wales, Australia, beverages sold together in what is known as "multi-packs" did not have individual barcodes. This would have created a situation where one container sold individually would be accepted by an automated reverse vending machine (RVM), whereas those sold in "multi-packs" would be rejected in many cases. Due to concerns about consumer confusion, the government updated labeling requirements to add individualized barcodes before the deposit system was implemented.

PRODUCER RESPONSIBILITY

9. Extended producer responsibility financing with eco-modulation: Incorporating the principles of Extended Producer Responsibility (EPR), successful deposit return programs engage producers and retailers to manage the environmental impact of a product back into the packaging production cycle. As an EPR program, producers cover the net costs. The fee-setting structure incentivizes producers to design packaging that is recyclable (known as "eco-modulation"). See also how producers can utilize several cost-saving measures in a DRS in the following element.

10. Reinvestment of unredeemed deposits and material revenue within the system: In exchange for financing a deposit return system, policymakers allow producers to reinvest unredeemed deposits and commodity income to reduce their net costs. Norway, with its 92% return rate, provides a notable example.



In 2024, the unredeemed deposits, revenue from material sales and other revenue were enough to cover more than 90% of Norway's DRS costs: 31% of system costs were offset by unredeemed deposits, 52% from material sales, and 12% from other revenues (mainly interest) – only 6% needed to be covered through an Extended Producer Responsibility (EPR) fee from producers.[16] In the case of aluminum beverage cans, those income streams are even high enough to avoid any additional EPR fee from producers. In fact, the EPR fee per aluminum can was negative, meaning NOK 0.04 was actually rebated to producers (€0.003 / US$0.004).[17]

11. Whether centralized or decentralized, roles and responsibilities are clearly defined: All deposit systems include a similar set of responsibilities in order to function, such as container pick-up, clearing of deposits and handling fees, product registration and more. Assigning these responsibilities to stakeholders should be based on an assessment of conflicts of interest in order to ensure the purpose of the program – collecting and recycling more beverage containers – remains paramount. High-performing programs establish the government agency with enforcement authority and define the convenience standards (e.g. retailer participation or a clear standard) and deposit values in statute. They may task producers with specific responsibilities including forming management entities. A "centralized" DRS is one where most operational responsibilities are delegated to a single Central System Administrator (CSA), whereas a "decentralized" DRS delegates operational responsibility to each producer and allows them to organize key aspects of the program collectively or independently. Most high-performing DRSs operate on a centralized basis. By designating a single management entity to fulfill the beverage industry's DRS responsibilities, a clear accountability structure is established, one that enables transparency and cost efficiencies. In jurisdictions first adopting a DRS where no existing infrastructure is in place, adopting a centralized model can bring benefits. However, a central management entity is not critical for reaching high performance. Germany, which achieves a return rate of 98%, operates on a decentralized basis. There is some structure within this open framework, including a requirement from the government that all producers and retailers be allowed to utilize the same national clearinghouse*, and producers have decided on their own to form a standard-setting organization to collectively mitigate fraud.

* See "Clearinghouse" definition, pg. 65.

SYSTEM INTEGRITY

12. Fraud protections: Deposit systems manage significant amounts of money, so ensuring fraud protection protocols are in place is critical to building a fair and cost-effective system. All high-performing systems require every deposit container redeemed to be counted electronically in order to accurately verify deposit markings, record the redemption transaction, and reconcile return data with the sales information received from producers. In order to gain deposit repayment for containers redeemed through reverse vending machines, retailers must compact containers to ensure they cannot be redeemed a second time, and this must be conducted using technology that has been certified. This is typically done by RVMs, which have compaction capabilities, barcode and shape recognition, and weight evaluation capabilities. For containers redeemed manually, they must be sent to a central counting center for proper counting and identification via industrial RVMs. Cross-border redemption is mitigated through the use of barcodes specific to the jurisdiction. Typically producers establish fraud protocols on their own out of self-interest to reduce costs; however, in the absence of this voluntary approach, the onus is on the government to establish an enforcement approach.

13. Government reporting and consumer communication: Annual reporting keeps regulators and the public informed about the performance of the program, to measure progress towards goals. Regular education raises awareness among the public about how to participate in the deposit program, which improves the public's confidence and the system's integrity and performance.

14. Government enforcement: While much of a high-performing DRS allows private-sector companies to implement and manage the system, government plays an important role as a regulator to maintain performance, arbitrate violations and maintain a competitive "level playing field". Clear penalties that are higher than the cost of non-compliance reliably motivate stakeholders to comply and also invest in making the system more efficient. Legislation also defines auditing protocols and the agency with enforcement authority.

All high-performing systems require every container to be verified by technology.

EU POLICY NOW REQUIRES DRS AS A SUITE OF SOLUTIONS TO ADDRESS PLASTIC POLLUTION

As the wide-ranging ramifications of plastic pollution are better understood, the European Commission is an example of a government that has begun to adopt a more stringent approach. In 2024, the Commission adopted new regulations through the Packaging & Packaging Waste Directive. Key elements include:

- **Deposit return systems:** By 2029, EU member states are required to set up deposit systems for beverage cans and plastic bottles. Previously countries simply needed to achieve a 90% separate collection rate for plastic beverage bottles by 2029. The new Directive states that member states need to adopt a DRS. States can seek an exemption, which requires the member state to achieve an 80% collection rate by 2026 and submit a plan with specific deliverables that would achieve 90% collection by 2029. However, this exemption is canceled if the collection rate falls below 90% for three consecutive years.[18]
- **Reduction targets:** Legal obligations to reduce packaging waste by at least 5% by 2030, 10% by 2035, and 15% by 2040.
- **Reusable beverage container requirements:** Specific targets for reusable packaging for both alcoholic and non-alcoholic beverages (with some exceptions) state that a minimum of 10% of beverages placed on the market should be in reusable packaging and a system of reuse by 2030, and aiming to reach at least 40% by 2040.
- **Reuse of take-away food and beverage packaging:** Take-away businesses will be required to implement reuse systems for packaging by 2028 and shall endeavor to achieve 10% of takeaway food and beverage packaging placed on the market should be in reusable packaging and a system of reuse by 2030.
- **Prohibitions on single-use plastics:** By 2030, the new regulation will ban single-use plastic packaging for a wide range of products at hotels, restaurants, and bars, including beverage packaging.[19]

The EU's decision to explicitly require DRS shifts the conversation from one about whether to adopt DRS to *how* to adopt DRS. More than 50 years of experience with deposit systems for beverage containers has generated a wealth of learnings about what works and what does not. By moving ahead with a thoughtful approach – one based on the principles of Circularity, Performance, Convenience, Producer Responsibility and System Integrity – more high-performing deposit return systems can become a reality.

CHAPTER 2

ABOUT TOMRA

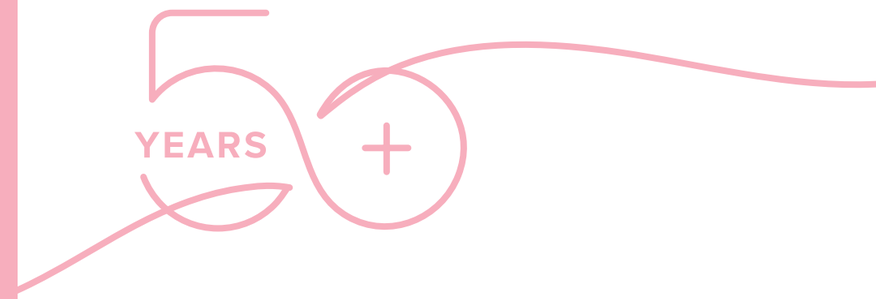
We are living in an age of unprecedented consumption. This is pushing us beyond the boundaries of what our planet can sustain.

TOMRA seeks to disrupt this paradigm with solutions that help to transform waste into resources. We believe TOMRA's contributions of sensor-based technology, and over 50 years' experience working on drink container returns with private, public and civil sector stakeholders around the world, can help the entire value chain optimize resource productivity. To do this, TOMRA has invested in three businesses and an innovation accelerator.

Built for impact: TOMRA's structure at a glance

TOMRA is set up to make the biggest difference where it matters most. Our three core divisions, TOMRA Collection, TOMRA Recycling, and TOMRA Food, develop smart, sensor-based solutions that help make every resource count.

Beyond that, TOMRA Horizon looks ahead, exploring new areas where we can have even more impact. With TOMRA Reuse, TOMRA Feedstock, and c-trace, we're building solutions that take circularity and efficiency even further.



Divisions overview

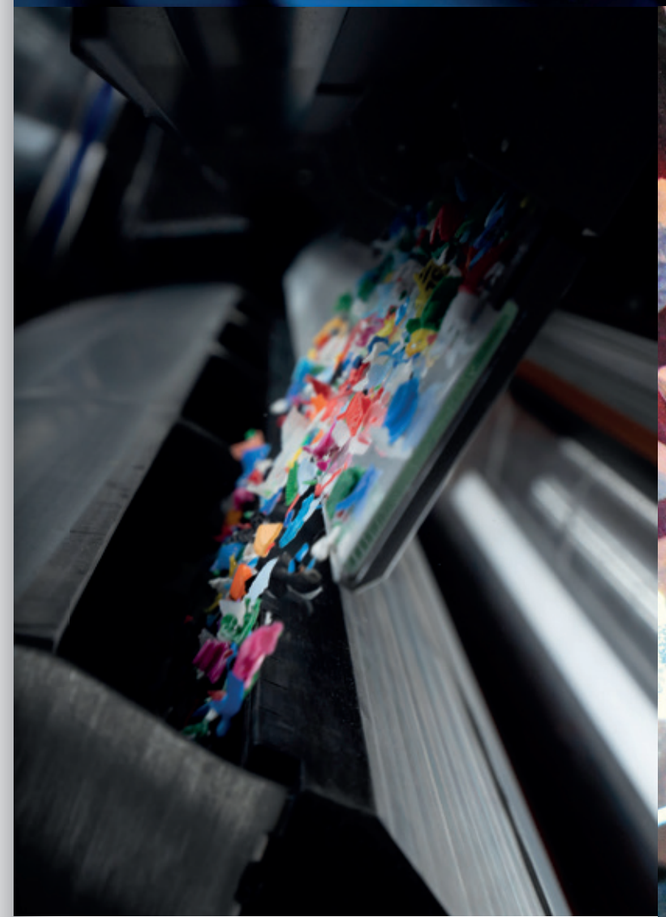
TOMRA Collection
TOMRA Collection specializes in reverse vending solutions that make beverage container recycling and reuse easy and efficient. With over 87,000 installations in 60+ markets, our machines and "bag drop" collection services now capture more than 50 billion used beverage containers every year.

This helps reduce plastic pollution and drive Clean Loop Recycling, where bottles and cans are kept separate from other waste, so they stay clean and can be reused or recycled into new containers, not downcycled into something else.

A well-designed deposit return system collects over 90% of containers, a target many countries are now working toward.

TOMRA Recycling
With over 11,000 systems in 100+ countries, TOMRA Recycling turns waste and metals into valuable resources. Our advanced sorting technology recovers and upgrades materials, helping boost recycled content in new products and cut emissions. Since launching the industry's first deep learning sorting solution in 2019, now known as GAINnext™, we've kept pushing AI for even smarter, more efficient sorting.

TOMRA Mining uses sensor-based sorting to make mineral processing more efficient and less resource-intensive. Our technology helps to reduce water and energy use, and has even enabled some extraordinary finds, like Motswedi, the second largest rough diamond ever recovered in Botswana and using our X-ray technology.



TOMRA Food
TOMRA Food develops sensor-based sorting and grading technologies that help reduce contamination and minimize food loss across the supply chain. With over 15,000 units worldwide, we support growers, packers, and processors with more accurate grading, higher yields, and new opportunities for profitability, all while helping deliver safe, high-quality food more sustainably.

A key milestone on that journey was in 2018, when we introduced LUCAi™, the first deep learning model for fresh fruit. It set a new benchmark in sorting precision, starting with blueberries and now used across a growing range of crops.

TOMRA Horizon
TOMRA Horizon is where we explore new business opportunities and circular models that move us closer to a world without waste.

Through TOMRA Reuse, we're helping shift from single-use takeaway packaging to reuse. In our pilot system in Aarhus, Denmark, over a million reusable cups have already been returned, with an impressive 85% return rate and growing.

With TOMRA Feedstock, we're tackling plastics that were previously left out of the recycling stream. Our new plant in Norway will sort 90,000 tons a year, bringing more material back into the loop.

In 2024, we also welcomed c-trace, a pioneer in digital waste collection. By combining their smart technology with our global reach, we're helping cities and businesses collect more and build truly circular systems.

TOMRA's experience in container deposit return systems
In 1972 our founders, Tore and Petter Planke, invented the first fully-automated reverse vending machine after a local grocery store asked for help with redemption of beverage containers. Now retailers could offer their customers a self-service option for returning their empty reusable bottles for the deposit. Since then, TOMRA has expanded to most container deposit markets in world, providing invaluable experience in system design, investment and execution.

TOMRA's deposit system competencies
TOMRA's experience extends beyond developing and managing technology. In some markets, TOMRA partners with beverage producers in managing data and material recovery (US and Australia).

Redemption
Reverse Vending Machine technology and bag drop services

Data management
Clearing deposits/fees and managing data integrity

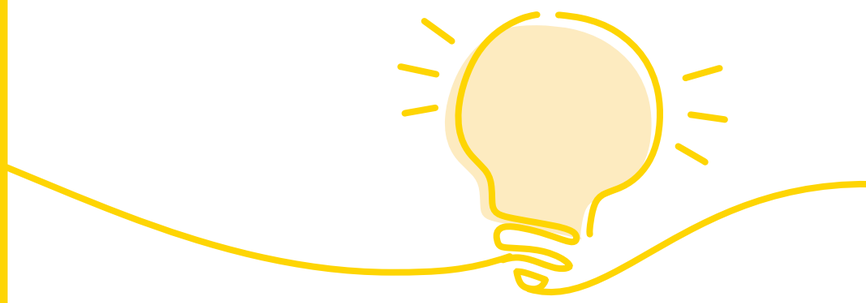
Collection
Material pickup

Material recovery
Container processing and commodity brokerage

CHAPTER 3

ABOUT THIS PAPER

This white paper was published for those stakeholders looking for best practices and guidance to accelerate the adoption of a circular economy, to meet performance targets, and to address the chronic problem of beverage container litter. This resource is also designed for legislative and regulatory drafters seeking to understand how to organize a DRS in a legal document. It is applicable in the design of new deposit programs and modernizing existing ones. However, it is recognized that local culture, socio-economic groups, infrastructure, and politics will add nuances. This paper does not seek to describe a comprehensive economic analysis of recycling systems. It provides information on the highest-performing DRSs and their best practices. However, where data is available, we have presented it to illustrate the cost efficiency of such a system.



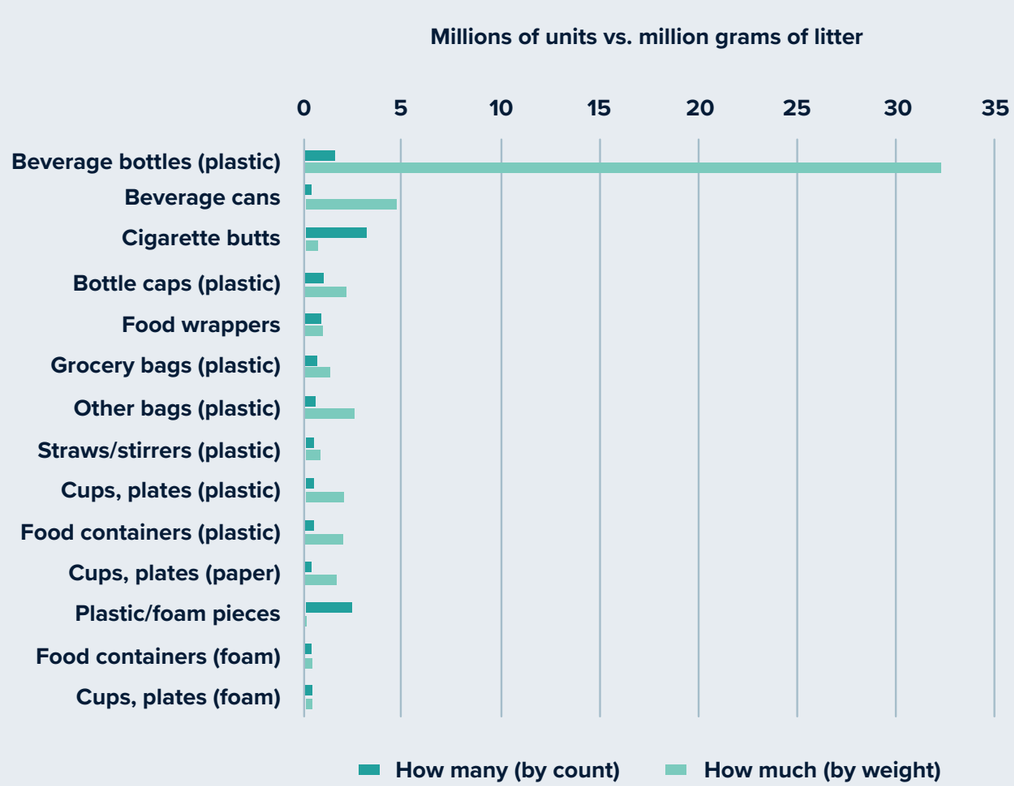
CHAPTER 4

THE CHALLENGE

Today, a number of trends are shaping a debate about how society approaches waste:

- **Ocean plastic leakage:** Scientists have determined that plastic waste is leaking into the oceans at a rate of one garbage truck per minute, and they forecast there will be more plastic in the ocean than fish by 2050 (by weight).[20] Today's plastic waste leakage into the ocean is projected to triple by 2060.[21] This has led to increased research from the scientific community, with studies now showing microplastics are present in the human brain[22] and placenta[23], indoor and outdoor air[24], freshwater[25], fish[26], etc. What started as a concern about biodiversity loss has become a concern for potential impacts on human health from plastic pollution.[27] This concern includes a special focus on beverage containers considering they are the world's most littered items by weight, by far.

Figure 4: World's most littered items by count vs. weight



Reloop analysis of International Coastal Cleanup data (2023-24)[28]

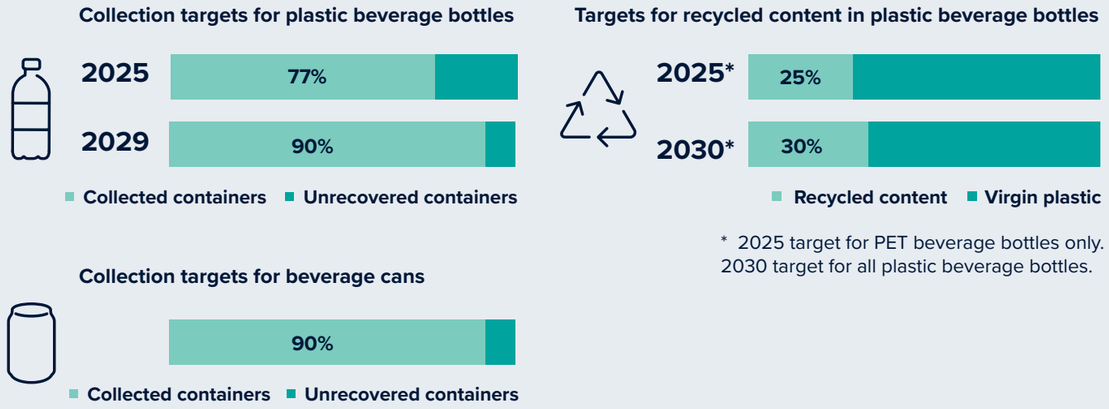
- **Concern about the effectiveness of recycling:** The pollution concern has led researchers to review how much plastic has actually been recycled given the current recycling systems in place. As of 2013, scientists determined that of all the plastic packaging ever produced, only 14% has been collected, 8% has been recycled into inferior products (“open-loop” recycling) and only 2% has been recycled into products of the same or similar high quality (known as “closed-loop” recycling.[29] A DRS, since it retains a container’s material quality throughout the collection process, produces commodities that contribute to this 2% of closed-loop recycling.

- **Rising recycling costs as the world focuses on material quality:** After years of pollution concerns, the China National Sword policy effectively prohibited the import of “household waste plastic” and “unsorted waste paper,”removing a major buyer from the global market. This nearly eliminated demand for low-quality recyclables and forced communities to invest in raising material quality or finding new markets. For example, the collective exports from the US to China and Hong Kong dropped by 94% for plastic scrap and 60% for paper scrap.[30] The Basel Convention Plastic Waste Amendments in 2019 only amplified this effect by placing regulations on the global trade of plastic waste. Where some communities used to make a small profit from recycling, many are now covering steep costs.[31] Some have shut down recycling services altogether due to budget concerns. Others have called for producers to take on a larger role in financing waste management.[32]

- **Circular economy aspirations:** A staggering amount of perfectly recyclable material is sent to landfills, incinerators or leaked into nature each year (86% of plastic packaging globally).[33] This material is actually sought after by industries seeking to use it for manufacturing new products, which means society is unnecessarily disposing of valuable resources.

- **Mandated performance targets:** As policymakers channel public sentiment to “fix” plastic waste issues into legislation, beverage producers have new, legally-mandated packaging collection targets to achieve. The European Union’s Packaging and Packaging Waste Regulation (PPWR), adopted in 2024, mandates the introduction of deposit return systems for plastic and metal beverage packaging, and requires cans and single-use plastic beverage bottles to be collected at a rate of 90% in all EU member states by January 1, 2029.

Figure 5: EU Targets for Beverage Containers



- **Access alone has not increased recovery:** As access to curbside recycling quadrupled in the US, the recycling rate of beverage containers actually decreased.[34] This suggests public motivation for recycling plays an important role in the success of waste management.

- **Glass recycling remains a challenge:** Glass, in particular, is challenging for curbside recyclers to handle (especially in single-stream operations) as it often breaks, contaminating other materials and reducing its own value. A survey of 45 material recovery facilities (MRFs) throughout the US Northeast found that facilities accepting curbside material sent almost 40% of glass straight to the landfill to be buried or used as landfill cover.[35] Glass collection systems in Europe that keep glass separate throughout the collection process perform better, with an average collection rate for recycling of 81% in 2023.[36]

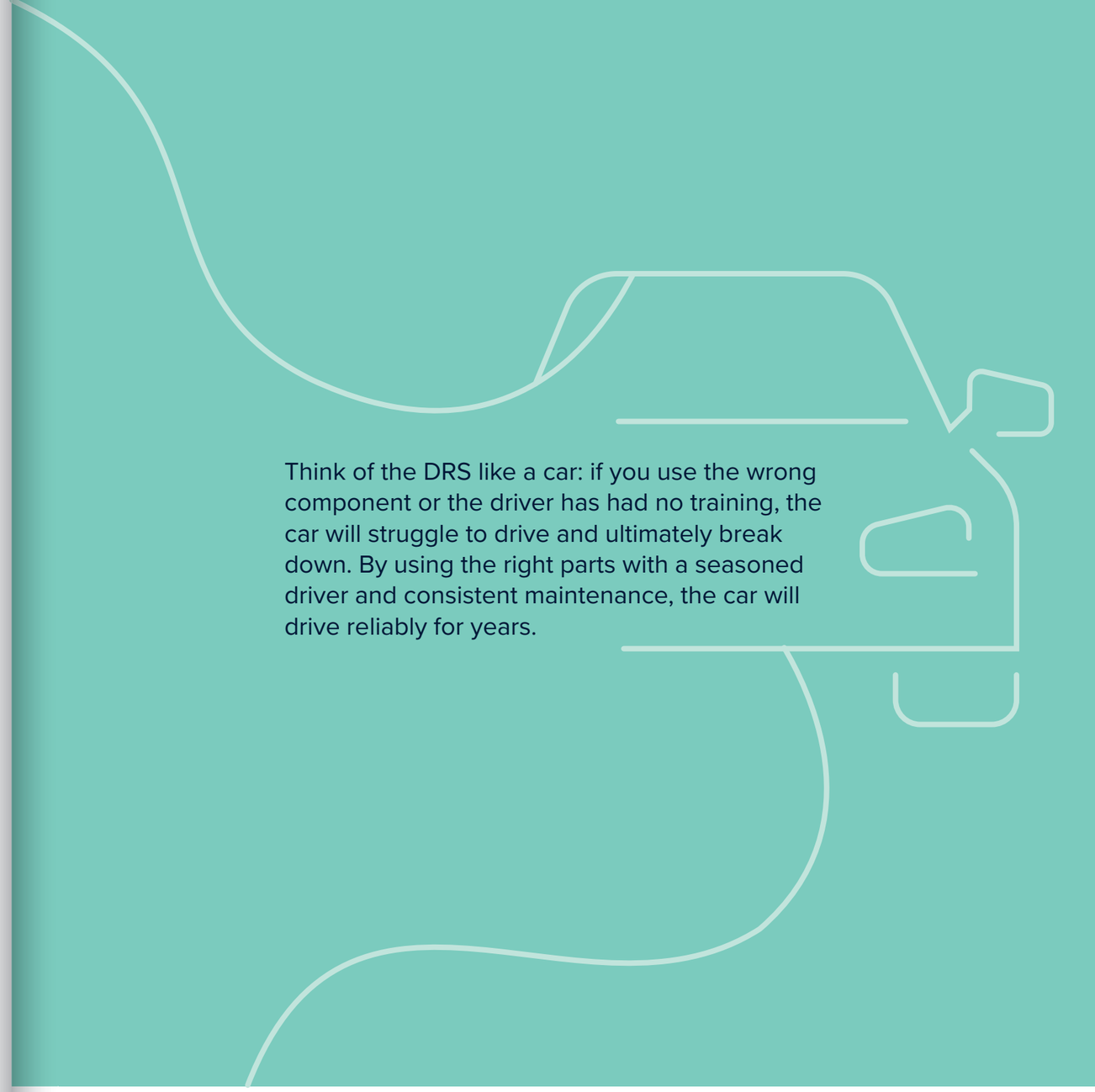
- **Committing to recycled content:** In part due to the challenges outlined above and the associated public pressure, policymakers have started to require manufacturers to increase the amount of recycled content in

containers.[37] In the long-term this presents a dilemma in the US, because, presently, there is simply not enough domestic post-consumer PET plastic collected and recycled domestically at a high quality to meet the private sector commitments. For example, the National Association of PET Container Resources in North America estimates that in order for US beverage producers to meet a 50% recycled PET content threshold nationally, the national recycling rate for PET bottles would need to rise to over 70%[38], up from 33% in 2023.[39] Producers are increasingly looking to imports to supply recycled content, which raises questions about the recycled content in the feedstock and the unintended consequences for domestic recycling industries.

These challenges have led policymakers to evaluate container DRSs for their ability to collect high quantities of beverage containers and maintain the materials' high quality in a way that enables closed-loop applications like "bottle-to-bottle recycling".

However, not all container deposit systems deliver high performance. This is due to the fact that no two deposit systems are alike. For example, both Norway and Massachusetts (USA) have deposit return systems, but they are vastly different in structure and performance. Norway's model allows producers to manage the system's operations and administration through a central non-profit entity, and retailers provide a convenient redemption system. (For the purposes of this paper, "producers" means beverage producers, importers and/or distributors). The deposit value itself is relatively high at €0.017-0.25 (US$0.19-0.28) and it achieves a container return rate of 92%. In comparison, Massachusetts' statute assigns responsibilities to producers, but it does so without a redemption target. Further, it does not encourage centralized management of operations and compliance measures. Two third-party systems serve a significant portion of the market and carry out these functions well, but there are opportunities to improve efficiency and apply controls. Massachusetts' deposit value has stayed at the same level since it was passed in 1981, US$0.05 (€0.04), and as a result the state has the lowest return rate in the world at 35%.[40]

In addition, the operators that manage deposit systems strongly influence their success. While fundamentals like a meaningful deposit value drive return rates, leaders need to maneuver wisely to evolve the program over time.



Think of the DRS like a car: if you use the wrong component or the driver has had no training, the car will struggle to drive and ultimately break down. By using the right parts with a seasoned driver and consistent maintenance, the car will drive reliably for years.

The challenge for policymakers and stakeholders alike is to negotiate legislation that will enable sustainably high performance. In the following chapter we outline what deposit return systems are capable of delivering, and in Chapter 6 what makes these programs "work" in practice.

Deposit Return Systems of the World and When They Were Introduced or Updated

Canada • USA • Australia • Europe • Oceania • Asia • Africa

\+ = DRS updated

CHAPTER 5

HIGH-PERFORMING DEPOSIT RETURN SYSTEMS: WHAT CAN THEY DELIVER?

To better understand deposit return systems, it helps to review the results of high-performing models, such as the following:

Reduction of litter and ocean plastic leakage
Beverage container litter is reduced by 54% on average as a share of total litter in regions with a DRS compared to those without, with studies showing reductions between 40% and 70% in some jurisdictions, and in other cases even higher.[41] No other approach to reducing litter has shown similar results to that of a DRS. Regions with a meaningful deposit value experience less beverage container litter as a proportion of all litter, compared to deposit systems with a low deposit value or no deposit system.[42]

More material captured for recycling and "saved" from disposal
The European median collection rate for PET plastic beverage containers in a curbside system is 50%, vs 87% for deposit return systems.[43] In the US, on average 25% of aluminum, glass and plastic non-deposit containers are collected for recycling, vs 66% of deposit containers.[44]

Guaranteed recycling
While collecting material is half the challenge, the other half is maintaining the material's value throughout the recycling process. The deposit stream is particularly successful at this component. For example, virtually all of the glass that TOMRA processes from New York's deposit return system goes to the glass bottle manufacturing process.

Climate benefits
Recycling materials enables manufacturers to replace the use of virgin material in the production of new goods. This avoids the upstream environmental impacts associated with virgin material extraction, transportation and processing. According to the Ellen MacArthur Foundation study, recycling 1 ton of plastics could reduce emissions by 1.1-3.0 tons of CO_2e* compared to producing the same ton of plastics from virgin fossil feedstock.[45] Modernizing Massachusetts' DRS to include more beverage containers

and reach a 90% return rate is projected to reduce an additional 182 thousand metric tons of CO_2 per year, the equivalent of removing 39,600 cars off the road for an entire year.[46]

More material recycled in a closed loop rather than "down-cycled"
Separate collection and processing of containers in a DRS maintains the material's quality. This results in more demand from manufacturers, and a significantly higher market value than containers handled by the "single-stream" recycling process (due to contamination).[47] For example, in April 2025, PET post-consumer bales collected and processed through California's DRS have a value 88% greater than PET collected through the state's curbside program.[48]

Waste disposal cost savings
Disposing of recyclable beverage containers in landfills or incinerators incurs a cost either through taxes or private waste services. Placing a meaningful deposit on containers has been shown to divert the majority of deposit-bearing beverage containers from disposal, which saves money and frees capacity for processing more recyclables.[49]

Litter clean-up cost savings
There is a cost on municipalities, regional governments and private property owners for dealing with littered material, and a further, uncalculated environmental cost when it escapes into the marine environment and food chain.[50] Modernizing New York's DRS, for example, is projected to save municipalities US$14m annually.[51]

Jobs
DRSs are a job creator in the sense that they create market demand for collection, sorting, counting, processing and recycling services.[52] In 2020, the calculated number of direct, indirect and induced jobs resulting from California's DRS was over 7,800.[53]

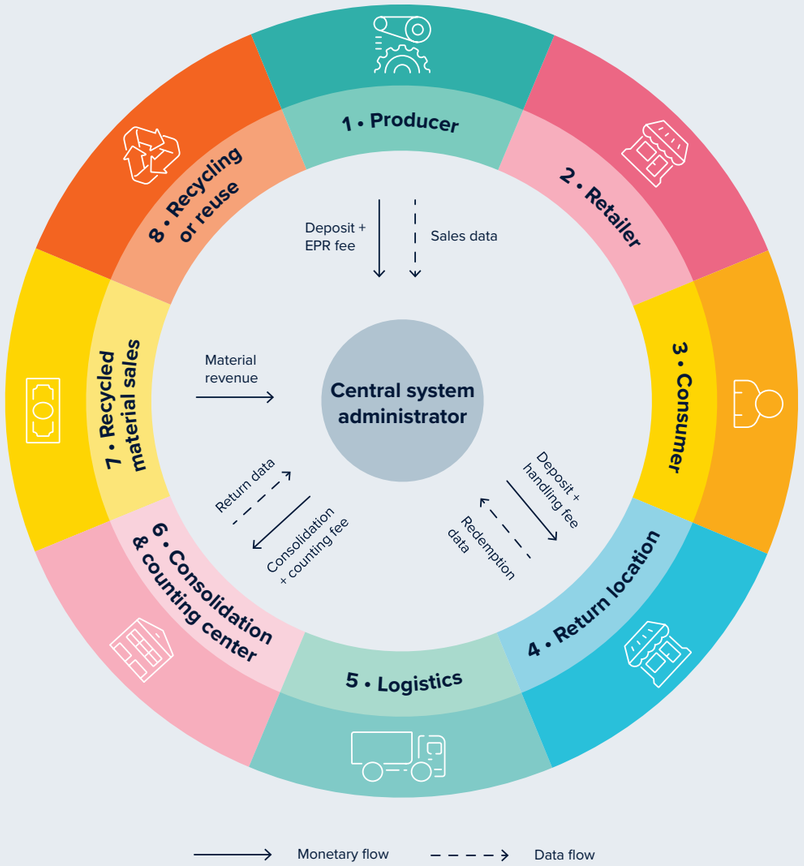
Enjoyment of local environment
Sociology studies have shown that people are willing to pay to live in areas without litter. A Belgian study, for example, calculated the willingness to pay for the removal of beverage litter at the equivalent of US$33.28 per household per year, which if applied across the EU and US would equate to US$11.6 billion (€9.8 billion).[54 55]

Facilitate the transition to reusables
DRSs are a mechanism that can facilitate the adoption of a system for reusable beverage containers, which is known to have superior environmental benefits.[56] DRSs help shift consumer behavior to return containers and build out the infrastructure needed to make reuse possible. Germany, for example, operates one of the most successful programs for reusable beverage containers in the world with a 43.3% reuse quota as of 2023, and a 56.7% single-use quota (46.5% deposit single-use containers, 10.2% non-deposit single-use).[57] Oregon's beer program for reusable containers started in part because the infrastructure and cost-sharing between producers was already in place through the DRS for non-reuseable containers.

Creation of a local circular economy
Regions that have DRSs are also likely to spur the creation of local material processors. A good example is New York, which is home to multiple processing facilities, two PET plastic reclamation facilities, and two glass bottle manufacturers, all of which depend on the deposit system's reliable supply of clean, high-quality material.

Access to recycling
High-performing deposit systems allow all households – regardless of demographic or income – equal access to recycling services. Increasing convenient access is a key component in increasing recycling.

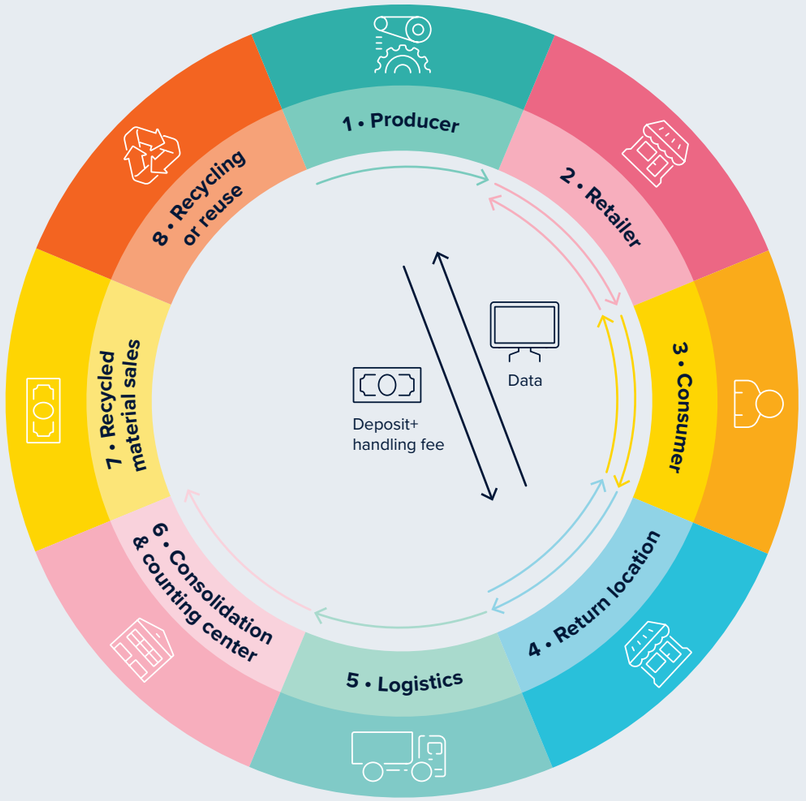
Figure 6: How a high-performing centralized deposit return system works in practice



1 • Producer pays deposit and EPR fee, and sends data for each container sold to CSA. Producers finance the net costs of the system through this eco-modulated EPR fee. Producers are aligned to design an effective system to reach the legislated return-rate target.
2 • Producer charges price + deposit for each container sold to retailer.
3 • Retailer charges deposit upon sale (regaining their deposit). Consumers are incentivized to participate through a meaningful deposit value and broad scope of beverage containers.
4 • Consumer returns beverage container, redeeming their deposit. Container redemption is easy due to a convenient network or return locations (e.g. retail, depots within a convenience standard).
5 • CSA arranges and pays for transport of containers.
6 • Consolidation, counting and validation of all manually-returned containers via technology.
7 • CSA sells material as feedstock to recyclers.
8 • Material recycled and converted into new packaging.

Trust is built into the system's processes through system integrity measures, transparent management, a data-driven clearinghouse and reliable redemption technology. The CSA uses unredeemed deposits and material revenue to balance the system's budget.

Figure 7: How a high-performing decentralized deposit return system works in practice



1 • Producer charges price + deposit for each container sold, reports sales to state agency. Producers are aligned to design an effective system to reach the legislated return-rate targets. Producers finance the net cost of the system through fee for return locations and contracted service providers.
2 • Retailer charges deposit upon sale (regaining their deposit). Consumers are incentivized to participate through meaningful deposit value and broad scope of beverage containers.
3 • Consumer returns beverage container, regaining their deposit. Container redemption is easy due to a convenient network or return locations (e.g. retail, depots within a convenience standard).
4 • Producer arranges and pays for transport of containers and receives data.
5 • Consolidation, counting and validation of all manually redeemed containers via technology.
6 • Producer or agent sells material to recyclers as feedstock.
7 • Material recycled and converted into new packaging.

Trust is built into the system's processes through system integrity measures, transparent management, a data-driven clearinghouse and reliable redemption technology. Producers use unredeemed deposits and material revenue to offset net costs.

CHAPTER 6

KEY DESIGN PRINCIPLES AND ELEMENTS

In reviewing the results of deposit return systems from around the world and reflecting on over 50 years of TOMRA's experience in the field, TOMRA found that effective deposit systems are built around five principles: Circularity, Performance, Convenience, Producer Responsibility and System Integrity.

This section explores these Principles, the Key Elements that deliver them in practice, and case studies that illustrate their importance.

All of the elements – when applied together – will address global waste challenges and advance a circular economy. Considering some but not all could disrupt the system's performance and cost effectiveness. For example, legislation that centralizes responsibilities under the beverage industry but does not explicitly require a convenient redemption system (e.g. retailer obligation to offer redemption) will underperform. Any system without a return-rate target backed by enforcement lacks producer accountability, which risks the system not reaching the target.

Note that policymakers should consider a region's current recycling context (e.g. infrastructure, historical learnings, etc.) when it comes to adopting significant system design measures.

Figure 8: Principles of high-performing deposit return systems

Circularity: A structure is in place to ensure material is collected and recycled or reused as many times as possible back into the same product or product of similar high quality.

Performance: Of utmost importance, the system is focused on meaningfully increasing recycling and/or reuse rates.

Convenience: The redemption system is easy, accessible and fair for everyone.

Producer Responsibility: Producers manage the end of life of their packaging within a framework set by the government and reinvest the system's revenue to continuously improve the system's performance.

System Integrity: The system works reliably through a mix of fraud protections, transparency, and oversight.

PRINCIPLE 1: CIRCULARITY

A structure is in place to ensure material is collected and recycled or reused as many times as possible back into the same product or product of similar high quality.

1. Accurate definitions of recycling:

Return rate

The performance of a deposit system is gauged by its "return rate" (also known as a "redemption rate") calculated as the number of deposit containers returned for a refund divided by the number of deposit containers sold. Due to the differences in material quality produced by curbside or alternative collections systems, containers collected through these channels are not counted towards return-rate performance targets or they are only counted towards a certain percentage of the target.

Recycling rate

Recycling virtually all containers collected in a deposit system is typically not a challenge for system operators. This is due to the fact that DRS policy typically only adds a deposit to containers that are already recyclable and the DRS preserves the quality of containers throughout the collection process. Therefore, the final commodity garners a high market value, ensuring it is recycled and not wasted.[58] Therefore, what is redeemed is recycled. For this reason, DRS policy generally sets a redemption rate target instead of a recycling-rate target. However, should policymakers adopt recycling-rate targets, the "recycling rate" is defined as the amount of material that is used as an "input to final recycling" divided by the amount sold (also known as "put on the market" or POM). The purpose of the "input" term is to ensure material that is collected, but ultimately disposed, does not count as "recycling".

System spotlight

Connecticut • When Connecticut adopted DRS modernization legislation in 2023, policymakers allowed producers a larger share of the unredeemed deposits in exchange for reaching a return-rate target. The state tasked the environmental regulatory agency with reporting the "redemption rate" each year, which is calculated as "the number of beverage containers redeemed for the deposit divided by the number of beverage containers sold."[59]

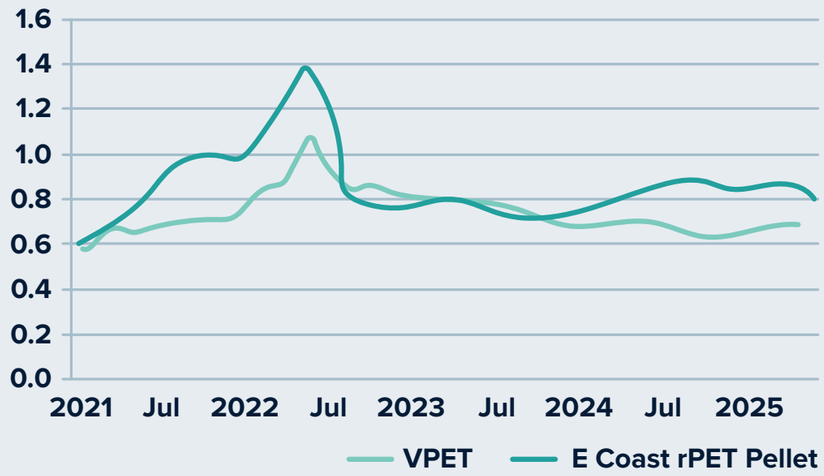
European Union • While various EU member states have operated Extended Producer Responsibility programs for packaging for decades that included "recycling-rate" targets, previously "recycling" included the amount of material collected for recycling, but that which was not ultimately used by manufacturers due to contamination or process losses. Subsequent reforms now properly define recycling as the amount of material used for inputs to final recycling. "Recycling rate" is defined as the amount of material used as input to final recycling divided by the amount of material sold.

2. Recycled content requirements and producer access to material

As TOMRA stated in The Resource Recovery Playbook, decoupling economic growth from resource extraction is one of the most critical challenges for regulators today.[60] The Ellen MacArthur Foundation points out if "all plastic packaging were to be recycled into lower-quality applications, the 'high-quality industries' such as packaging would remain dependent on continuous virgin material input (e.g. oil)."[61] In 2018, many beverage producers responded to the growing public pressure to reduce the environmental footprint of packaging by setting goals to utilize a greater amount of recycled PET (rPET).[62] Yet in 2025, the target year for most of those goals to be met, the majority of companies rolled back their commitments, either by lowering the target rates[63] or extending the timeline to 2030 or beyond.[64] This follows a similar patten from the 1990s and 2000s of setting voluntary goals then discontinuing them over time.[65] This demonstrates the challenges of relying upon voluntary commitments to drive market demand.

One major reason for this rollback is the typical price premium for rPET compared to virgin PET.

Figure 9: U.S. rPET vs virgin PET plastic prices (2021-2025)



"PET/RPET Market Update: Q1 2025," NAPCOR. 2025.

Research firm S&P Global states, "Plastics recycling needs a high-priced virgin polymer environment to be economically viable on a standalone basis."[66] In that environment, producers are pressured to opt for the cheaper virgin PET option.

A second major challenge facing the plastics recycling industry is a flood of cheap rPET imports. Imports of rPET rose by 65% in the US between 2022 and 2024.[67] While international supply chains play a role in the global recycling landscape, the surge in foreign-sourced material raises serious concerns about the strain it places on the fundamentals of domestic recycling systems.

The plastics recycling industry – in North America, Europe and most recently India[68] – have felt the consequences of these two factors (lack of producer follow-through on rPET goals and cheap imports). Several plastic recyclers have filed for bankruptcy, which the North American-based Association of Plastic Recyclers (APR) labeled a "wake up call for policymakers." In short, businesses cannot expand recycling operation if there is not consistent demand for the recycled content from the region.

Recycled content requirements are an essential policy tool to help overcome the primary price preference for virgin plastic. To enable the fundamental shift towards the circular economy, well-designed policy frameworks are necessary to catalyze the needed investment and reduce risk. Pew Charitable Trusts, which published a landmark study on interventions needed to meaningfully reduce ocean plastic pollution, acknowledged the low value of recyclable material and recommended "mandating the use of recycled content to increase demand for secondary materials."[69] Further, a study published in the journal Science found that the most impactful isolated policy to reduce mismanaged plastic waste is to require the use of more recycled plastics to make new products.[70]

That would help ensure brand owners continue to value high-quality collection which will "monetize the entire waste management system" says Steve Alexander, CEO of APR.[71]

All decarbonization pathways have highlighted the need to switch to low-carbon energy sources and to reduce the demand for energy.[72] By increasing the use of recycled content, society would reduce the demand for energy associated with production. This is why it is so important to collect, sort, and process materials for recycling in such a way that enables their re-integration into new products. According to at least one Life Cycle Assessment, the use of recycled plastic reduces energy consumption by more than 75% for PET, HDPE, and PP plastic containers, the most commonly recycled plastics.[73]

Enshrining rPET packaging requirements in law may raise questions about the availability of high quality rPET to meet those requirements. This is a valid concern in the long term but not in the short term. At least in North America, data from plastic recyclers shows that existing plants have the capacity to recycle nearly two billion pounds of additional plastics if there is stronger market demand. This includes being able to recycle 36% more rPET.[74] Reaching more ambitious levels of PCR in PET packaging nationwide, say 40-50% would require significant increases in the recycling rate – with some estimates up to 70%[75] or 84%[76] from 34%[77] today. However, recyclers today have material that producers are not buying due to the price premium and lack of short-term policy requirements.

DRS can help achieve these long-term policy requirements. Indeed, the Ocean Conservancy notes, "this level of collection [a 84% recycling rate] is currently only achieved in efficiently operating deposit return systems."[78]

This highlights how supply-side policy like DRS goes hand in hand with demand side policy like recycled content requirements.

Beyond increasing the collection rate, deposit systems are uniquely suited to deliver a large supply of clean, high-quality material to fulfill such recycled-content requirements, due to minimal contamination of the collected material. For example, in April 2025, PET post-consumer bales collected and processed through the California DRS had a value 88% greater than PET collected through the state's curbside program.[79]

In the context of a deposit system, establishing recycled-content minimums, such as requiring PET beverage bottles to be manufactured with 30% recycled content by 2030, provides a complementary benefit: cost reduction. If recycled content requirements were put in place, this would send a signal to the markets that the demand for recycled material is consistent, increasing its value. After multiple U.S. states adopted PCR minimums for plastic beverage bottles, rPET bale prices nearly tripled between 2020 and 2022. Even removing anomalous pricing during the COVID-19 era, when DRS rPET supply was limited, as of March 2025, A-grade rPET bales in the U.S. are at the highest level in 10 years.[80] Since most deposit systems allow producer-funded Central System Administrators to retain revenue from collected material sales, this elevated price would generate increased revenue for the DRS itself. Higher revenue from commodity sales reduces the need to charge producers higher fees to fund the DRS Central System Administrator.

If lawmakers are interested in supporting local recyclers, establishing simple recycled content requirements are likely not enough due to the influx of cheaper foreign material. To respond to this situation, the Association of Plastic Recyclers has advocated for:

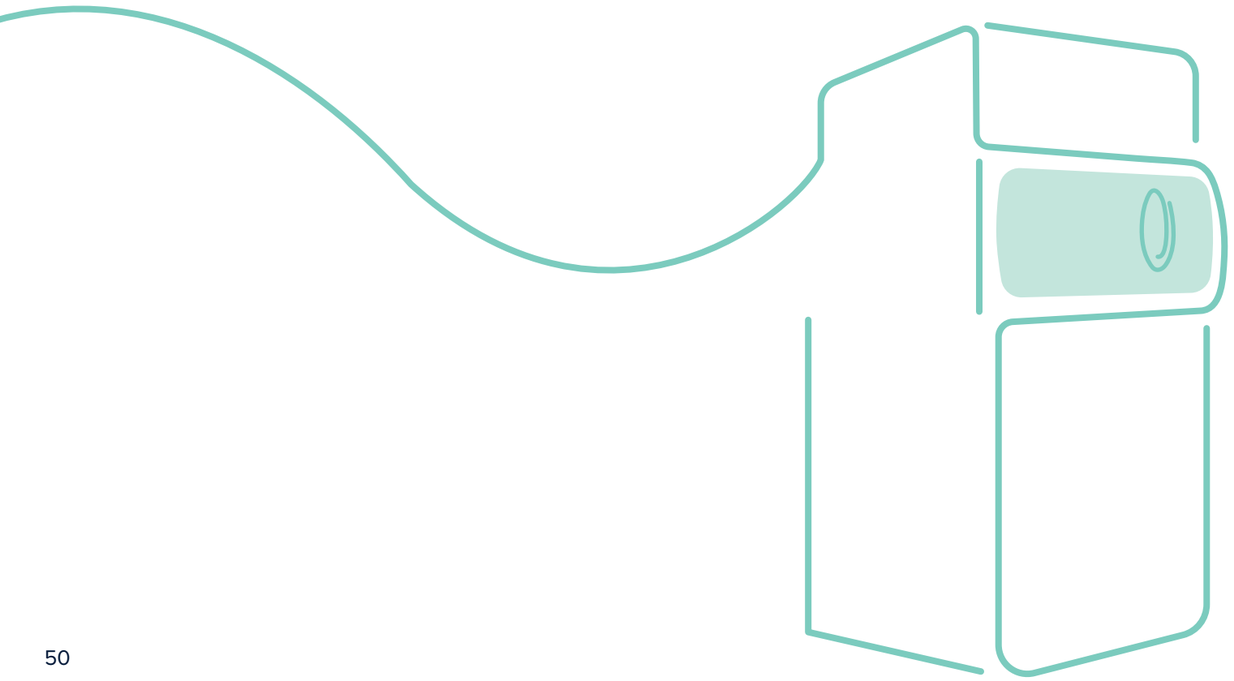
- Stronger verification systems for imported content – to confirm the material is indeed post-consumer recycled material.
- Transparent reporting on the country of origin of imported materials
- Regulatory action, including anti-dumping investigations
- Incentives and policy tools that give preference to North American post-consumer recycled content (PCR)
- Integration of North American PCR standards into state Extended Producer Responsibility programs

Giving producers the right to their own recycled material

If policymakers require producers to utilize recycled content in packaging, DRS policy can ensure producers have access to their own collected containers so they can reach these performance targets. Several high-performing deposit systems establish what is known as the “right of first refusal”, which gives producers the right to use or sell their equivalent share of collected material. “Equivalent share” is typically defined by a producer’s market share determined by sales or share of redeemed material. This is important because recycled content can be sold to many different markets. For example, rPET from beverage containers is also used by the carpet or clothing industry. If producers have invested in funding the recycling system for their products, then that warrants giving them first access to the materials, at fair market value.

Conclusion

Given PCR requirements can reduce the overall cost of a DRS, and a DRS can deliver on collecting high-quality material to reach those PCR requirements, it makes sense to include PCR requirements within DRS legislation. In addition, setting local PCR requirements provides stability for the local recycling industry. For these reasons, high-performing recycling jurisdictions set recycled content minimums, and increasingly we expect to see those minimums require the material to be collected within the country or region.



System spotlight

European Union • The EU’s Single-Use Plastics Directive was designed to target the most commonly littered items on European beaches in an effort to stem ocean plastic pollution. To incentivize the collection and recycling of valuable plastic resources, the Directive incorporated recycled-content mandates for plastic beverage containers alongside a 90% collection target. The Directive establishes a 25% target for recycled content in PET bottles by 2025 and 30% for all plastic bottles by 2030.[81]

California, USA • Upon signing the world’s most ambitious recycled content law for beverage containers to date, Governor Newsom said “California has long led the way on bold solutions in the climate space, and the steps we take today bring us closer to our ambitious goals.”[82] The law requires plastic beverage containers subject to a deposit (CRV - “California Refund Value”) to include 15% recycled content by 2022, 25% by 2025, and 50% by 2030. Previously, the state had established minimum recycled content requirements for glass containers, rigid plastic packaging containers, newsprint, trash bags, and other products.[83] Washington, New Jersey, Connecticut and Maine have passed similar legislation.[84]

Norway • Norway’s DRS, operated by Infinitum, incorporates a formal right of first refusal into its sales agreements with beverage producers. This contractual provision ensures that producers have the first opportunity to purchase the high-quality recycled materials collected through the system. To manage access fairly, Infinitum has developed a “fair share” model that allocates available recycled content among producers and importers based on their market share.

Diving deeper • DRSs and “Responsible End Markets”
Due to concerns over packaging collected for recycling eventually ending up disposed or leaking into the environment, policymakers have sought to control the flow of resources to “responsible end markets.” Typically, this involves placing the responsibility for EPR on a Packaging Producer Responsibility Organization, to ensure packaging counted as “recycled” has been sent to a buyer that has in fact recycled the material. Auditing mechanisms are required to ensure buyers, especially those overseas, can be considered a responsible end market. Within a DRS, this extra regulatory mechanism is not as important, because DRSs produce high-quality material that is in high demand by local manufacturers and processors. For example, virtually all of the deposit containers that TOMRA collects throughout the Northeast US’ deposit systems are recycled by North American buyers, and the vast majority go back into beverage containers or products of similar high quality.

Diving deeper • Reuse and deposit return systems
Deposit return systems were first established to collect and refill or reuse beverage containers, rather than recycle. Over time, producers transitioned to using single-use beverage containers, but in dozens of jurisdictions (across Europe, Canada, and South America in particular), the deposit systems for refillable containers remain in operation. A DRS provides a “road-map to refill”, given it provides a platform for producers to collectively fund takeback infrastructure, establishes charging and refunding deposits, and incentivizes consumers to return containers. Building on the success of existing deposit systems for reuse, policymakers have set targets or quotas to require a certain percentage of beverage containers to be sold in a refillable system. For example, Europe’s Packaging and Packaging Waste Regulation requires a minimum of 10% of beverage packaging sold to be in reusable packaging and in a reuse system by 2030, rising to 40% by 2040.[85]

A consumer returns a crate of refillable bottles to a reverse vending machine, which scans containers for eligibility and deposit refunds. RVMs are commonly used in scaled refillable deposit systems to automate and reduce the cost of the takeback process.

Principle 2: Performance

First and foremost, the system is focused on meaningfully increasing recycling and/or reuse rates.

3. Return-rate target

Programs with return rates matching or exceeding 85% of the containers sold are considered “high performers” (see Figure 5 for examples). This is achievable primarily through setting a meaningful deposit value and ensuring redemption is easy for the consumer. Inflation pressures may weaken this, as will a consolidation or decline in the number of redemption points. In addition, “unredeemed deposits” may provide a perverse incentive to prioritize income over performance.

Setting a target for the return rate defines a common goal for producers, retailers and regulators. It aligns design, investment, and data management, and encourages cooperation. It is also a way for producers to maintain their “license to operate” the program, with some flexibilities in setting fees and maintaining the unredeemed deposits to help finance the program. An enforceable return-rate target ensures the program is on track for high performance so policymakers can give producers flexibility to design the system (within some convenience guardrails). Taxes, delisting products or implementing a “trigger” to automatically raise the deposit value are some of the ways used to ensure a fair playing field for all brand owners and to raise the return rate. Penalties are set at a level to properly incentivize compliance. (For more see Key Element #14: Government enforcement).

$$\text{Return rate} = \frac{\text{deposit containers redeemed}}{\text{deposit containers sold}}$$

System spotlight

Massachusetts, USA • Massachusetts is an example of what happens when a performance target is not in place. With a 2024 return rate of 35%, Massachusetts is by far the lowest return rate in the world. With a deposit value of US$0.05 (€0.04), the incentive to participate has diminished significantly since the law was implemented in 1983.[86] Without a return-rate target and penalties associated with underperformance, producers lack incentives to improve the system at scale. In addition, unredeemed deposits are diverted to the government, which may incentivize the regulatory body to keep the return rate low.

Sweden • Sweden increased its deposit value in 2025 to increase the redemption rate to achieve a return-rate target of 90%.

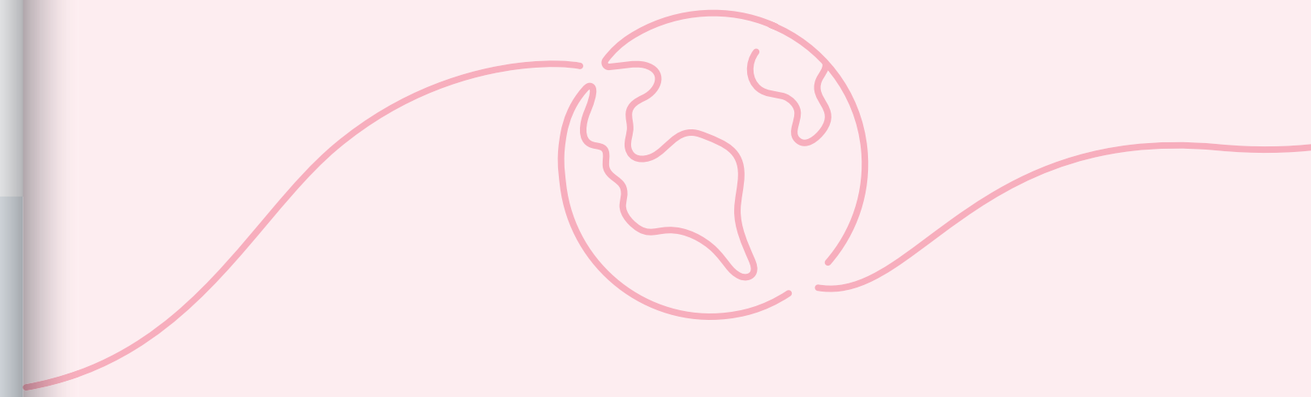
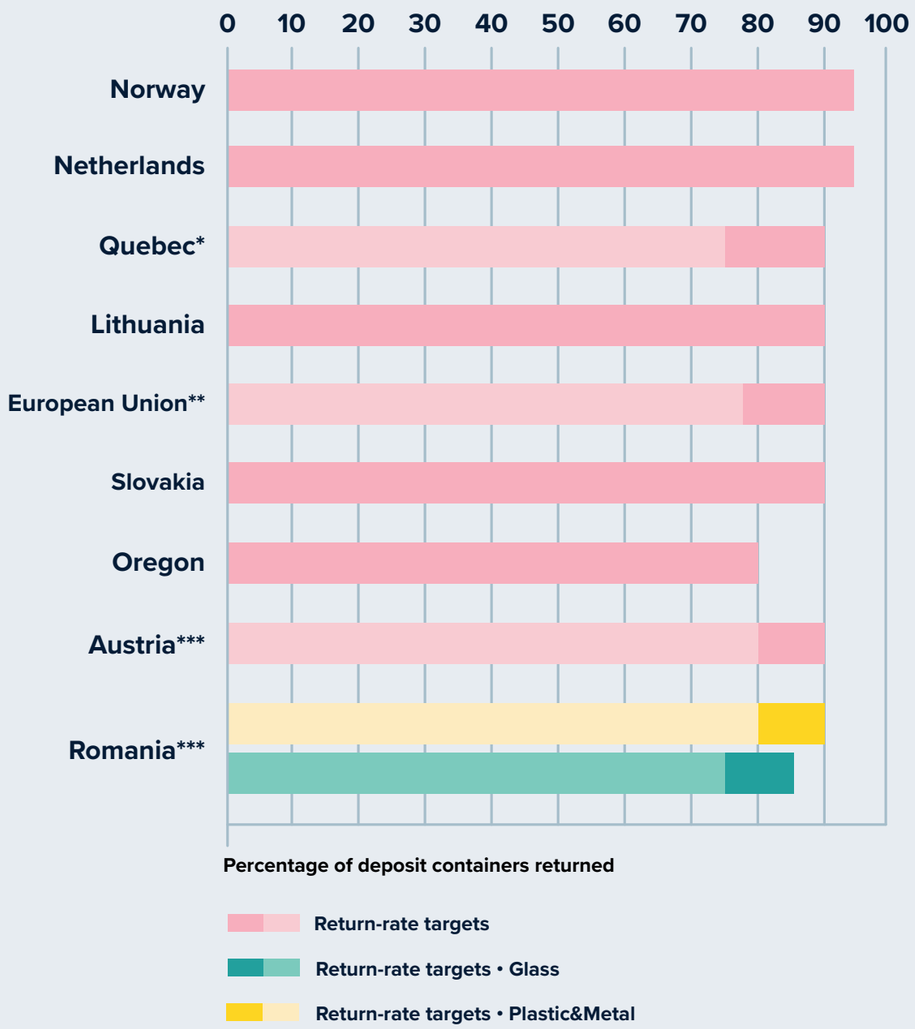


Figure 10: Beverage container return-rate targets (%)



* In 2022, Quebec instated a staggered target of 75% collection by 2025, and 90% by 2030.
** The European Union set through the SUPD staggered goals of 77% collection of plastic bottles by 2025 and 90% by 2029, as well as through the PPWR a 90% collection rate for cans by 2029.
*** Austria: 80% by 2025 and 90% by 2027
**** Romania: 75% Glass, 80% Plastic&Metal by 2025. 85% Glass, 90% Plastic&Metal by 2026.

4. Broad scope of beverages and beverage containers

To maximize capture rates, prevent consumer confusion and create a fair playing field among producers, effective systems accommodate what's sold on the market today, and consider this in three ways:

a. Beverage type
Specified by using industry-identified categories (i.e. bottled water, carbonated soft drinks, sport drinks, energy drinks, juice and juice drinks, beer, hard cider, wine, spirits, plant-based beverages, and non-dairy drinks). Legislation can empower the regulatory or managing body to ensure that new beverages placed on the market are added to the program.

b. Material
Defines the packaging material to be included such as plastics, metals, glass, and liquid paperboard. Policymakers typically prioritize recyclability and packaging commonly used by producers.

c. Size
Using volume as the metric, ranges are often set at 100 ml up to 3 liters. In many countries, this range will capture the vast majority of the containers on the market – while allowing the return of all deposit containers to be automated through reverse vending machines. For example, over 99% of the beverage containers sold in Austria, Germany, Romania and Slovakia fit within this size range.

However, local container shapes may require special consideration, so engagement with the system operator and beverage industry is recommended prior to codifying accepted sizes. Local market beverage consumption patterns should be considered when defining scope, to ensure the DRS achieves maximum recycling performance and avoids market distortions.

System spotlight
The regions below all include broad yet well-defined specifications:

	Beverage Type	Material Type	Size
Oregon USA	118ml up to and including in 1.5 L (4-50 oz): Coffee/tea, energy and sports drinks, fruit and vegetable juice (does not have to be 100%), juice smoothies, coconut water, non-alcoholic wine, marijuana beverages, protein shakes (unless marketed as meal replacements), kombucha, cocktail mixers. Up to and including 3 L (101 oz): Soda (carbonated/sparking beverages), beer and malt beverages, water, hard seltzer, kombucha. Up to and including 3 L (101 oz): Soda (carbonated/ sparking beverages), beer and malt beverages, water, hard seltzer, kombucha. 118ml up to and including in 1.5 L (4-50 oz) containers in cans: Table/still wine, cider more than 8.5% ABV, sake, mead, sparkling and fortified wine 0.05% ABV to 21% ABV.[87]	Plastic, metal (aluminum/ tinplate), glass.	118 ml to 3 L in some cases (4-101 oz).
Estonia	Soft drinks, water, juice, juice concentrates, nectars, beer, cider, perry, low-alcohol beverages (up to 6% alcohol content).	Plastics, metal, glass.	100 ml up to 3 L (3-101 oz).
Lithuania	Beer and beer cocktails, cider and other fermented beverages, mixed alcoholic and non-alcoholic beverages, all types of water, juice and nectars. Fruit wines and wine product cocktails are included when sold in plastic and metal packaging.	Plastic, metal, glass.	100 ml up to 3 L (3-101 oz).
New South Wales Australia	All beverages sized 150 ml up to 3 L (5-101 oz). Excluded: Plain milk (or milk substitutes); 1 L (33 oz) or more of: flavored milk, pure fruit/ vegetable juice, wine and water casks; wine and spirits in glass containers; wine sachets of 250 ml (8.4 oz) or more; cordials and concentrated fruit/vegetable juices; registered health tonics.	Metal (aluminum/steel), glass, plastic (HDPE, PET), liquid paperboard.	150 ml up to 3 L (5-101 oz).

System spotlight

USA • Numerous states with deposit return systems in place could benefit from modernization and expanding the scope of beverage containers included in their programs. Michigan, Vermont and Massachusetts all do not include modern beverage categories like bottled water.[88] Conversely, New York, which expanded its DRS to include water alone in 2009, doubled the amount of PET plastic containers captured by the system. Water containers now make up over 30% of all the containers that New Yorkers redeem for recycling.[89]

Diving deeper: How will AI-equipped redemption machines affect DRS?

Like any industry, AI presents a variety of opportunities to enhance the performance and efficiency of deposit systems. Some deposit systems are experimenting with image recognition technology paired with AI "deep learning" to quickly identify the brand and material type of redeemed containers. While AI has unlocked rapid container verification, system operators have expressed concern about maintaining material quality after consumers drop off containers – and the cost of that quality control. Fast acceptance needs to be paired with fast sorting to avoid contamination. While this technology continues to mature, policymakers define the scope of deposit containers based on what can be automatically redeemed today (4 oz to 3 liters). It may make sense for policymakers to build in the flexibility to expand deposit coverage as the technology improves.

5. Meaningful deposit value

Providing a financial incentive to prevent littering and promote recycling is what separates deposit return systems from other collection programs. The deposit motivates consumers to treat packaging as a resource, rather than trash. Decades of redemption data shows that meaningful deposit levels effectively drive more containers out of the waste stream and into the recycling stream. The higher the deposit amount placed on a beverage container, the higher the collection rate.

As Figure 10 illustrates, it is difficult to reach an 80% return rate or above with a deposit value at or below €0.05 (adjusted for Purchasing Power Parity (PPP)).

Figure 11: Return rates compared to purchasing power parity – adjusted deposit values[90]

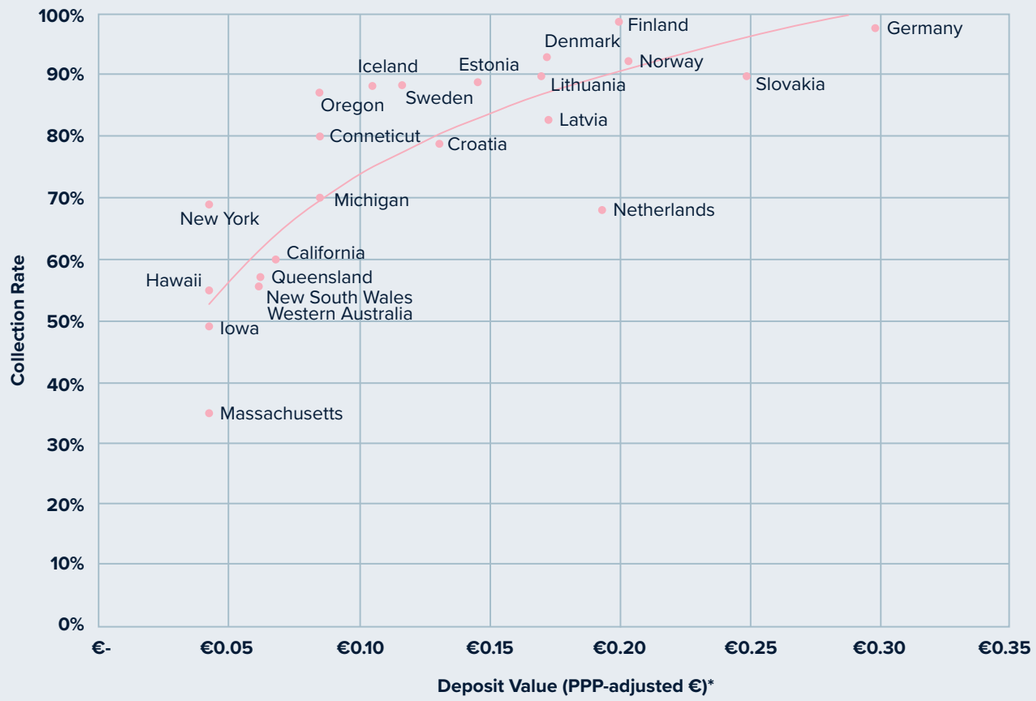


*Figure 11: For countries with multiple deposit values depending on beverage type, material or size, a weighted average based on return volume and rate has been calculated to determine an average deposit value.

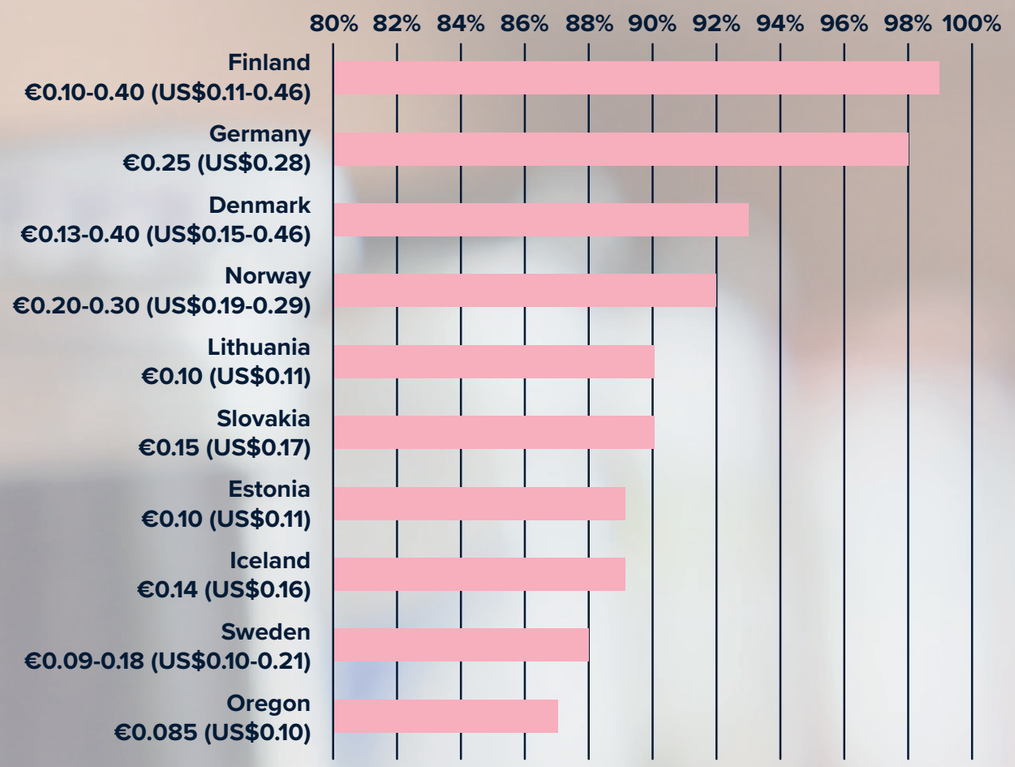
High-performing systems set values by considering the purchasing power of the respective market, which takes into account the relative strength of economies and differences in wealth. Based on a review of global return rates, a good principle appears to be setting the deposit value high enough to motivate consumers to return empty containers at a rate of 90%+, while low enough to discourage fraud. While the definitive deposit amount will depend on the system's collection infrastructure and the government's collection target, performance metrics suggest that policymakers consider a deposit of a minimum €0.10 (PPP-adjusted) or US$0.10 to be effective at this time.

When coupled with a performance target, policymakers will set a minimum deposit value(s) while empowering producers to raise it if they choose. As discussed later under Element #11, effective systems allow producers to manage the day-to-day operations of the DRS, including the deposit value. Producers may choose to voluntarily set a higher deposit value if they seek to achieve a performance target, or if there are penalties associated with underperformance.

Stakeholders may debate the use of a single or "flat" deposit value vs a variable deposit value for all beverage types, materials and sizes. A flat deposit value is easiest for consumers and other parties to understand. In that case, a harmonized or flat deposit value provides clarity in the system. However, policy-makers may choose to set higher deposit values on containers that are larger and more expensive in order to ensure the incentive to redeem remains meaningful. Ultimately, the goal is to capture and recycle the highest number of containers.

While a meaningful deposit value is critical, high return rates also depend on a convenient network of redemption points to ensure the deposit does not act as a tax.

Figure 12: Return rates and deposit values for the world's highest-performing deposit return systems[91]



*all rates as of 2024, except Estonia and Iceland as of 2023.

Multiple deposit values refer to instances where a DRS utilizes multiple deposit values depending on beverage type, material or size.

System spotlight

Germany • Germany has deposit systems for both reusable and one-way containers. German law initially required beverage producers and retailers to sell an overall 72% of beverages in reusable containers (known as a “reuse quota”). As the quota was not met, a DRS for one-way containers was implemented. To ensure one-way containers do not overtake reusables, policymakers set a high deposit value of €0.25 (US$0.28), but allowed producers to set a higher value if desired.[92] With a return rate of 98%, producers have not seen a need to increase the deposit value. Empowering the producers this way allows for flexibility to manage the program to achieve objectives.

Connecticut, USA • Connecticut passed its DRS legislation in 1978. At the time, the deposit value was set at US$0.05 (€0.04). By offering convenient access to return locations at retail and redemption centers, this five cent deposit value reached high performance for many years, reaching 88% as of 2000.[93] However over time the purchasing power of five cents declined as did the redemption rate, reaching 44% in 2023. In 2024, the state increased the deposit value to US$0.10 (€0.085). The redemption rate for 2024 increased to 65%, and the Q2 2025 redemption rate reached 87%.[94]

PRINCIPLE 3: CONVENIENCE

The redemption system is easy, accessible and fair for all users.

6. Convenient redemption system for consumers

High-performing programs make redemption easy for the original consumer by making it as easy as it was to purchase the product in the first place.

“Return to retail” refers to the aspect of deposit systems where retailers who sell beverages must take the empty containers back for recycling. Nine out of 10 of the world’s best-performing deposit return systems employ some form of return-to-retail collection, achieving an average return rate of 92%.[95] As of 2024, the median return rate for return-to-retail-only deposit systems was 89%, vs 77% in systems that do not involve retailers at all.[96]

Retailers have been involved in container returns since at least the early 1900s when the original systems for reusable containers were common. As one report on the history of packaging put it, “if an apothecary or merchant provided goods in a bottle, there was typically an understanding that the bottle belonged to its purveyor and was to be returned after use.”[97] Today retailers continue to share responsibility with producers for the end-of-life collection of deposit containers.

As a deposit is charged, a promise is made to consumers that they will be able to recoup their money. Producers, retailers and the government have an obligation to make it so, otherwise they run the risk of creating an unauthorized tax or eco-fee. Effective systems consider cost- effectiveness in the design of a DRS – but also the consumer’s experience and rights. Return-to retail systems deliver both.

Setting the redemption system up for success
High-performing systems do not allow design of collection point infrastructure and operations to be left to producers or a central beverage industry-run administrator alone, due to conflicts of interest. Convenience is guaranteed through at least one of these methods:

a. Legislation defines a retailer takeback requirement (e.g. “return to retail”), which by the nature of retailer density, establishes an accessible network of return locations. The legislation may define convenience in this way and/or it may use the approach below:

b. The legislation defines a specific “convenience standard” that a producer-funded Central System Administrator or independent network operator must meet. (See the Quebec case study on pg. 46 and the New South Wales case study on pg. 55 for more). The final convenience standard might be different for each jurisdiction depending on existing infrastructure, population, and population density. For that reason, some currently proposed deposit system legislation tasks the CSA with defining a convenience standard in a plan which a designated government agency has authority to amend. This approach allows the time and resources to properly evaluate possible redemption locations, while avoiding a CSA’s interest in reducing costs at the expense of consumer convenience.

Measuring convenience
High-performing programs are effectively providing consumers locations to return their containers in parallel with retailer density, which is, as the data suggests below, a ratio of 1 point of return for every 366 – 1,100 people. Due to higher populations in urban areas, effective systems approach those localities differently. For example, the number of collection points per square kilometer across Norway is 0.3, but in the capital Oslo it is 11. Other metrics used to evaluate convenience include the return rate and the percentage of consumers that participate in the system.

Figure 13: Redemption points per person 2024[98]

System	Norway	Germany	Lithuania	California[99]
Return rate	92%	98%	90%	60%
Redemption locations	15,000	130,000	2,600	1,269
Population	5.6m	84m	2.8m	39.7m
Redemption point to consumer ratio	1 : 375	1 : 647	1 : 1089	1 : 31,256

Design for efficient transportation logistics
Container compaction provides an important value within deposit systems. By compacting (or crushing) containers with reverse vending machines, PET bottles are reduced in size by a ratio of 2.5 : 1 and aluminum cans 6 : 1. This saves space and therefore transportation costs during material pick-up and mitigates against unauthorized redemption since containers cannot be redeemed twice (known as a “devaluation of containers”). The closer container compaction occurs to the point of redemption, the more fuel, carbon and resources are saved. For this reason, among others, systems like Norway and Sweden promote return to retail and incentivize the use of RVMs that can compact containers, as discussed under Element #10.

Retailer participation
- Typically, retailers are paid for their redemption services in the form of a “handling fee”. In high-performing systems this is paid by the beverage-industry-funded Central System Administrator to the retailer on a per-container basis (see Element #11 for more detail on Central System Administrators). It is typically set by the CSA. Eight out of the top-10 performing deposit systems pay a handling fee to retailers.[100]
- With benefits for both the consumer and retailer, consumers may return deposit containers to any retailer in the network, and retailers take back containers similar to the types they sell.
- Retailers below a certain size might not be obligated to participate but can offer redemption services if they wish.

Redemption centers, depots, and/or kiosks can also play a role in redeeming containers by:
- Serving high-volume redeemers and consolidating volumes for operational efficiencies.
- Maintaining a minimum number of redemption points per capita (e.g. one redemption point per 366 - 1,100 people).
- Providing redemption locations close to high-consumption points, like outdoor eateries and marketplaces.
- Providing unmanned redemption kiosks at retail locations including parking lots, to provide cost efficiency and convenience.

Why a return-to-retail approach leads to high performance

Not all deposit systems require that retailers take back containers, but there is ample evidence showing return-to-retail deposit systems can achieve the highest performance, convenience and cost efficiency.

Consumer's perspective

- **Convenient redemption options:** A 2021 survey in Quebec found that 9 out of 10 respondents say they are more likely to participate if they could return their containers where they shop.[101]
- **No extra trips required, and additional travel time is eliminated:** By positioning container return facilities in locations that people already visit regularly, this removes the barrier of "going out of your way" to recycle. In the US, 97% of shoppers say they shop at a physical grocery store at least once a month.[102] And despite the growth of digital grocery shopping, grocery pick-up is more popular than delivery, indicating that consumers are seeking convenience and time savings, but not always willing to pay all of the additional convenience fees.[103]
- **Ability to redeem containers while "on the go":** Beverage containers are often consumed on the go, so a high number of redemption points makes redemption more convenient. One US study estimates the percentage of on-the-go consumption between 30-50% of all US beverage container consumption.[104] And although trends indicate that percentage may be lower post-pandemic with more home-centric habits, there is continued growth in categories like energy drinks and bottled water that are generally consumed on the go.[105]
- **Frequent recycling without waiting is possible:** With many supermarkets and grocery stores available, consumers can access multiple return points locally. This reduces waiting or queuing times at the return location, so consumers have the option to take a "little and often" approach to redemption. In user surveys from Norway, over 80% of respondents said having access to a return point without waiting was extremely important in returning their empties.[106]

Government's perspective

- **Addressing plastic pollution:** Beverage container litter as a proportion of all litter is 54% less in regions with a DRS than without, based on Ocean Conservancy's 2021 International Coastal Cleanup (ICC) data from more than 80 countries and 114 jurisdictions.[107] And given that the average return rate for return-to-retail deposit systems is 89% vs 77% in systems that do not involve retailers, it is reasonable to infer retailers play a significant role in reducing plastic pollution.[108]

- **Achievement of targets:** As regions (especially EU member states) seek to achieve ambitious recycling, collection and recycled content targets, deposit return has been recognized as a reliable way to achieve high performance. For example, in a study commissioned by the Government of Ireland to evaluate pathways to achieve the EU's 90% collection target for plastic bottles, the authors state, "no evidence has been presented to suggest that the current (waste management) system could be enhanced to reliably achieve a 90% separate collection rate… On the basis of this study, a DRS is a feasible option for Ireland, and indeed the only way in which it can confidently be asserted that a 90% collection rate for plastic beverage bottles can be achieved." The study goes on to recommend return to retail because those models "generally have higher return rates."[109]
- **Convenience:** Governments requiring deposits to be charged on container purchases also seek to maximize convenient opportunities for citizens to recoup their money. Convenience is built into return-to-retail models, because retailers have already designed a system to make purchasing products convenient. For example, Norway's return to retail model offers one redemption point for every 370 people and achieved a 92% total return rate in 2024.[110]
- **Immediate results:** Governments are currently under pressure to quickly address plastic pollution and rising recycling costs related to the impacts of National Sword. Leveraging existing retail infrastructure in a DRS helps accelerate progress. For example, after Lithuania implemented its return-to-retail-based DRS, beverage container return rates rose from 34% to 92% in less than two years.[111]

Producer's perspective

- **Hitting targets in a cost-effective way:** Off-retail redemption centers tend to incur higher and increasing costs such as labor, site maintenance, profit margin for independent site operators, etc. This is due to the fact that the cost of redemption at off-retail redemption locations reflects 100% of the fixed costs for the location, like insurance, labor, utilities, taxes, etc. In a retail environment, the cost of redemption in the system is reduced because other businesses are sharing those costs and labor. As a result, generally, the system costs are lower when retailers are involved because the redemption network is based on this existing infrastructure and labor that would otherwise need to be paid for in whole.

- **Leveraging an existing network:** Building on existing logistics networks and infrastructure can form an efficient reverse logistics system. With supermarkets located close to residential areas, the infrastructure for convenient redemption is already in place. A return-to-retail approach reduces the need to permit, build and outfit new recycling locations. As such, the DRS can launch faster, and more cost-effectively. Supermarket chains typically have networks across whole regions, including remote communities, ensuring shopping points are available for everyone. Supermarkets already accommodate trucks for delivery of goods; these could also be used for reversing the logistics or consolidating pick-up and transportation services.

Retailer's perspective

- **Consumers spend deposit refund at retailers:** Providing the opportunity to redeem cans and bottles adds another reason for consumers to visit retail locations, and consumers tend to spend their deposit refund money in stores. In a survey of Michigan consumers, 80%[112] say they spend their deposit refund money at the store where they returned their containers, while assumptions in other markets are as high as 95%.[113] In another study across four European countries, shoppers returning containers spent up to 50% more money in that store visit than those who did not return empties.
- **Many retailers today are also brand owners selling their own private label:** In this case they share the “Producer’s perspective” above.
- **Positive environmental impact and brand image:** Offering convenient access to recycling in store enables retailers to track data on how many containers they help to collect and recycle every year and to tell a brand story about products made from recycled containers, supporting Corporate Social Responsibility commitments. The service also provides a regular reminder to consumers that retailers practice environmental stewardship. For example, in Germany in 2020, the retailer Lidl launched a large advertising campaign promoting how containers returned by customers to more than 6,200 RVMs at Lidl locations are recycled into new bottles, enabling the store’s private label water brand to manufacture new bottles out of 50% recycled content on average.[114]

System spotlight

Michigan, USA • Since 1990, Michigan's DRS has collected 93% of all deposit containers sold on average.[115] To help retailers manage the redemption volume and accelerate the redemption process for consumers, Michigan offers retailer provisions such as limiting the number of containers that any one consumer can redeem per day (250) and only requires retailers to take back brands that they sell (though the latter can cause consumer confusion). A 2019 poll showed that 94% of Michiganders supported the deposit law.[116] It should be noted that return rates in Michigan have dropped since the pandemic when the government banned redemption for several months. Recent government grants on technology and public education have sought to re-engage the public.

Norway • Norway offers 15,000 redemption locations, which equates to a ratio of one redemption point per 366 people.[117] Only 23% of redemption locations utilize RVMs, but those locations collect 93% of returned containers. This allows the Central System Administrator (see Element #10 for more), Infinitum, to make the transportation network as efficient as possible due to container compaction and redemption data that predicts pick-up routes. In 2024, Norway achieved a 92% total return rate.[118]

Quebec • Prior to modernizing its deposit system to include more beverage categories and raise the deposit value, retailers were the only type of return location in the province. To accommodate the increase in redemption volume, policymakers determined that the province needed at least as many return locations as they had at the time in 2022. This was determined to be 1,500 active return locations. Eventually policymakers required the DRS Producer Responsibility Organization (similar to a CSA) to ensure at least 1,200 return locations across the province by the first effective date for expansion (November 2023) and to reach return-rate targets that eventually ratchet up to 90%. The legislation designated a certain number of required return locations per region, depending on their population and density. For example:

- Montreal and Laval (pop. 2.2m): one return point per 15,000 people
- Monteregie, Estrie (pop. 1.9m): one return point per 8,000 people
- Saguenay-Lac-Saint-Jean (pop. 275k): one return point per 6,000 people
- Abitibi-Temiscamingue (pop. 147k): one return point per 4,000 people

The beverage industry Producer Responsibility Organization (PRO) was not expected to operate all of these return locations. They share takeback responsibility with retailers 375 square meters and larger (though retailers can limit redemption to 50 containers per person, per day). The DRS PRO was required to sign contracts with obligated retailers by November 2023 or undergo formal mediation. During this process the beverage industry and retailers worked out a privately negotiated handling fee, which serves as financial compensation from the beverage industry to the retailers taking back used beverage containers. Several retailers may collectively finance and operate a “Return Center” nearby instead of taking back containers in store, as long as they gain approval from the PRO.

The PRO may open and operate “bulk return points” (e.g. a “depot” or “redemption center”). Opening bulk return points comes at the expense of the beverage industry-run PRO. However, the industry is incentivized to open such return locations due to a) the need to meet the 90% return-rate target, b) assisting their retail customers in balancing redemption volume, and c) an interest in reducing container pick-up costs by consolidating volumes of returns at a relatively few number of locations rather than province wide. As of August 2025, 300 such Bulk Return Points are planned.

Depots, retailers, and Return Centers all count towards the 1,200 minimum number of return locations required, as long as they meet minimum criteria for site opening hours, safety, and accessibility.

California, USA • California is a perfect example of the impact of inconvenience on recycling performance. Retailers are only obligated to redeem containers if they are not located near redemption centers (or if redemption centers close, as is now the case in many instances). Until 2025, retailers were allowed to opt out of redemption by paying a fee of US$100 (€86) per day, but this was largely unenforced.

Redemption centers (known as “recycling centers” in California) have been hobbled by a rigid and outdated state funding formula that leaves the centers with insufficient revenue while commodity prices plunge and operating costs such as the minimum wage rise.

As a result, redemption centers have closed en masse since 2013. Closures have left California with 1,286 recycling centers, less than half the 2,578 centers that were in operation in 2012.[119] San Francisco has only one center to serve nearly 900,000 residents.[120] This has created a situation where California consumers have lost convenient access to a deposit redemption point, making deposits difficult to redeem and essentially turning the deposit into a tax. The recycling rate for the deposit program has declined from 74% in 2013 to 60% in 2024.[121]

Figure 14: Comparing California's redemption performance vs number of redemption locations[122]

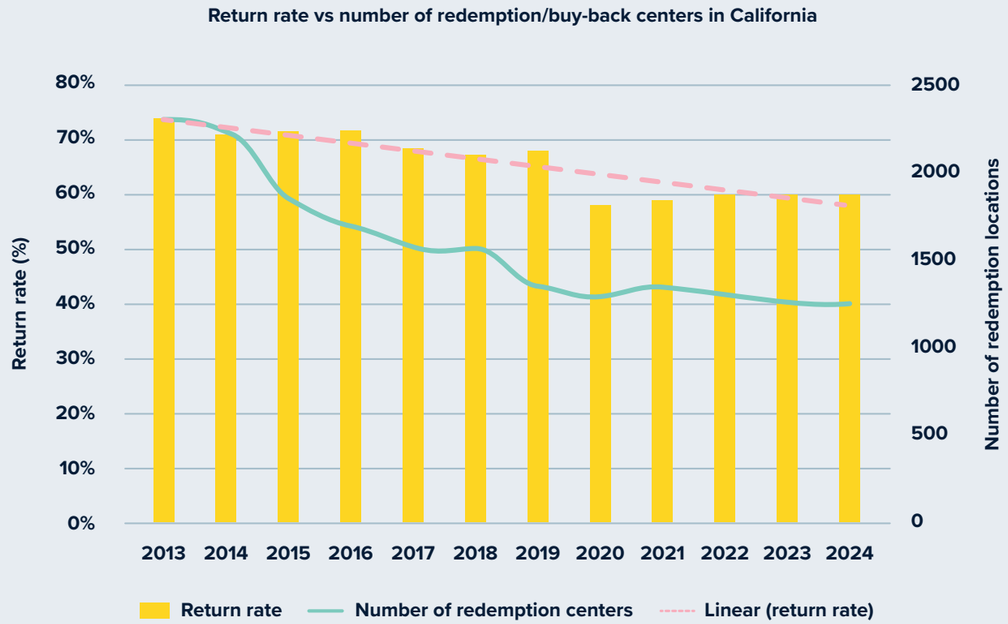
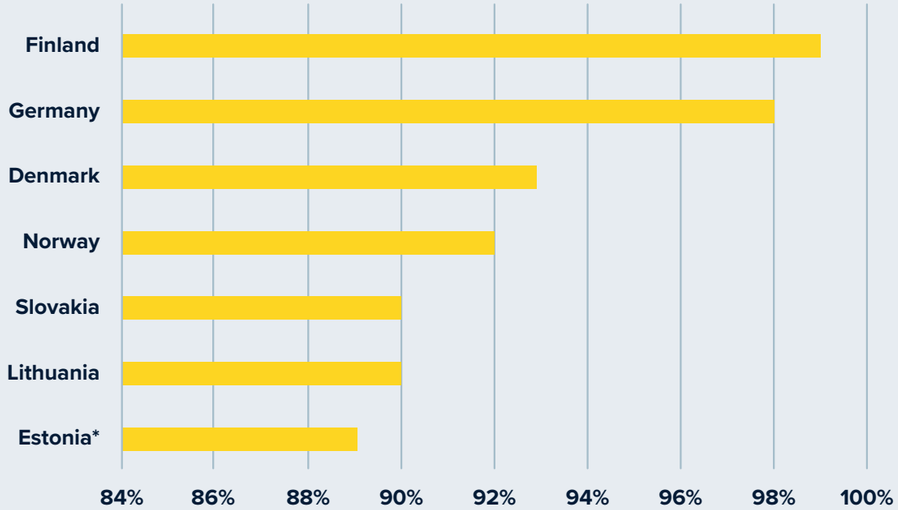


Figure 15: Container return rates for best-practice return-to-retail models (2024)



*2023 rate, 2024 data not available

SNAPSHOT: HOW INNOVATION HAS BROUGHT DEPOSIT RETURN SYSTEMS INTO THE 21ST CENTURY

When public deposit return systems first launched in the 1970s, consumers had to rely on manual redemption: meaning literally handing a crate or bag of cans and bottles over to be counted, while redemption providers kept track of the accounting by hand. Today, technology has enabled the automation of these processes and added a number of new features that increase the system's accountability, cost efficiency and convenience.

Reverse vending machines (RVMs)
RVMs provide a range of services:

- **Automated redemption and accounting:** RVMs enable redemption operators to accept containers and manage accounting automatically, which reduces labor time and associated costs and allows retailers to focus store staff on other tasks like stocking shelves, etc.
- **Sorting and processing:** RVMs start the process of recycling by separating materials at the collection point. This keeps materials free from contamination, protecting their material value, and enabling recycling into high-value applications like new containers.
- **Container verification:** The latest RVMs take 1,500 pictures per second of the returned containers and perform other inspections to analyze the shape, weight, material, barcode, and (if applicable) any security markings on each container. Analyzing these features allows retailers and the system operator to keep track of exactly which containers are accepted for redemption. Such measures also ensure non-deposit containers cannot be accidentally accepted for redemption.
- **Remote monitoring:** Modern DRSs require RVMs to be placed online, because this allows the system administrator, operators and regulators to monitor the entire redemption system remotely and through real-time data. Irregular redemption can serve as an "early warning system" to alert operators to potentially fraudulent activities.
- Compaction eliminates repeat redemption: RVMs come equipped with compaction capabilities, which prevents consumers or redemption employees from redeeming the same container more than once.
- **Data administration:** RVMs scan container barcodes and check against a database of tens of thousands of products to verify the container is registered in the system, in order to reconcile return data with sales data for the beverage producer associated with that product. Operators can instantly update the products eligible for redemption across entire networks of participating RVMs by providing new databases online.
- **Consumer marketing:** The redemption process is another marketing "touchpoint" for redemption operators, especially retailers who can offer advertising and coupons via RVM touch screens and paper or digital vouchers. Reverse vending digital tools enable retailers to track consumer insights, gamify the recycling experience, and link to operators' own loyalty programs.
- **Consumer choice in payment options:** RVMs offer consumers greater options for payments including paper and paperless vouchers redeemable for cash or in-store credit, digital transfers directly into consumer accounts, and donation options.
- **Cost and space reduction through compaction:** As mentioned earlier, compaction reduces the size of PET bottles by a ratio of 2.5 : 1 and aluminum cans 6 : 1, which makes storage and transportation more efficient. When Norway expanded the use of compacting RVMs, despite return rates increasing, the Central System Administrator, Infinitum, reports that they reduced their transport costs by 35%. Much of this is attributable to compacting RVMs, which Infinitum relies on to reduce the number of collections that are required. Infinitum also utilizes the redemption data sent directly to them from RVMs to improve pick-up logistics.[123]
- **Convenience:** RVMs have steadily increased how many containers can be accepted per minute. The latest models offer 60 containers per minute, or 100+

per minute with “multi-feed” or “bulk” models that allow consumers to empty an entire bag into the machine at once. This design has been paired with digital payment solutions and QR codes to enable consumers to simply empty their bag of containers at once and walk away. The machine automatically counts containers and pays the consumer through an app.

Bulk Reverse Vending Machines

- **Convenience:** Also called "Multi-feed Reverse Vending Machines", Bulk RVMs provide the same benefits as traditional single-feed RVMs mentioned above, but accept 100+ containers per minute. The machines can also handle aluminum, glass, and plastic containers so redeemers do not need to sort containers by material type.

Bulk counting equipment

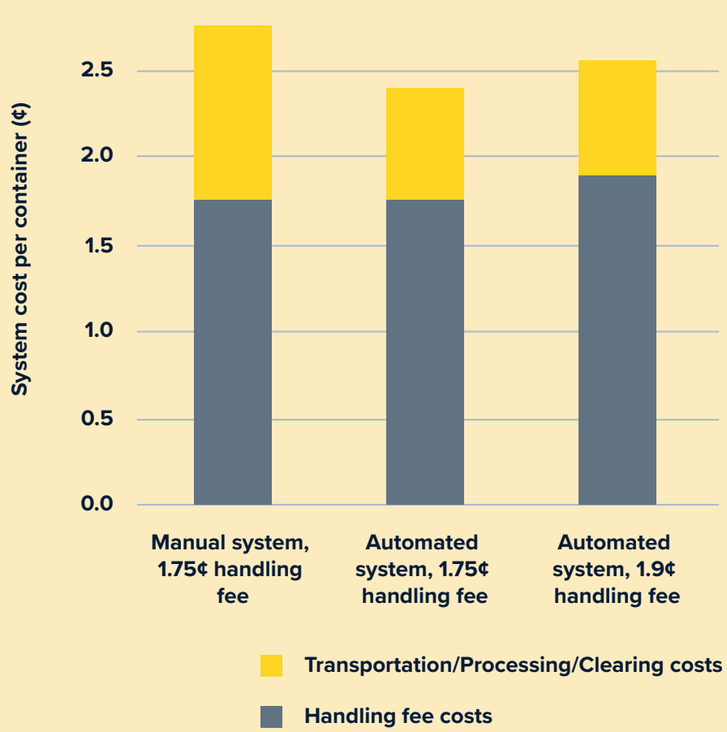
Bulk counters are industrial-sized reverse vending solutions that automatically count and verify the barcode and/or security marking of each container.

- **Accountability:** While manual redemption is still in place in some form in all deposit systems, it can be susceptible to inefficiencies and fraud if not supported by automated counting at some stage in the process. Effective DRSs address this by requiring containers redeemed manually to be verified through a second count, through automated equipment during or after initial collection. Alberta, for example, directs all manually-redeemed containers to centralized counting centers where bulk counting equipment counts containers at high volumes.

It pays to compact

Transitioning a DRS from a manual to automated system through compacting RVMs reduces the total system costs even in a scenario where the handling fee is slightly increased to incentivize the use of RVMs. This is due to an RVMs ability to generate savings through automating clearing services and compacting containers which creates savings inthe transportation and processing stages.

Figure 16: Impact of Compacting RVMs on System Costs



Bag drop

- **Convenience:** Bag-drop services provide a quick way to redeem an entire bag of containers at once. Consumers sign up for an account with their local redemption operator, download a mobile app or pickup a physical card linked to a digital wallet. The operator provides stickers with a personalized code that consumers place on bags that they purchase. Funds are deposited in user accounts typically within 2-4 days.

How bag drop works

1. Bag it
2. Stick it
3. Scan it
4. Drop it

Door-to-door

- **Convenience:** Retailers, technology players and system operators are collaborating to offer more pick-up services right from the consumer's doorstep. For example, Norway's Central System Administrator, Infinitum, partnered with local grocery stores with internet sales to offer a service where the delivery team picks up consumer empties and takes them back to the company warehouse. It delivers the empties to Infinitum where the system operator utilizes bulk counting equipment to count containers and reconcile consumer transactions. Consumers buy special bags from the retailer that are barcoded and embedded with a code to track their containers and ensure they receive an accurate refund. The system operates on a small scale. Approximately 1% of returns are processed through home delivery.[124] As with bag drop, door-to-door redemption may come with additional consumer fees for processing or bags.

7. Separately charged and fully refundable deposits

A true “deposit”, in any context, is designed to be returned in full. Systems issuing partial refunds in order to hold back funds for paying system costs (also known as “half-backs”) collect significantly fewer containers, because they reduce the incentive to participate. The top-five performing deposit systems in the world (Germany, Finland, Denmark, Lithuania, and Norway) all offer fully refundable deposits. Together they average a 94% return rate.[125] Effective DRSs engage the consumer at the point of sale by making them fully aware that they are being charged a refundable deposit on top of the sales price. Separately listing the deposit value from the sales price on both the store shelf and receipt avoids unnecessary consumer confusion. Exempting the deposit from value-added or sales taxes help reinforce the perception among the public that a container deposit is not a tax.

System spotlight

Separately charged deposits

- **All European deposit systems (Germany, Norway, Sweden, Finland, Estonia, Netherlands, etc):** All of these systems require the container deposit amount to be clearly listed on both the store shelf and sales receipt.
- **All Australian states:** While deposit containers in Australia indicate the container has a “refund” value, sales receipts and product labels on shelves do not, which misses a key public education and consumer behavior change opportunity.

Fully refundable deposits

- **Newfoundland & Labrador, Canada:** In Newfoundland & Labrador, consumers pay a deposit and receive about 70% of the value back upon redemption. For example, consumers pay CA$0.08 and get CA$0.05 back (US$0.06/$0.04) for beer cans and imported bottles. In 2024, the region’s overall container return rate was 69%.[126]
- **California, USA:** The California Refund Value (CRV) is the amount paid to consumers when they recycle beverage containers at certified recycling centers. The minimum refund value established for each type of eligible beverage container is 5 cents for each container under 24 ounces, and 10 cents for each container 24 ounces or greater. The typical means for redeeming containers at state-certified recycling centers is by first weighing them and then using a state-supplied conversion formula. For every deposit consumers pay at checkout, they are most often paid less when redeeming through this “weight-based” system. While container-based redemption is straightforward (one deposit for one container), weight-based redemption requires regular updates of the average weight calculation. Weight estimates are skewed by the wide and evolving bottle sizes and weights – an example most obvious when redeeming plastic bottles, because some categories like water have undergone extensive efforts to reduce container weights.

8. Container deposit markings for consumers and manual returns, barcodes for accurate accounting

In order for consumers and manual return points to easily identify containers eligible for a deposit, it is standard practice for DRSs to require standard text or a logo to be printed on each container. Barcodes serve a similar purpose as they enable automated redemption technology to recognize and count each deposit container – in the same way that grocery cashiers scan items at checkout. This provides the same accurate payments, a baseline level of security and fair financial accounting by keeping track of each brand. Virtually all deposit systems around the world, except for California and many Canadian provinces, have barcode-based recording systems that can identify whether containers qualify for redemption.[127] To further enhance accountability, modern deposit systems require or incentivize unique deposit markings and market-specific barcodes to prevent fraudulent redemption of non-deposit containers, reducing costs. Producers utilize these controls for their cost-saving benefits. In the United States this is utilized voluntarily by some brand owners where the benefit is clear. If direct printing of labels is not viable (e.g. small quantities of imported beverages), a sticker or stamp can be purchased from the CSA and affixed to the label.

System spotlight

Norway • Beverage producers pay a fee to register their products with the Central System Administrator (CSA), Infinitum. Containers must be marked with the deposit logo, deposit value, and a barcode. Prior to product launch, these containers are sent to Infinitum for testing and approval to ensure that that they can be read by reverse vending machines. As part of the registration process, manufacturers can choose whether to use a universal barcode (which allows the beverage to be sold in any country), or a barcode unique to Norway. Norway-specific barcodes carry lower fees for producers since they prevent consumers from potentially collecting deposits for containers bought outside of Norway. Infinitum retains all unredeemed deposits, so preventing unauthorized redemption reduces cost to the system. By contrast, universal barcodes carry slightly higher fees for producers due to potentially higher unauthorized redemption, since the product is sold across multiple markets. All bags used for transporting the containers after collection are tagged with a unique radio frequency identification (RFID) chip so they can be traced electronically. The bags, provided by Infinitum, are filled in the storage areas of RVMs and sealed with integrated closing tape so the contents cannot be tampered with.[128]

Examples of visual container deposit markings for consumers

Germany Sweden Norway

Croatia • For the first nine years Croatia's DRS was in place, deposit containers only included small text and no visual deposit marking. This made the process confusing for consumers, especially foreigners. Croatia overhauled its system in 2015, at which point logo container markings were required.

California, USA • The program utilizes visual markings, but not barcodes. This creates unnecessary vulnerabilities to fraud. Barcodes enable automated redemption equipment to verify each container as eligible for a deposit. As Eunomia stated in a comprehensive analysis of California's system, the "payment by weight option increases the potential for out-of-state containers and also out of scope containers to be redeemed."[129] The lack of barcodes also leaves the system unnecessarily vulnerable to fraud. CalRecycle spends somewhere between US$40 million and $200 million annually due to loss of unredeemed deposit revenue by way of weak accounting standards and cross-border fraud.[130]

New South Wales, Australia • Before the deposit system was launched in New South Wales, beverages sold together in what is known as "multi-packs" did not have individual barcodes. If nothing had changed, this would have created a situation where one container sold individually would be accepted by an RVM whereas those sold in "multi-packs" would be rejected in many cases. Due to concerns about consumer confusion and fairness, the government updated labeling requirements to add individualized barcodes before the system was implemented.

Diving deeper: QR codes to support consumer education

In jurisdictions where beverage companies sell products in multiple jurisdictions, the beverage industry has raised cost concerns about jurisdiction-specific container marking requirements. A 2-D code such as a QR code could be utilized as a tool to enable consumers with a smartphone to scan and identify the jurisdiction where that container is eligible for a refund as well as other helpful information such as where the nearest return location might be. The tool provides an option for the beverage industry to reduce container labeling costs while still educating consumers. Policymakers need to weigh this benefit vs the equity concern for consumers who do not have access to a smartphone.

Diving deeper: Thoughtful consideration of the informal economy

In non-DRS jurisdictions and even existing DRS markets that are pursuing modernization, an extensive informal economy often exists of people that regularly collect recyclable containers for a living. Individuals working in this manner are often referred to as “professionals”, “canners”, “waste pickers” or “valoristes”. Modern DRS designers are increasingly incorporating the unique needs of this population within the DRS, including ensuring they have convenient access to high-volume return locations and measures are taken to uphold the dignity of professionals, such as providing social support services near return locations or paying a premium value per container redeemed at these return locations. For example, the CSA for the Quebec DRS, The Quebec Beverage Container Recycling Association (QBCRA/Consignaction), actively seeks the participation of social economy enterprises in the DRS. One measure QBCRA has taken is paying a “solidarity allocation” per container redeemed at return locations managed by a local informal economy organization, Valoristes Quebec.[131]

PRINCIPLE 4: PRODUCER RESPONSIBILITY

9. Extended producer responsibility financing with eco-modulation

Extended Producer Responsibility (EPR) is defined as an "environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product."[132] DRSs engage beverage producers to manage the take-back of packaging and cover the costs of the system. In principle and practice, in high-performing models, producers reinvest the unredeemed deposits and the sale of returned material (or "commodity revenue") within the system. Should costs exceed these revenues, the net costs are paid for by the producers. When producers manage the deposit system through a centralized organization, they can agree to pay this net cost in the form of an "EPR fee" (see Figures 13 and 14 on pg. 45)*. EPR fees are charged to the producer for the remaining net costs and can be set based on the full cost of handling and recycling the material type that the producer chooses to place on the market (known as "eco-modulated" fees). This ensures no one producer is cross-subsidizing for another. It has the added incentive for producers to utilize packaging that is designed for recyclability (see Figure 12).

* Not to be confused with a "handling fee", which is a payment from the Central System Administrator to redemption providers such as retailers or redemption centers for container redemption and storage services.

System spotlight

Norway • Norway's Central System Administrator, Infinitum, establishes EPR fees for each producer based on the recycling cost and material value of each container material, even differentiating between clear vs colored PET. For example, aluminum cans carry no additional EPR cost for producers in Norway because their inherent commodity value plus the unredeemed deposits outweigh their cost to recover and process (see -0.04 NOK in Figure 12).

Alberta, Canada • Alternatives to producer responsibility financing include models that force consumers to pay for part of the system. Consumers pay this fee when purchasing a product, yet only recoup a portion of their deposit upon redemption. Half-back models only exist in regions with relatively small populations (1.5 million and less). For half-back models with significant populations*, the highest return rate is Alberta at 85%. This contrasts with Finland, a full redemption market, with a 99% return rate.[133]

*Over one million citizens

Figure 17: Eco-modulated EPR fee structure for Norway's Central System Administrator, Infinitum[134]

	Aluminum Can	Steel Can	PET Bottle	HDPE Bottle
Basic Fee	- 0.04 NOK	0.23 NOK	0.16 NOK	0.16 NOK
Surcharge for standard barcode (also sold outside Norway)	0.06 NOK	0.06 NOK	0.06 NOK	0.06 NOK
Surcharge for light blue container			0.08 NOK	0.08 NOK
Surcharge for colored container or a sleeve that covers 75% or more of the packaging			0.15 NOK	0.15 NOK
Surcharge for label or sleeve that covers 75% or more of the packaging	0.03 NOK	0.03 NOK		

10. Reinvestment of unredeemed deposits and material revenue within the system

There are two main revenue streams in a DRS:

1) Unredeemed deposits: Revenue from deposits that consumers choose not to redeem.

2) Packaging commodity (or "material revenue"): Revenues from the sales of deposit containers to processors or recyclers.

High-performing deposit models allow producers to reinvest these two revenue streams into the system, reducing the need for any additional charges or fees. Having a return-rate target (as discussed in Elements #3 and #14), a meaningful deposit value (Element #5), and convenient redemption system (Element #6), will drive high return rates, counteracting any perverse incentive for producers or governments to discourage redemption.

System spotlight

Norway • Unredeemed deposits and material revenue are enough to cover almost all of Norway's DRS costs: 52% of system costs are offset by material sales, 31% from unredeemed deposits, and 12% from other revenues (mainly interest). In the case of aluminum beverage cans, those income streams are even high enough to avoid any additional EPR fee from producers.[135] With these three revenue streams, producers reinvest in the deposit system's infrastructure. Infinitum incentivizes the use of compacting RVMs, due to their cost-saving benefit with respect to fraud mitigation and transportation efficiencies. Retail sites with compacting RVMs are paid a higher handling fee than those redeeming manually or without compaction.[136]

Figure 18: Profit and loss overview of Norway's Central System Administrator (2024)[137]

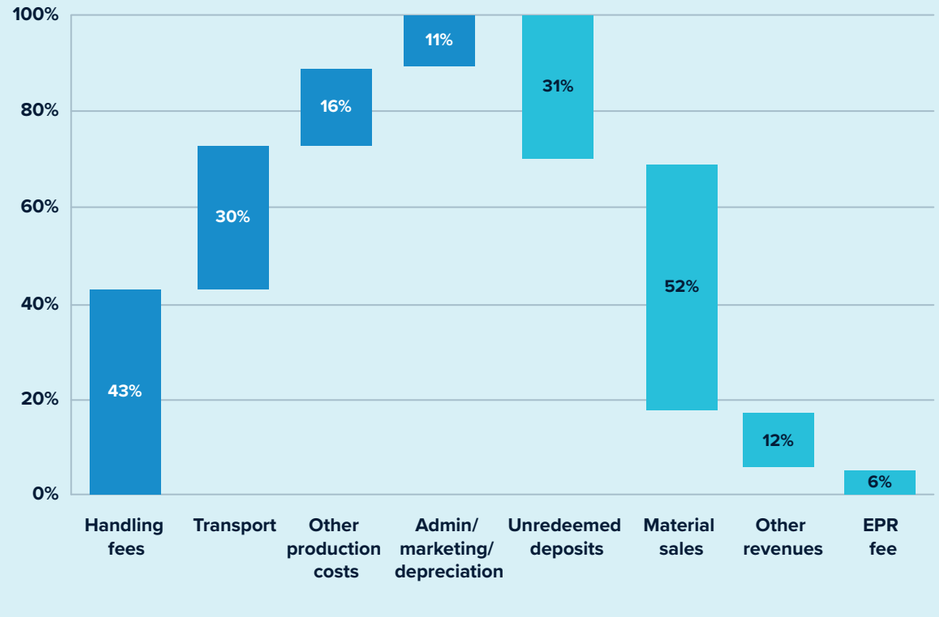


Figure 19: Detailed profit and loss statement of Norway's Central System Administrator (2024)[138]

Expenses		
Handling fees	332,319,000 NOK	43%
Transport	233,863,000 NOK	30%
Other production costs	126,219,000 NOK	16%
Admin/marketing/depreciation	83,975,000 NOK	11%
Total expenses	776,376,000 NOK	100%
Income		
Unredeemed deposits	240,663,000 NOK	31%
Material sales	412,276,000 NOK	52%
Other revenues	91,621,000 NOK	12%
EPR fee	44,401,000 NOK	6%
Total Income	788,961,000 NOK	100%
Operating profit in 2024	12,585,000 NOK	

Figure 20: Handling fees as set by Norway's Central System Administrator (2024)[139]

	Handling fee		
	Aluminum can	**PET bottles**	**HDPE bottles**
RVM with compaction	0.20 NOK	0.25 NOK	0.25 NOK
RVM without compaction Manual receiving	0.05 NOK	0.10 NOK	0.10 NOK

Sweden • Sweden's CSA, Returpack Svenska AB, keeps the revenue from both material sales and unredeemed deposits within the system. This funding model has allowed Returpack to reinvest in technology to drive cost- and eco-efficiencies. In the 1990s, 80% of Sweden's deposit cans were serviced by automated equipment. The remaining 20% was handled manually and, due to its relatively high cost, Returpack looked to automate. Returpack already offered a higher handling fee to retailers that utilize RVMs with compaction, but to accelerate the transition to a low-cost automated redemption network, the CSA granted a one-time sum of 20,000 SEK (€1,925/US$2,188) to each manual collection point willing to invest in an RVM.[140]

New York, USA • New York presents an example of a DRS where policymakers decided to revoke unredeemed deposits from producers in part due to a lack of reinvestment of the revenue in the performance of the DRS. In 2009, after the global financial crisis, governments faced steep budget shortfalls that threatened public programs. It was in this climate that New York policymakers adjusted the distribution of unredeemed deposits. Previously 100% diverted to producers. There was a perception that producers had not utilized the revenue to reinvest in the performance of the deposit recycling system, and policymakers diverted 80% of the unredeemed deposits to the government, with a portion going towards the Environmental Conservation Fund and 20% remaining with producers to offset costs.

11. Whether centralized or decentralized, roles and responsibilities are clearly defined

Deposit systems provide a platform for producers and retailers to responsibly manage the take-back and recycling of used beverage containers. All deposit systems include a similar set of responsibilities in order to function, such as container pick-up, clearing of deposits and handling fees, product registration and more. In general, DRSs can be categorized into two primary management models:

- **A "centralized" DRS** is one where most operational responsibilities are delegated to a single Central System Administrator (CSA). Typically, a CSA is owned by beverage producers or their respective importers plus retailers and distributors, with a Board of Directors composed of representative companies. It can also be owned and operated by a business with those stakeholders as customers. A CSA can be organized as a mission-driven, not-for-profit corporation to ensure the organization reinvests revenue generated by the system back into the collection program.
- **A "decentralized" DRS** delegates operational responsibility to each producer and allows them to organize key aspects of the program collectively or independently.

Whether DRS responsibilities are managed in a centralized or decentralized fashion, policymakers assign these responsibilities to stakeholders based on an assessment of conflicts of interest in order to ensure the purpose of the program – collecting and recycling more beverage containers – remains paramount. Effective policies balance the private sector's interest in cost reduction, to ensure the system makes it easy for consumers to redeem their containers and attains both social and environmental targets. Critical governance measures that establish these checks and balances are namely:

- **A return-rate target:** A performance target ensures the industry is constantly striving to deliver high rates of container collection and recycling (pg. 26).
- **A convenient redemption system for consumers:** A network of convenient redemption points, usually including retailers, provides a way for consumers to fairly recoup their deposit money (pg. 28). Convenience standards are outlined in legislation through either return to retail or requirements on the CSA or an independent network operator to provide a certain number of return locations by region, which may include retail.
- **Government enforcement (pg. 58):** Governments play the role of "referee", arbitrating violations and enforcing performance targets. When these elements are in place, producers have proven they can deliver high return rates at the lowest possible cost.

Centralized management
Most high-performing DRSs operate on a centralized basis. By designating a single management entity to fulfill the beverage industry's DRS responsibilities, a clear accountability structure is established, one that enables transparency and cost efficiencies. In jurisdictions first adopting a DRS where no existing infrastructure is in place, adopting a centralized model can bring benefits including the ability to establish a deposit system more quickly.

A central organization facilitates cross-industry problem solving and realizes cost efficiencies. No two deposit systems are identical so the responsibilities that are centralized in one market may not be the same in another. Local market needs or politics often make allowances in responsibility and execution.

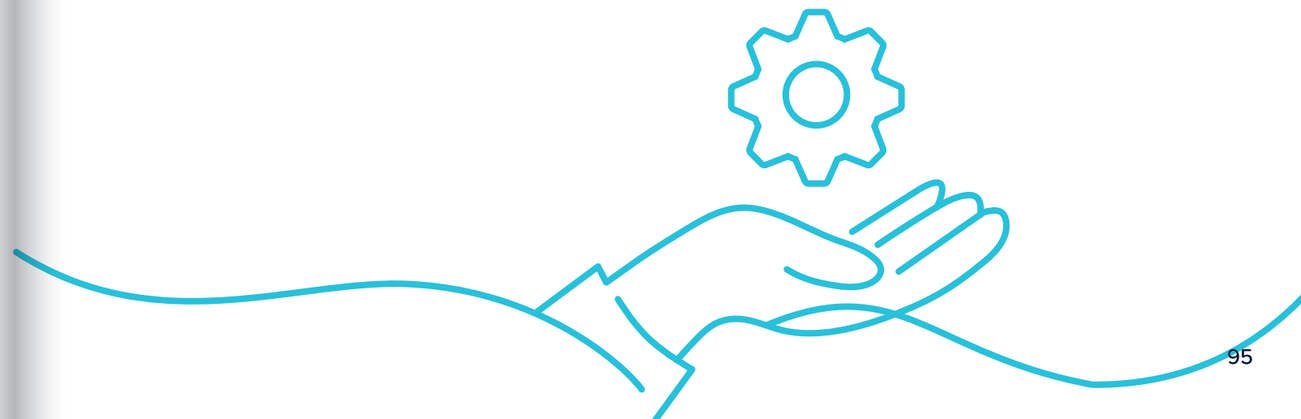
It is difficult for programs defined completely in statute to "continuously improve". Policies with clear targets, roles and responsibilities have allowed the private sector and regulatory bodies to execute innovatively. When needing to amend the deposit value, handling fees and add new beverage categories, that flexibility has proven more successful. Tackling this challenge is made easier when the stakeholders are aligned within a system operator or administrator organization.

Decentralized management
However, a central management entity is not critical for reaching high performance. Germany, which achieves the world's second highest return rate in a DRS of 98%, operates on a decentralized basis. To maintain a fair operating environment, it is critical to provide some standards within a decentralized DRS, standards that would be established by a CSA in a centralized program. For example, in Germany, while producers have the responsibility to repay deposits and pick-up containers directly instead of a CSA, the government did require that all producers and retailers had access to a national clearinghouse. Within this framework, retailers and beverage producers decided on their own to form an entity, Deutsche Pfandsystem GmbH (or DPG), to establish and execute fraud mitigation protocols throughout the system. (See Element #12 Fraud Protections for more information).

Any deposit system undergoing modernization takes into account the existing infrastructure and stakeholders before proposing reforms. Transitioning to a central, producer-managed CSA can be challenging in markets where independent depots or redemption centers are authorized and a DRS processing industry exists. In this case some markets have decided to make strategic upgrades (e.g. raising the deposit value to be meaningful) rather than establishing a CSA.

All effective deposit systems take on the following responsibilities, though differ in which responsibilities they delegate to producers or a CSA:

Common DRS responsibilities	
System operation	• Fulfilling collection performance targets • Managing the system's finances including setting any EPR (administration) and handling fees • Designing and funding the redemption infrastructure, including return to retail and where applicable branded redemption centers, to enhance the number of convenient redemption points • Registering sellers and new containers into the system • Assessing fraud risk and developing countermeasures (e.g. container markings) • Developing and signing contracts with all stakeholders and service providers (e.g. pick-up and processing) • Auditing producers and service operators • Approving and conducting quality assurance of manual and automated collection procedures and technology
Data management, deposit clearing, and reporting	• Maintaining a central database for all participating products' barcodes (provided by producers) and provision to parties in need • Aggregating data from automated and manual collection points • Clearing of deposits across the different trade levels • Administering handling fees/compensations • Reporting program performance to government
Sale of collected material	• Negotiating conditions/prices and sale of materials • Conducting quality assurance and product development
Public communications	• Establishing branding and communication guidelines • Conducting public awareness campaigns regarding (at a minimum) deposit value, covered containers and how to participate • Providing standardized marketing packages to every collection point



System spotlight

Norway • Norway's deposit system is unique in that it was established voluntarily by the beverage and retail industries. Norway issued an eco-tax on used beverage containers that are not collected (the lower the collection rate, the higher the eco-tax). After an analysis showed a deposit system was the most efficient way to collect the most packaging placed on the market, the beverage and retail industries formed Infinitum, a non-profit corporation that is designed to collect and recycle beverage containers by managing the deposit system. Infinitum is wholly owned by beverage associations (50%) and retailer associations (50%). Its Board includes Coca-Cola Enterprises, the retailer Coop Norge SA, two of Norway's major breweries, the largest grocery wholesaler and a leading grocery chain. To ensure a convenient redemption system for consumers, retailers selling deposit containers are obligated to take them back for recycling. Infinitum manages the system including managing the system's finances, data management, clearing, government reporting, commodity sales, and public communication. As of 2024, Infinitum achieved a total 92% return rate.[141]

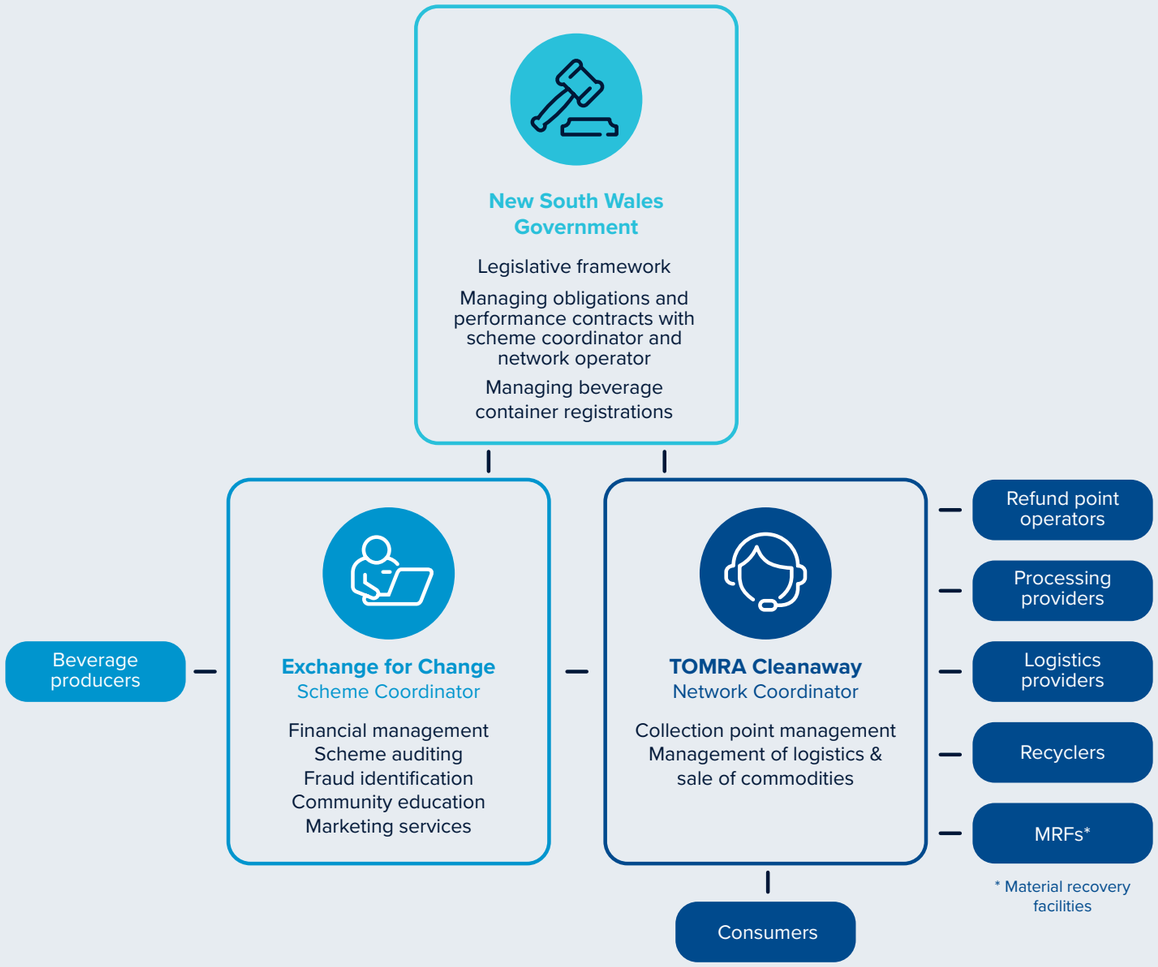
Finland • Finland's DRS model is nearly identical to Norway. Producers can avoid paying a packaging tax on beverage containers if they are registered in a deposit system. If retailers sell deposit containers, they are obliged to accept them for recycling. To manage the deposit system, retailers and the beverage industry formed a Central System Administrator, Palpa, of which they each own a 50% share. In contrast to Norway, Palpa's strategy is to operate the DRS on a free-market basis, outsourcing all but a few key responsibilities in order to reduce costs. For example, the system is serviced by two container pick-up providers and two processing providers. Palpa covers all system costs, management, service providers' and retailers' costs with the help of unredeemed deposits and materials' revenues plus the EPR fees from the industry. In 2024, Palpa achieved a total 99% return rate.[142]

New South Wales, Australia • New South Wales (and Victoria) operate what is referred to as a "split-responsibility" model. While a return-to-retail-based system is recognized as the gold standard of convenience due to its numerous and cost-effective return points, a split-responsibility model is a viable alternative when a strong convenience standard is in place. When retailers are not included in legislation, strong governance is required to ensure industry system administrators balance convenience with cost effectiveness. In New South Wales the government issued calls for tender for two distinct organizations that are responsible for certain roles:

- The "Scheme Coordinator" provides financial management, auditing, fraud identification, community education and marketing services. A key part of the scheme coordinator's role is to manage producers and ensure producer funds are paid into the system. Five Australian beverage companies (Asahi, Carlton United Breweries, Coca-Cola Amatil, Coopers and Lion) formed a joint venture, Exchange for Change, to operate as the Scheme Coordinator.
- The "Network Operator" provides set-up and management of a state-wide network of redemption points, as well as manages the logistics and sale of commodities to ensure all collected containers are recycled. Cleanaway, a waste management company, and TOMRA formed a joint venture (TOMRA Cleanaway) to act as the Network Operator.

The government is responsible for the design and development of the system, managing product registration and enforcing contracts for the Scheme Coordinator and Network Operator. Exact roles, responsibilities and financial arrangements are specified between each entity and the NSW government. As the Victorian Government recently put it, "The split responsibility creates a self-correcting tension between cost minimization of the scheme and achieving high return rates." The Scheme Coordinator is incentivized to minimize overall system costs. The Network Operator is driven to collect as many containers as possible because it is their revenue source. Also, the Scheme Coordinator is driven to validate the redemption claims of the Network Operator, which incentivizes enhanced transparency.[143] The New South Wales system involves a variety of redemption point operators including the private sector and charities. However, retailers are not obligated to take back containers, which has raised the overall cost of the system. The New South Wales DRS has collected 14 billion containers to date (December 2017 – August 2025).[144]

Figure 21: Roles and responsibilities in the New South Wales, Australia deposit return system[145]



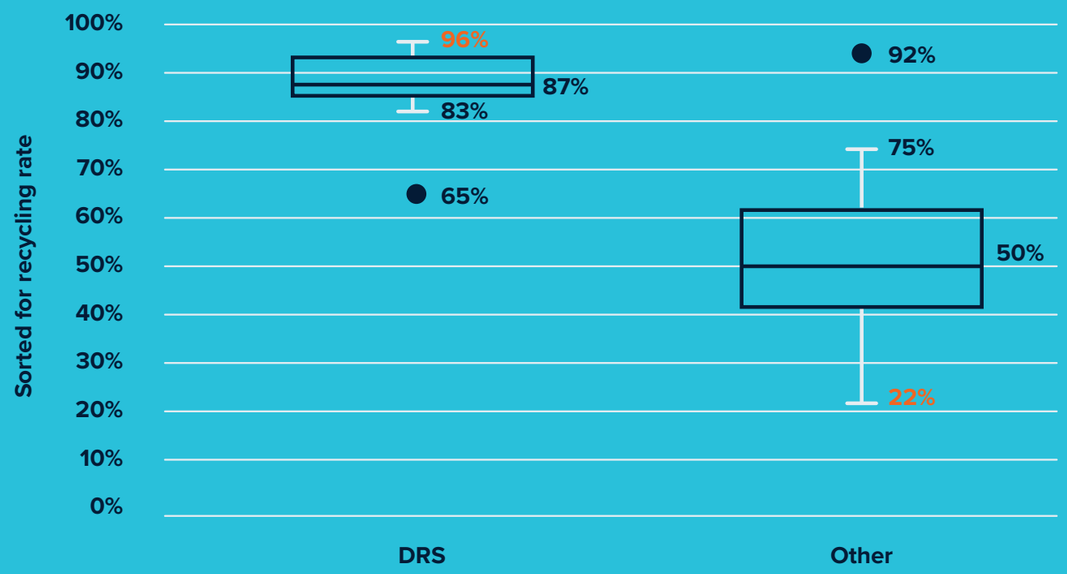
Diving deeper: DRS + EPR = Comprehensive EPR for packaging legislation

As the world responds to plastic pollution, the climate crisis, and the rising cost of waste management, more jurisdictions are regulating the end-of-life of packaging. Some jurisdictions have had sophisticated waste management programs for beverage containers and other packaging for decades, while others are just getting started. Comprehensive management of the end-of-life of packaging includes both a DRS for beverage packaging and an EPR program for non-beverage packaging. Of the 96 jurisdictions that have some form of this packaging management structure, 53 jurisdictions have EPR and DRS fully implemented or in the process of being implemented, 27 have DRS alone or are in the process of implementing DRS alone, and 16 have EPR alone or in the process of implementing EPR alone.[146]

A DRS targets beverage packaging since it is one of the most commonly littered items. Industry estimates report that a third of beverage packaging is consumed away from home where recycling bins are not always available.[147] A DRS also provides a platform to ensure beverage packaging is recyclable and that producers are engaged to cover the cost of collection, recycling and reuse of containers. EPR for Packaging programs are leveraged to address the design, collection, recycling and reuse of non-beverage packaging.

DRSs are adopted for their unique ability to achieve high collection, recycling and reuse rates relative to curbside-centric collection systems including EPR for Packaging programs. This is attributed to the meaningful reward for consumers to return containers: the deposit refund. For example, in Europe where all EU member states have implemented EPR for Packaging policies, the “sorted for recycling” rate for PET plastic beverage containers in the EPR-funded curbside and drop-off collection systems ranges from 22% to 75%, whereas the deposit systems collect 83% to 96%. Belgium is an outlier here who has reported a 92% “sorted for recycling” rate for PET plastic beverage containers without a deposit system. However, country officials are in discussions to adopt a deposit system in order to reliably achieve 90% collection or higher to remain in compliance with the EU Single-Use Plastics Directive and Packaging & Packaging Waste Regulation.

Figure 22: Sorted for Recycling rate for collection schemes in Europe[148]



In Ontario, Canada where some beverage categories are covered by the deposit program and others by the curbside EPR program, the recycling rate differs substantially: 75% of containers with a deposit are collected through the deposit system for recycling[149], whereas only 50% of containers without a deposit are collected for recycling.[150]

While these are traditionally distinct waste management programs managed by separate entities, it is possible for a DRS and EPR for Packaging (EPR-P) program to be managed by the same entity and adopted in the same piece of legislation. There are some examples of integration between EPR-P and DRS programs today. For example, in British Columbia the EPR Producer Responsibility Organization (PRO) pays the DRS PRO for collecting hard-to-recycle packaging at its network of deposit container depots. In Quebec, the DRS PRO pays the EPR PRO for deposit containers that are recycled through the EPR-funded curbside system.

PRINCIPLE 5: SYSTEM INTEGRITY

The system works reliably through a mix of fraud protections, transparency, and oversight.

12. Fraud protections

Like all systems which manage large sums of money, proper fraud protections are required to create a fair and cost-effective system with integrity. High-performing deposit systems rely on a portfolio of technology, governance and protocols to mitigate fraud.

Fraud type targeted	Best-practice fraud protection tool	Is the tool typically set in legislation or optionally adopted by producers or a CSA?
Repeat redemption – When the same container is attempted to be redeemed twice.	**Compacting (or "devaluing") containers** through technology once they are redeemed so as to prevent repeat redemption. Compacting and placing specific crush or cut marks on a container clearly indicate that the container has already been redeemed and therefore is not eligible for a deposit refund, even if the containers were brought to a second return location. Typically, this cancelling of the deposit refund is conducted by reverse vending machines with compaction capabilities.	It is common to see RVM compaction specifications set in statute but the requirement to devalue each container redeemed may be left to producers or a CSA to establish.
Attempting to redeem containers that do not exist – Claiming more containers have been redeemed than in reality.	Requiring all redeemed containers to be verified by technology – All high-performing systems require every deposit container redeemed to be counted electronically in order to accurately verify deposit markings, record the redemption transaction, and reconcile return data with the sales information received from producers. Containers are allowed to be redeemed through either RVMs that meet specifications or through manual drop-off locations. However, to reduce susceptibility to fraud, all manually redeemed containers must be verified through a second count via bulk RVMs at "counting and consolidation" facilities.	Voluntary initiative from the CSA or producers.

Cross-border redemption – Consumers attempting to return a container for which a deposit was never paid.	**Barcodes unique to the jurisdiction –** RVMs are programmed to only accept barcodes that are registered in the system. High-performing deposit systems require or incentivize the use of barcodes (and/or security markings) so only containers sold in the jurisdiction are eligible for a refund. In areas where sales commonly take place across multiple jurisdictions, some deposit systems have instead opted for reinvesting a portion of the unredeemed deposits into enforcement from a state agency.	• Unique barcodes – Voluntary initiative from the CSA or producers. • State enforcement – Set in legislation.
"Free-riding" producers – Producers who sell containers but are not reporting deposits charged, refunding deposits, or paying EPR fees.	**Product registration –** In order to sell a deposit container in the jurisdiction, the legislation requires all producers to register in the system and to register each product type including the barcode. **Requiring all containers to be verified by technology –** This requirement mentioned above, identifies (at a systemic level) any producers who have not registered.	• Product registration Set in legislation. • Requiring all containers to be verified by technology – Voluntary initiative from the CSA or producers
General fraud risk	**Data management and monitoring –** High-performing systems utilize a redemption network connected to the internet to collect and monitor data. With data, regulators and the CSA can conduct auditing and enforcement to prioritize response and ensure compliance throughout the system. **Standard-setting –** Dialogue amongst producers or a CSA to establish standards to protect against fraud. Generally this takes the form of the unique barcodes mentioned earlier, but it extends further to ensuring a variety of controls throughout the system.	• **Data management and monitoring –** Voluntary initiative from the CSA or producers. • **Standard-setting –** Voluntary initiative from the CSA or producers.

Key elements of high performing deposit systems - Fraud protections

System spotlight

Germany • With a relatively high deposit value of €0.25 (US$0.28), German producers and retailers voluntarily established a standard-setting organization, Deutsche Pfandsystem GmbH (or DPG), to establish and execute fraud mitigation protocols. Two notable protection measures adopted by DPG include the requirement for return locations to "devalue" (compact) containers in order to gain a deposit refund. This is made possible by RVMs that meet specifications set by DPG. The second notable measure is standards set for both a barcode and security marking unique to Germany. All deposit containers must include this on the label in order to be compliant with the DRS. RVMs are programmed to only accept containers that match both the unique barcode and security ink.

Norway • See the universal vs unique barcode case study on pg 53 under Element #8 Deposit Markings for Consumers, Barcodes for Automated Redemption.

Connecticut, USA • Connecticut operates a decentralized DRS that has recently modernized several aspects including making the deposit value a meaningful amount ($0.10 / €0.08). While some producers voluntarily utilize barcodes unique to Connecticut and nearby deposit states, some producers expressed challenges to adopting a state-specific barcode. In lieu of this systemic approach, policymakers adopted several protection measures including banning cross-border and repeat redemption in statute, setting penalties for violators, funding enforcement by the state police[151], limiting container returns to 240 containers per person at retail locations and setting an upper limit on the number of containers that can be redeemed at depots (5,000 per person).[152]

13. Government reporting and consumer communication

Key to any program's success is communicating with its constituents. System managers do this through performance reports and marketing to:

1. Keep regulators and the public informed about their progress towards goals
2. Engage both of these constituents to retain long-term support for industry's management of the system (a "license to operate")

Performance reporting
Typically, CSAs audit and report performance data annually to the regulator. Such reports include the aggregate sales and collection data per material type for the previous period. Regular and accurate performance reporting is easily made possible by registering all returned containers through technology.

Marketing to stakeholders, including consumers
CSAs raise public awareness about the redemption process, the location of redemption points and beverage types that are eligible for a deposit. CSAs also utilize marketing to increase participation in the system, improve public perception of the industry stewards, and ultimately raise return rates.

Annual reports from central system administrators

Oregon Beverage Recycling Cooperative
Oregon, USA

Infinitum
Norway

Alberta Beverage Container Recycling Corporation
Alberta, Canada

System spotlight

Alberta, Canada • In its annual report, the Alberta Beverage Container Recycling Corporation publishes information pertaining to the amount of material collected for recycling, as well as proof it was recycled, by sharing data related to material type, the material buyer, the percentage finally recycled, and ultimately what the material was used to produce.[153]

Norway • Norway's CSA, Infinitum, evaluated opportunities to increase the return rate to reach a mandated performance target. The analysis found that the millennial age group was among the least likely to participate in the deposit system. To attract more participants from this demographic, Infinitum launched a marketing effort complete with millennial-focused branding (Infinitum Movement), a lifestyle blog and comedic television advertisements.[154]

Maine, USA • In 2018, when Maine's Office of Program Evaluation and Government Accountability analyzed its state's deposit system for effectiveness, it realized a key metric was missing: the return rate. Under the law, producers had no legal obligation to report redemption performance. The government oversight body recommended a requirement for initiators of deposit to report beverage sales and redemption data, and reform legislation was passed in 2023 to require this change.[155]

Lithuania • Lithuania's deposit legislation specifies that 1% of the CSA's annual turnover must go towards public education and communications.

14. Government enforcement

At a minimum in high-performing systems, enforcement procedures are clearly stated in statute and regulations, including penalties and the government agency with the authority to enforce them. While enforcement priorities and procedures are established, the program requires an active government agency to maintain regulatory compliance. The agency itself is an empowered owner of the program's success. It ensures performance standards are met by producers and retailers, maintains a competitive "level playing field", and communicates program performance.

Figure 23: Return rate of plastic bottles (Oregon)

System spotlight

Oregon, USA • Today the return rate exceeds 85%, but Oregon's program was in decline pre-2008. Advocates sought a number of changes including raising the deposit value, adding new beverage categories, and even reverting to the state the unredeemed deposits that were not being invested into the redemption infrastructure. A compromise created the industry-owned CSA, Oregon Beverage Recycling Cooperative, and allowed it to modernize the system, while also setting a "trigger" mechanism to raise the deposit if the return rate fell. In this case, the CSA and regulatory body, the Oregon Liquor Control Commission (OLCC), worked together.

In 2016, when data showed the return rate had fallen below 80% for the previous two consecutive years, the deposit was increased from five to 10 cents in 2017. The result: a steady increase from 64% in 2016 to 86% in 2019. By 2024 the program has sustained an 87% return rate.[156] The plastic bottle return rate itself increased from 55% in 2016 to 83% in 2019.

Oregon legislators set goals in statute, and enabled the OLCC to establish rules to ensure they were met over time. For example, the program excludes "milk", but as products came onto the market that included milk as one of several ingredients, OLCC conducted a rule-making process to define what beverages would be included or excluded. In partnership with OBRC, the agency decided to exclude all beverages where milk is the first ingredient (mostly a milk product).[157]

CHAPTER 7

CONCLUSION

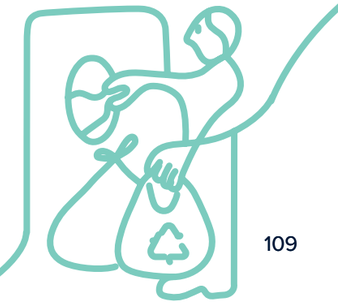
When it comes to beverage container recovery, Unlocking Circularity is about identifying what works and what doesn't.

As leaders grapple with the extent of challenges ahead – from plastic pollution and rising recycling costs to climate change – it's evident the ambition of public policies will need to grow to meet the moment. Based on decades of data illustrating high recovery rates, deposit return systems are the proven solution to many of these challenges. Yet, as this paper shows, the performance of these systems varies depending on their design. Since multiple jurisdictions including several national governments are defining deposit regulation at this very moment, with the fate of billions of beverage containers at stake, it is imperative policymakers grasp the principles that separate successful models from ones that are failing. Based on over five decades of operating experience in most deposit markets in the world, TOMRA identified the success factors for effective systems:

- **Circularity:** A structure is in place to ensure material is collected and recycled or reused as many times as possible back into the same product or product of similar high quality.
- **Performance:** Of utmost importance, the system is focused on meaningfully increasing recycling and/or reuse rates.
- **Convenience:** A redemption system that is easy, accessible and fair for everyone.
- **Producer Responsibility:** Producers manage the end of life of their packaging within a framework set by the government and reinvest the system's revenue to continuously improve the system's performance.
- **System Integrity:** The system works reliably through a mix of fraud protections, transparency, and oversight.

Crucially, TOMRA encourages stakeholders to consider the 14 elements discussed in this paper as part of an ecosystem rather than a menu of options. Prioritizing one but not the other could disrupt the system's performance and cost effectiveness. While there is no one-size-fits-all approach, the concepts outlined here seek to educate the system design discussion based on evidence.

While plastic pollution and climate change are enormous challenges, there is a recognized blueprint for action when it comes to beverage container waste. By embracing a thoughtful approach to deposit system design, leaders can turn the tide on plastic pollution, curb climate change, and deliver on the promise of circular economy.



CHAPTER 8

APPENDIX

Frequently asked questions

How does a container deposit return system work?
See page 40.

Are retailers compensated for redeeming beverage containers?
Mostly yes, and compensation varies among states/countries. But, in some cases, like Oregon, Germany and the Netherlands: no, retailers are not compensated. It may be specified in statute (e.g. New York), or as a percentage of the unredeemed deposits (25% in Michigan). In Europe, compensation in the form of a handling fee is typically set by the CSA in ways that progressively encourage cost-efficient investments by the retailer. For example, Norway and other markets award a higher handling fee to retailers who utilize compacting RVMs rather than manual redemption (see Figure 15 on pg. 46), because of efficiencies for storage and pick-up logistics.

What happens to the unclaimed deposits?
In the high-performing programs, unclaimed deposits are retained by the producer-operated, non-profit Central System Administrator. Most importantly, this allows for sustainable reinvestment in the program's redemption infrastructure, material processing and marketing to consumers.

How effective is using a deposit refund for reducing litter and increasing recycling rates?
Beverage container litter as a proportion of all litter is 54% less in regions with a deposit system than without.[158] The European median collection rate for PET plastic beverage containers in a curbside system is 50%, vs 87% for deposit return systems.[159] Across the US, deposit containers are captured for an average recycling rate of 67%, vs 25% for non-deposit containers,[160] with Oregon achieving return rates above 85%.[161]

Why do we need both curbside and deposit collection systems?
Because the social demand to capture beverage containers is high. Both systems complement each other in the fight against waste and litter. Here's how:

- Ensuring quality from the start guarantees recycling. To achieve "circularity", manufacturers need recovery systems that retain the material quality of resources. Due to food safety concerns, a bottle manufacturer will have more rigorous quality specifications than one producing fiber for carpet or fiberglass. Materials collected through a

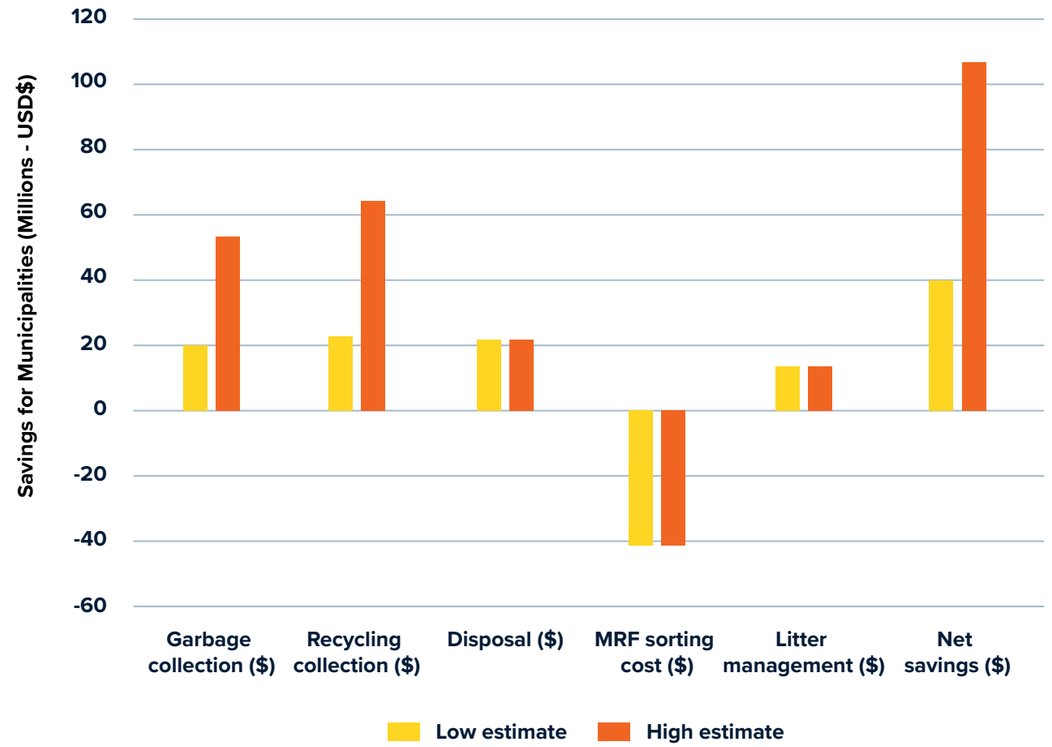
DRS are valued by producers seeking food-grade recycled material that can help them achieve recycled-content commitments for new beverage containers.[162] For example, PET post-consumer bales collected and processed through DRSs in the US can have a value approximately 40% greater than PET collected through a curbside program.[163]

There are many examples where DRSs and curbside collection work together to achieve high collection rates, but no instances where curbside collection is the sole collection system.[164] Saskatchewan, for example, achieves an 84% deposit container collection rate[165] and a 66.3% packaging and paper product collection rate via curbside.[166]

Curbside and deposit collection systems • collecting higher quantities anywhere they are consumed, be it on the go or at home:

How do local communities benefit from a DRS?
A common finding is that deposit systems result in net savings for local communities. Reloop has compiled a fact sheet of 33 studies that concur with this finding.[167] One recent study, for example, from 2025 found that a modernized DRS in New York state that achieves a 90% return rate would result in net savings for municipalities statewide between US$39 million and $109 million. Despite a projected loss of $42m on material revenue loss (which would be recycled through the DRS instead of curbside collection programs), this loss would be more than offset due to savings on garbage collection ($21-49m), recycling collection ($24-65m), disposal ($23m), and litter cleanup ($14m).

Figure 24: Summary of projected savings for New York State from a modernized DRS with a 90% return rate



In addition to the economic savings, deposit systems provide communities with reductions in litter as described earlier, divert more material from the waste stream, and create jobs. The 2025 study found an expanded and high-performing DRS in New York would lead to an estimated 1,866 additional jobs compared to 2025. The study accounted for potential lower throughputs at landfills and MRFs. New jobs created included servicing retail RVMs, operators at redemption centers, beverage container collections truck drivers, among other recycling positions.[168]

How do the best programs manage the risk of unauthorized or "fraudulent" redemption?
See Key Element #12: Fraud Protections on pg. 101.

Do all retailers need to participate in a deposit return system?
Yes, all retailers play a critical role by charging the deposit to consumers at the start of the process. However, their participation in taking back containers and issuing refunds varies. Since redemption systems are designed to make redeeming one's deposit money as easy as it was to charge the deposit in the first place, beverage retailers are almost always required to take back containers and refund deposits. See "Why a return-to-retail approach leads to high performance," on pg. 31 for more information.
Policymakers have made allowances for small-format stores (i.e. less than 100 m^2) by limiting the number of containers that a consumer can redeem per day, or allowing such stores the choice to opt in to the system. In some markets, redemption centers complement the return-to-retail redemption network by offering a more suitable option for high-volume redeemers. In markets where retailers are not required to take back containers (like New South Wales, Australia), network operators compensate retailers in order to utilize space in their parking lots for return kiosks.

Glossary of key terms

Beverage distributor: A business entity that provides transportation, storage and delivery of deposit drink containers from drink producers to drink retailers.

Beverage producer: A manufacturer of drinks whose containers are eligible for a deposit. Throughout this paper, a "producer" is the company first selling the deposit container in the market, which technically could be a manufacturer, an importer or a distributor.

Beverage retailer: In the context of deposit return systems, a beverage retailer is the business entity that sells deposit containers to consumers. In almost all cases, these same stores take back containers for recycling and repay deposits.

Carbon dioxide equivalent (CO^2e): The number of metric tons of CO_2 emissions with the same global-warming potential as one metric ton of another greenhouse gas (e.g. methane).

Central system administrator (CSA): A cooperative entity established by beverage producers (and sometimes retailers) to manage the day-to-day deposit system administration roles (e.g. product registration, anti-fraud processes, clearing deposits, etc). It may undertake operational roles such as system design, awarding of vendor contracts, approval of collection equipment, etc.

Circular economy: A circular economy is one that is restorative and regenerative by design. It looks beyond the take-make-waste extractive industrial model, and aims to redefine growth, focusing on positive society-wide benefits. It is based on three principles: design out waste and pollution, keep products and materials in use, and regenerate natural systems.

Clearinghouse: An institution that facilitates the exchange of data, settling of deposits and fees, and government reporting. Key responsibilities of a deposit system clearinghouse include: aggregation of data from automated and manual collection sites, settling of deposits across the different trade levels in the system, administration of handling / delivery / logistics / consolidation / counting fees, and facilitating collection-rate reporting to government.

Closed-loop recycling: Recycling of materials into the same or similar quality applications (e.g. "bottle-to-bottle recycling").

Clean loop recycling: A type of closed-loop recycling. Consumers are incentivized to utilize a dedicated collection infrastructure (e.g. RVMs) which minimizes littering, maximizes material cleanliness, and (if applicable) guarantees prior food-grade use. Recycling efficiency and process yield is maximized due to dedicated collection and logistics solutions.

Deposit return system (DRS): A system in which a small deposit is placed on the price of drinks sold in beverage containers, which is repaid when the consumer returns the container for recycling. Also known as deposit return schemes, container deposit schemes (Australia), or bottle bills (US).

Down-cycling: A recycling process where a recyclable item is recycled into a new object, which at the end of its life will not (or cannot) be recycled.

Extended producer responsibility (EPR): Policies that obligate producers to contribute to the end-of-life costs of products they place on the market, such as packaging collection, recycling and disposal.

Extended producer responsibility fee (EPR fee): The fee that brand owners or manufacturers pay when putting products on to the market in a centrally-operated DRS. The fee is dependent on the cost of collecting and recycling

the material of each product and its market value. Decentralized systems do not have a published fee; rather, producers execute program services themselves or through third-party agents, and own the collected material commodities themselves. EPR fees are set based on the Central System Administrator's operating expenses, which are substantially reduced when the producer-run non-profit retains revenue from unredeemed deposits and commodity sales.

Handling fee: Where required or negotiated, a fee that the CSA pays to retailers and redemption center operators who accept used beverage containers for redemption. In Norway, the DRS CSA's board sets this fee amount. In some markets the handling fee is set in statute as a whole number (e.g. 3.5 cents in New York), as a percentage of the unredeemed deposits (25% in Michigan), or not set at all (Oregon, Germany, and the Netherlands). Typically, this fee is based on an analysis of container collection, storage and transportation costs, and as such normally differentiates between manual and automated redemption.

Material recovery facility (MRF): A specialized plant that receives commingled materials from residential and commercial collection programs for the purpose of separating, quality control, and compacting like materials to ship to recyclers.

Material revenue: The money made from selling the materials collected in a deposit system, such as PET, aluminum, glass, and liquid paperboard. Material revenue is commonly used to offset DRS costs. Depending on the system's design, revenue from material sales may be owned by the Central System Administrator, the beverage producer, the retailer or redemption center operator. High-performing systems allow the CSA and/or producers to retain material revenue.

PET plastic: Refers to a specific plastic polymer type, Polyethylene Terephthalate, commonly converted to plastic beverage containers. The material is known for properties such as flexibility, durability, light weight, and an inability to biodegrade.

Redemption centers/depots: A location with return facilities where consumers can return their empty beverage containers and receive their deposits back. Redemption centers can be owned by private business owners or the Central System Administrator.

Redemption network: The infrastructure that enables consumers to return beverage containers to receive their deposits back. Collectively refers to all retailers and redemption center redemption options in a market.

Return rate/redemption rate: The percentage of beverage containers sold with a deposit that are returned for recycling in exchange for the deposit refund.

Return to retail: A reference to the redemption model that relies on beverage retailers to take back deposit containers.

Reverse vending machines or reverse vending systems: The technology used to automate the redemption and collection of used beverage containers for recycling. A reverse vending machine will confirm, identify, compact and sort eligible empty containers. It refunds the user's deposit in the form of a paper voucher or digital voucher (e.g. linked to a digital wallet). Redemption data is collected and then shared with a central administrator for the purposes of reimbursing the redemption provider the deposit and handling fee (if applicable) and informing container return logistics.

Sensor-based sorting: A process using machine sensors to identify and sort different material types from each other, e.g. separating plastic by polymer type.

Single-stream recycling: A curbside collection program that accepts authorized materials from homeowners in one mixed or commingled format. Materials are sorted at the MRF.

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