STUDY 2025

Efficiency and Performance of Packaging EPR Systems in the EU

A Comparative Analysis of Different Countries and Market structures

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adelphi

Imprint

Publisher:
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Photo credits:
Cover: Elena Feodrina, iStock

Disclaimer:
This study was financially supported by the following system operators active in Germany: BellandVision GmbH, Duales System Deutschland GmbH, EKO-PUNKT GmbH & Co. KG, Interzero Recycling Alliance GmbH, Landbell AG für Rückhol-Systeme, Noventiz Dual GmbH, PreZero Dual GmbH, Reclay Systems GmbH, Zentek GmbH & Co. KG.

The design of the research framework, the analysis of data, and the formulation of the conclusions were carried out independently by adelphi. Full editorial responsibility rests solely with adelphi.

Status: 04.11.2025

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List of Abbreviations

AI	Artificial Intelligence
ARA	Altstoff Recycling Austria
BMK	Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology
CEAP	Circular Economy Action Plan
CONAI	Consorzio Nazionale Imballaggi
DfE	Design for Environment
DRS	Deposit Return System
EEA	European Environmental Agency
EC	European Commission
EPR	Extended Producer Responsibility
EU	European Union
ISPRA	Italian Institute for Environmental Protection and Research
IRPC	Interregional Packaging Commission
KIDV	Netherlands Institute for Sustainable Packaging
MS	Member State
MASE	Ministry of Environment and Energy Security
M&E	Monitoring and Enforcement
MITECO	Ministry for the Ecological Transition and the Demographic Challenge
PET	Polyethylene terephthalate
PMD	Plastic, Metal, Drink Cartons
PP	Polypropylene
PPC	Paper, Paperboard and Cardboard
PPWD	Packaging and Packaging Waste Directive
PPWR	Packaging and Packaging Regulation
PRO	Producer Responsibility Organisation
R&D	Research and Development
SUP	Single-Use Plastic
SUPD	Single-Use Plastic Directive
WFD	Waste Framework Directive

VKS	Verpackungskoordinierungsstelle
ZSVR	German Central Registry

Executive Summary

The European Union (EU) and many of its Member States consider Extended Producer Responsibility (EPR) to be an essential approach to implementing a circular economy, with EPR forming a core pillar of the EU's Circular Economy Action Plan. EPR became mandatory throughout the EU in 2018, as per the Packaging and Packaging Waste Directive, with further regulations being implemented as part of the Packaging and Packaging Waste Regulation, binding from 2026. EPR systems for packaging waste now exist across Europe, but there are still important questions about the best way to design these systems. Although EU law sets common recycling targets, such as 65% (of total packaging waste) by 2025, each country uses its own implementation model (for example, Germany has a competitive system while Italy uses a centralised monopoly model). This study addresses a central question for policy guidance: Which systems in Europe **deliver superior cost-effectiveness and environmental performance under which circumstances?**

Our primary objective was to comprehensively assess and compare the performance of several (competitive, monopolistic, and quasi-monopolistic) EPR systems across Europe, identifying success conditions that drive effective packaging waste management. It is important to know which system designs work best, so that EU recycling targets can be met with optimal cost effectiveness for producers and society. This research conceptualizes EPR as a complex policy mix operating across multiple hierarchical levels. Because of this policy mix, it is too simplistic to only use one distinguishing variable like monopolistic and competitive. Success depends on many factors and cannot be measured by just one indicator. Plastic packaging represents the most challenging waste stream and recycling rates vary dramatically across countries. Understanding which system designs achieve better performance is essential for meeting ambitious EU recycling targets while optimizing costs to producers and society.

Therefore, to be able to effectively understand the complex EPR landscape, we developed five detailed country case studies on Germany, Italy, Belgium, France and Spain. In addition, we employed a comparative analysis of eight European countries (Germany, France, Italy, Belgium, Spain, Netherlands, Austria, Czech Republic) using a systematic evaluation framework. This included conducting an efficiency analysis using cost-effectiveness ratios adjusted for purchasing power parity. This allowed us to compare cost efficiency between countries in one indicator, representing the percentage of material recycled per euro spent. Our multi-dimensional scoring system converted quantitative performance data and qualitative system characteristics into standardized 1 (low)-5 (high) point scores across four categories:

1. Environmental performance
2. Cost and economic efficiency
3. System design and governance
4. Innovation capacity

Our analysis shows that recycling rates vary widely across Europe, and there is no clear advantage for a black or white comparison between competitive or monopolistic systems. Using the indicators for environmental performance, Germany has the highest recycling rates in Europe for household packaging. If PET quantities from the Deposit Return System (DRS) are included (which are managed separately), a weighted average rate of 76.1% is reached. This is well above the EU target (though for general packaging), with the EU is only aiming for 50% in 2025 and 55% in 2030 for overall plastic packaging. Belgium demonstrates the second-highest plastic recycling performance at 60.8%, proving that monopolistic systems can achieve strong environmental outcomes when supported by adequate financing and regulatory oversight.

Our analysis shows that how a system is designed matters more than whether it is competitive or monopolistic. Competitive systems can sometimes reduce costs, but competition alone is not enough. When analysing cost efficiency indicators for plastic recycling, Germany emerges as the clear leader, followed by Italy. For Paper, paperboard, and cardboard (PPC), the Netherlands are ahead, followed by Italy. For glass recycling it is again Italy followed by France and Germany. Belgium, with a non-profit, monopolistic structure presents a particular challenge for cost efficiency analysis, despite a good recycling performance of 60.8%, indicating the impact of a lack of competitive pressure.

In our analysis, Germany emerges as an innovation leader, scoring high across most criteria, with Italy, a monopolistic EPR system, also demonstrating good innovation potential, particularly in eco-design promotion and consulting services. Overall, competitive systems demonstrate clear innovation advantages: Germany's 10 competing Producer Responsibility Organisations (PROs) drive technological advancement and cost optimization through market pressure. However, a strong regulatory framework is needed here, setting ambitious targets while ensuring fair competition. Monopolistic systems may excel in contexts with appropriate regulatory controls, sufficient institutional capacity and advantageous geography like in Belgium. The evidence suggests that operational responsibility and material ownership by PROs represent more fundamental performance drivers than market structure alone.

Systems where PROs assume direct responsibility for collection, sorting, and recycling - whether competitive like Germany or monopolistic like Belgium - consistently outperform systems where PROs primarily serve as financial intermediaries and municipalities have a strong role. Belgium achieves the EU's highest glass recycling rate of 97.8% and strong performance across other materials despite its monopolistic structure. Conversely, France's quasi-competitive system struggles with plastic recycling performance despite regulatory sophistication, achieving only 35.9% compared to Germany's 76.1%.

As per the results from this research, four critical design factors drive performance regardless of market system type:

Figure 1: Critical Design Factors

When PROs control the entire value chain from collection to recyclate marketing, they can optimize for material quality, volume efficiency, and cost effectiveness. This end-to-end responsibility creates results that go beyond market structure considerations. However, competition provides additional performance benefits when combined with operational responsibility. The German experience demonstrates how competitive pressure drives continuous innovation, cost efficiency, and service quality improvements beyond what might be achieved through operational responsibility alone. The combination of competition and operational control creates a dynamic system where market forces drive performance while operational accountability ensures effective implementation.

Both competitive and monopolistic systems can succeed when implementing professional operational responsibility, complete cost internalization, and robust oversight mechanisms. The optimal approach depends on the national context including market size, institutional capacity, and existing infrastructure. Future EPR development should focus on strengthening these core design elements rather than pursuing one-size-fits-all structural solutions. In our analysis and under the mentioned circumstances, a competitive EPR model like Germany shows clear advantages in cost effectiveness and environmental performance.

The EU could make greater efforts to ensure comparability through harmonized data collection, indicators, and definitions in order to make performance of member state systems more transparent and comparable. This implies mean harmonization, particularly with regard to data and definition standards.

1 Introduction

1.1 EPR Background Context

The transition to a circular economy is increasingly recognised as a key strategy for addressing planetary crises, as it aims to reduce resource use, minimise waste, and lower greenhouse gas emissions across key sectors, including electronics, plastic, and packaging. To promote the implementation of a circular economy, the member states of the EU as well as the European Commission recognise the importance of EPR systems. This is evident in the Circular Economy Action Plan (CEAP) of the COM/2020/98 final, 2020 (EC), which emphasises EPR as a key instrument for promoting the circular economy. Additionally, EPR is included across a range of EU legislation, beginning in 1994 with the Packaging Directive (94/62/EC), which encouraged the introduction of EPR systems. Although the Packaging Directive did not explicitly mention EPR, it contained the principle that producers should be responsible for the disposal and recycling of their products, thereby laying the foundation for later legislative provisions, and incorporating the polluters pay principle.

The first explicit provisions on EPR were outlined in the 2008 EU Waste Framework Directive (2008/98/EC), which defined the concept of EPR in its basic features and empowered EU Member States to take measures to ensure that manufacturers and producers take responsibility for their products in the post-consumer stage. EPR was subsequently integrated into a series of EU directives and regulations on specific waste streams, such as packaging, batteries, electrical and electronic equipment, and end-of-life vehicles. For packaging, the revised Packaging and Packaging Waste Directive (2018/852/EU), which came into force in 2018, required all EU Member States to introduce EPR systems for packaging and packaging waste by the end of 2024. Similarly, the European Packaging and Packaging Waste Regulation (EU/2025/40), which came into force in February 2025 and will be binding from August 2026, requires all manufacturers, importers and distributors to take financial responsibility for the entire life cycle of their packaging and extends the EPR rules to commercial and industrial packaging

In addition to the complex EU legislative landscape, national EPR systems are very heterogeneous, as the design, implementation and success of these schemes varies strongly across the EU, despite operating under common EU framework directives. This is due to a variety of diverse and intersecting EPR design characteristics, including stakeholder responsibility, operational and financial scope, regulatory coordination and governance frameworks, cost allocation mechanisms (e.g. full cost versus partial cost), fee structures, their non-profit or for-profit status, coverage scope, and implementation of eco-modulation approaches, among other factors (Mallick et al., 2024; Pruess, 2023).

Furthermore, another key difference, focused on in this study, is whether the system is monopolistic, where EPRs are managed by one, or predominantly one (over 90% of market share) PRO, or competitive, characterised by market situations where multiple PROs are present (Pruess & Garrett, 2025). Germany, like other Member States (MS) such as Austria, have competitive models, with the German EPR system featuring ten competing PROs operating in an open market (Stiftung Zentrale Stelle Verpackungsregister 2025b). Comparatively, countries like Belgium, Italy and France rely on centralised, monopolistic or quasi-monopolistic models, with either one or mainly one PRO in operation.

The Figure 2 below shows EU EPR systems and whether they have a monopolistic, a quasi-monopolistic or competitive structure. Systems are counted as quasi-monopolistic if multiple PROs exist in the market, however only one PRO holds more than 90% or the market share. In the EU, most EPR systems for packaging are competitive, though there are some monopolistic and quasi-monopolistic set-ups, as indicated in the map below.

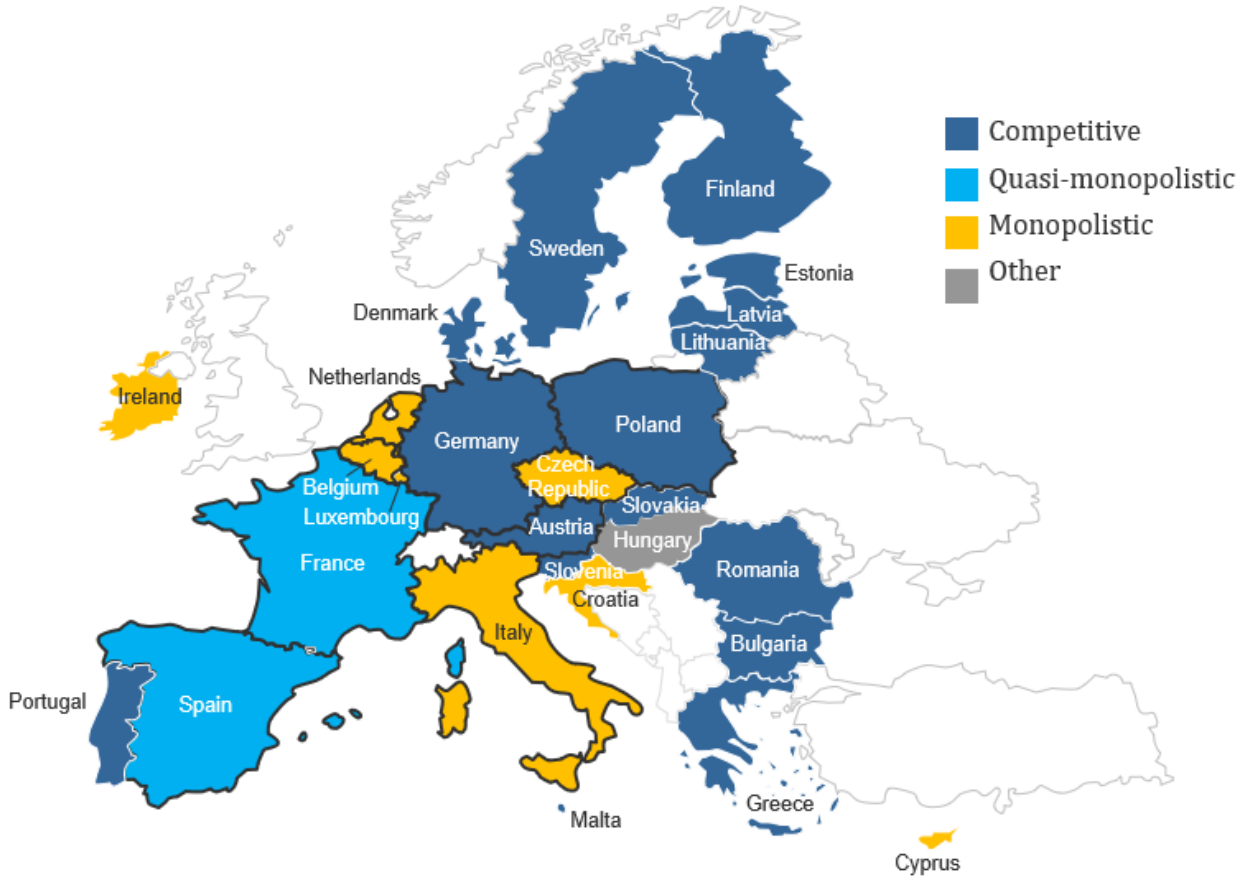

Figure 2: EU EPR System Market Design for Packaging

Whether competitive or monopolistic systems have higher performance is subject to debate, with comparisons between the different systems difficult due to high levels of difference in design (Deloitte Sustainability, 2017). However, research indicates that competitive and non-competitive systems vary across economic efficiency, environmental effectiveness and innovative capacity (Ahlers et al., 2021). Additionally, governance, monitoring and consumer involvement, also impact on the effectiveness of such models (Colelli et al., 2022; Pruess, 2023).

Due to the complexity of the EU legislative and policy landscape, as well as the disputed effectiveness of the competitive versus non-competitive models, this study provides critical research to inform discussion on the impacts of different EPR market structures.

1.2 Objectives

Against the heterogeneous and complex EU EPR background, the design choices by policymakers and industry stakeholders are especially impactful. Therefore, this study provides research on different EPR market structures, as informed through key indicators, with the aim of comprehensively assessing and comparing the cost-effectiveness (ratio of recycling rate impact to EPR costs) and performance of competitive and monopolistic EPR systems in Europe, with a focus on the packaging sector.

Secondly, the study aims to identify conditions for success within different EPR packaging systems. To do this, we draw on the literature and develop a series of qualitative and quantitative indicators that provide information about the performance of the systems, with the aim of understanding how different EPR market structures perform as per different indicators. These indicators focus on environmental performance, cost and economic efficiency, system design and governance, and innovation in differing EPR market structures.

The results of the study are intended to provide policy makers and industry stakeholders with scientifically sound and methodologically robust information on the impact of market structures on optimal EPR implementation.

1.3 Methodology

This study employed a purposive sampling approach to select eight European countries for comparative analysis of EPR schemes for packaging waste. The selection criteria prioritised EU member states with large populations to ensure representative coverage of major European markets, with particular emphasis on Germany, Italy, France, and Spain due to their significant economic and political influence within the EU and established EPR frameworks. The sample was expanded to include Belgium, the Netherlands, Austria and the Czech Republic, to capture a number of smaller countries with EPR design structures across Europe. Importantly, the selected countries represent varying market structures within their EPR systems, encompassing monopolistic (e.g., Belgium, Italy), competitive (e.g., Germany, Austria), and quasi-monopolistic systems (e.g., Spain, France). Thus, this selection enables comprehensive analysis across different system architectures and governance models.

The literature review was conducted through systematic searches of academic databases including Web of Science, Scopus, and Google Scholar, using key terms such as "extended producer responsibility," "EPR systems," "packaging waste," and country-specific terms, covering publications mostly in the range from 2020 to 2025. Grey literature sources were also extensively reviewed, including reports from European Environment Agency, national environmental agencies in all countries, PRO annual reports, PRO Europe publications, and policy documents from the European Commission to capture the most current regulatory developments and system performance data.

An analytical framework was developed to provide the methodological foundation for the study. This framework consisted of a comparison and evaluation matrix that served as the central instrument for the comparative assessment of EPR system cost efficiency and performance. The framework was structured around four main categories, each containing specific indicators (16 in total). The indicators are derived from the literature.

Environmental Performance:

- Collection Rate in % (Household packaging)
- Recycling Rate in % (Plastic)
- Recycling Rate in % (Glass)
- Recycling Rate in % (Paper/Cardboard)

Cost and Economic Efficiency:

- EPR Cost efficiency (Plastic)
- EPR Cost efficiency (Glass)
- EPR Cost efficiency (Paper/Cardboard)
- Total System Cost Coverage

System Design and Governance:

- Collection Responsibility
- Collected Material Ownership[1]
- Monitoring/Enforcement
- Data Transparency

Innovation:

- Innovation Potential
- Eco-Modulation
- Consumer Awareness/Education

[1] The term ‘material ownership’ that we use here and subsequently is not to be understood exclusively in the sense of civil law ownership, but also in the sense of authority of disposition over the material.

– Innovation for Eco-Design

Following the framework establishment, an extensive data collection process was initiated for each country. The year 2023 was chosen as the base year. Because of reporting requirements, the data sources cannot be taken from more recent years, as some data are not yet available. The prices used are the current licensing prices for 2025. For each country, a fact sheet was compiled. The data collection encompassed multiple indicator categories, including but not limited to

– **Collection rates:** Overall packaging collection rates and material-specific collection rates
– **Recycling rates:** Performance metrics for plastic, glass, and paper/cardboard
– **Fee structures:** Licensing costs and total fees paid by material type
– **System costs:** Total operational costs including collection, sorting, recycling, and administrative expenses
– **Innovation indicators:** Presence of eco-design promotion, eco-modulation, advisory services, and R&D activities

Across countries, the metric underlying officially reported recycling rates is not fully harmonised. In some systems, the denominator is the Amount Licensed (i.e., quantities declared for EPR/fee purposes); in others, it is the Amount Placed on the Market (i.e., total marketed quantities). In our dataset, the recycling-rate base reflects what was officially available and reported per country at the time of collection: Amount Licensed is used for Belgium, Germany, Spain, and the Czech Republic; Amount Placed on the Market is used for the Netherlands, Italy, and France and Austria. Given known challenges such as under-declaration and potential free riding in some markets, we acknowledge possible gaps between licensed and actual market quantities. Nevertheless, we consider the reported figures to be the best available approximations of market totals in each country, and we therefore use these official series as denominators for the recycling rates throughout the analysis.

Data sources varied by country and indicator, drawing from national environmental agencies (e.g., ADEME for France), European Environment Agency reports, PRO annual reports (e.g., Citeo) and statistical databases (Eurostat). A critical component of the methodology involved determining licensing fee structures across different market configurations. This process proved challenging in competitive markets due to commercial confidentiality but was more straightforward in monopolistic systems. The RECYDA database was utilised as a tool to access current pricing information where available (Recyda, 2025). RECYDA is a software that is intended for companies to assess recyclability and calculate EPR fees for their products - ensuring compliance with global packaging regulations. The platform makes it possible to compare licensing costs for specific packaging items (e.g. 500ml yoghurt pot made of polypropylene with aluminium lid) in various European countries.[2] This ensures good comparability between prices. Licensing fees for ten typical packaging items were determined and compared across countries for 2025. The average licensing costs are intended to serve as a proxy for the total costs of the EPR system, since the exact costs of each system are not available. We used Recycda software to obtain prices for comparable packaging items for all countries compared except Germany. For that country, we obtained weighted average prices (across all PROs) for the licensing of waste streams directly from the PROs (Gemeinsame Stelle dualer Systeme Deutschlands GmbH, 2025).

Careful consideration was given to whether countries operated under full cost or partial cost models. However, since these licensing costs are the main source of income for PROs and therefore reflect their cost necessity, they are a widely accepted proxy (Sachdeva et al., 2021) This approach enabled standardised cost comparisons despite varying system architectures and financing mechanisms. The efficiency rate of each system was then calculated as the ratio of the respective recycling rate of the material stream to the average licensing price of 10 typical household packaging items. A list of the items can be found in Annex 1.

Each indicator within the four framework categories was assigned a numerical score ranging from 1 to 5 points, based on system performance and available information quality. The scoring methodology considered:

– **Score 5:** Excellent performance, best practice example
– **Score 4:** Good performance, above EU average
– **Score 3:** Average performance, meeting basic requirements
– **Score 2:** Below average performance, areas for improvement identified

[2] https://www.recyda.com/product/epr-reporting-and-compliance-platform

- **Score 1:** Poor performance, significant systemic challenges

Individual indicator scores were aggregated within each category and subsequently combined to derive an overall system performance score. This approach enabled systematic comparison across qualitative and quantitative indicators and across countries while maintaining methodological consistency.

To gain comprehensive understanding of the impacts of system structures and operational mechanisms within the EU, detailed country studies of 10-15 pages were developed for the five countries in the sample: Germany, Belgium, France, Italy and Spain. These case studies provided qualitative context to complement the quantitative analysis, exploring:

- Historical development of EPR systems
- Regulatory frameworks and governance structures regarding material ownership, role of municipalities and PROs, eco-modulation etc.
- Stakeholder relationships and responsibilities
- Implementation challenges and innovations
- Performance outcomes and trends

Based on comprehensive data analysis, performance scoring, and case study insights, success criteria were derived through systematic evaluation of high-performing systems. Key factors contributing to EPR system effectiveness were identified by analysing correlations between system characteristics and performance outcomes, particularly in recycling rates, cost efficiency, and innovation metrics.

The research culminated in the compilation of findings into this comprehensive study, documenting system variations, system performances, best practices, and analysing the relationship between system design features and performance outcomes. Various contributing factors to system success and failure were systematically derived to provide evidence-based recommendations for EPR system optimization. This methodology ensured systematic comparison of EPR systems while accounting for national context variations and system architecture differences across the European landscape.

2 Current Landscape of EPR systems in the EU

Since its introduction in the 1990's, EPR has evolved into an extensive policy and regulatory ecosystem within the EU, with EPR playing a vital part of the European Green Deal's Circular Economy Action Plan, adopted in 2020. Broadly, EPR legislation in the EU is covered within the Waste Framework Directive (WFD), an overarching legal framework outlining performance targets and legal requirements for EU waste management. There are also EPR directives and regulations focusing on specific waste streams, including the Single-use Plastic Directive, the EU Batteries Regulation, and the Waste from Electrical and Electronic Equipment (WEEE) Directive. Inter-relatedly, there are also legislations that cover life cycle aspects, including eco-design, distribution, and use (Mallick et al., 2024). In addition, the Packaging and Packaging Waste Directive (PPWD), first adopted in the 1990s, includes rules on packaging design and packaging waste management, and mandated the introduction of EPR systems for packaging and packaging waste in 2024. Replacing the PPWD, the **Packing and Packaging Waste Regulation (PPWR)**, adopted in February 2025 and binding from mid-2026, includes new rules such as minimum targets for recycled packaging content and aims to harmonise national EPR methods (European Commission, 2025a).

EPR has increased recycling rates within the EU, especially for packaging, as primarily incentivised by specific material targets within the directives (Mallick et al., 2024). This includes an EU-wide 10% increase in packaging recycling from 2005-2022, although for other waste streams, and the overall recycling rate, this number has stagnated. In addition, as EU EPR policy and directives so far have provided flexibility in how these performance targets and legal requirements are achieved, EPR systems across the EU are heterogeneous. This includes the development of different EPR designs, including competitive for-profit EPR in MS such as Germany, comprising over ten competing PROs, whereas in other countries such as Belgium, EPR is non-profit and monopolistic, managed by one PRO (Pruess & Garrett, 2025). The disharmonious nature of EPR systems within the EU has created barriers for both policymakers and manufacturers, adding additional complexity, impeding the effectiveness of the EU single market (Ahlers et al., 2021; Mallick et al., 2024) and influencing the national performance of EPR systems . In addition, as EU EPR policy and directives so far have provided flexibility in how these performance targets and legal requirements are achieved, EPR systems across the EU are heterogeneous.

On the other hand, this heterogeneity has also allowed for a diversity of systems throughout the EU to flourish, showing how different EPR design, such as monopolistic, quasi-monopolistic and competitive, as well as other design choices such as full-cost and partial-cost systems, impact on the success of EPR systems within the EU.

2.1 Overview of EPR for Packaging

As of 2022, 80 million tonnes of packaging waste were generated annually in Europe, with paper and cardboard (34.0 million tonnes) the main packaging waste material in the EU, followed by plastic (16.1 million tonnes) and glass (15.7 million tonnes) (Eurostat, 2025a). To minimise packaging waste, EU EPR legislation includes all forms of packaging on the EU market, regardless of whether the waste is from household, commercial, or industrial sources, with main waste streams including paper and cardboard, plastic, glass, wood, and metal. As mentioned above, one clear impact of EPR is the increase in packaging recycling rates, with analysis indicating that EPR implementation has a positive impact on recycling rates within the EU (Cahill et al., 2011; Rubio et al., 2019).

Initially, EPR was implemented in the EU for packaging through the introduction of the PPWD in 1994, with other streams following suite, including batteries and WEEE. In 2018, a legal basis for the mandatory establishment of EPR schemes for all packaging was introduced into the PPWD, to be implemented by the end of 2024 (Directive (EU) 2018/852, 2018). In addition, the PPWD set a requirement that by the end of 2025, at least 65% of all packaging waste must be recycled (Directive (EU) 2018/852, 2018). Building upon this, the PPWR, binding from 2026, provides a regulatory framework to both expand and unify EPR system requirements in the EU. This including mandating national registers to monitor compliance with EPR requirements, as well as the introduction of harmonised criteria for EPR fee modulation (Regulation (EU) 2025/40, 2024). This includes

measures to prevent the production of packaging waste, and increase the reuse, recycling and other recovery, and includes ambitious targets including that all packaging must be recyclable by 2030, a 70% recycling target by 2030, as well as mandatory labelling requirements for packaging from 2028 (Regulation (EU) 2025/40, 2024).

Notably, 40% of plastic in the EU is used for packaging, contributing 193 million tonnes of CO_2 to the atmosphere (European Environment Agency [EEA], 2023b), with single use packaging also making up half of all marine litter (Ahlers et al., 2021; European Commission, 2025a; EEA, 2023a, 2025d). To attempt to minimise the environmental harm from single use plastic (SUP), the Single-Use Plastic Directive (SUPD) was adopted in 2019. The SUPD includes limiting the use of specific SUPs and includes a separate collection target for plastic bottles of 77% 2025 and 90% by 2029. It also includes a target for recycled plastic in PET beverage bottles of 25% in 2025, and 30% in all plastic beverage bottles from 2030 (European Commission, 2025c). Under the SUPD, companies must assume EPR for single use plastic, including the cost of waste disposal and labelling products (European Commission, 2025c).

To meet EU wide regulations and directives relating to packaging, EU MS have taken their own approaches to EPR to meet recycling targets. This has led to a diverse system of national level laws and frameworks. For example, in Germany, this includes the Packaging Act, with household packaging managed by a so-called dual systems approach, as well as a DRS, which is specifically dedicated to beverage containers such as PET bottles and aluminium cans. In France, this includes the Environmental Code, with an EPR system covering all household, commercial, and industrial packaging. In Spain, EU directives have been transposed into national law, with the National Waste Framework Plan expanding EPR to include commercial and industrial packaging from 2025 (Comisión Nacional de los Mercados y la Competencia, 2024)

For household packaging, the performance of EPR across MS is mixed, with some countries failing to meet EU targets, leading to infringements (Voloschuk, 2024). However, the 2025 EU packaging recycling target of 65%, as per the PPWD, (European Union, 2025a), has been met, with average recycling rate in the EU at 65.4% as of 2022 (Eurostat, 2025b).

GERMANY CASE STUDY

Germany has over 10 competing PROs competing for market share. The German EPR system for packaging waste is characterized by a highly competitive and efficient model. Particularly noteworthy are the high recycling rates, full-cost coverage and operational responsibility by PROs and a strong regulatory framework.

2.2 Typology of Systems

A number of EPR systems co-exist within the EU, with EPR design across EU member states including different targets, stakeholders, and governance mechanisms, as well as differences in market and operational structures (Mallick et al., 2024). Indicating the breadth of different systems, EPR systems can be differentiated into full-cost, and partial cost, non-profit and for-profit models, competition and monopoly and various other forms. Pruess (2023) highlights the considerable heterogeneity and increasing complexity of EPR systems in Europe, which have evolved from originally often monopolistic structures into a multifaceted mosaic of different system architectures. This complex landscape is overviewed in Figure 3: “PRO Responsibility Allocation” with orange boxes denoting governance and responsibility; and red, indicating EPR instrument families.

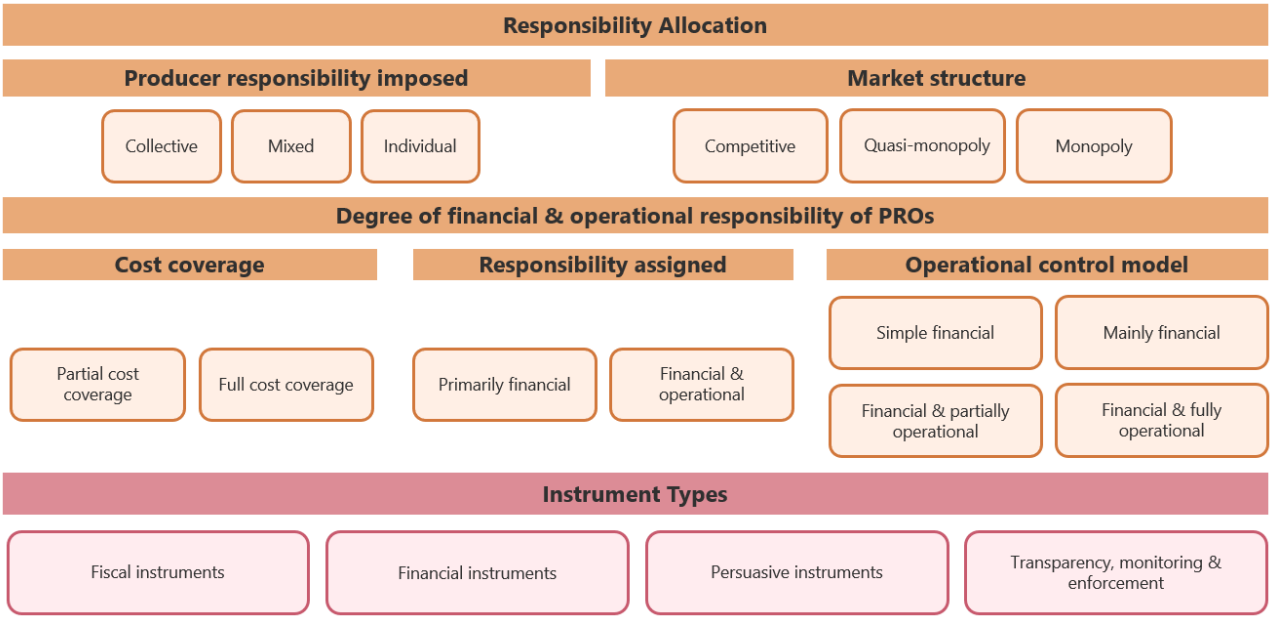

Figure 3: PRO Responsibility Allocation, Source: Adapted from Pruess (2023)

2.2.1 Operational Models

EPR systems are typically differentiated into full-cost and partial-cost models, where partial-cost models involve PROs paying a significant portion of the costs for collection, sorting, and recycling, as shared with municipalities, or taxpayers. An example of this is the French EPR system for household packaging, where municipalities bear 20% of the costs, which are ultimately passed on to taxpayers (Citeo & Adelphe 2023). Italy also uses a partial-cost coverage model, with EPR fees covering at least 80% of the total costs (CONAI, 2024), and remaining costs are largely covered by waste disposal fees paid by residents (European Environmental Agency [EEA], 2022f). However, Italy's centralised management through CONAI, together with other factors such as economies of scale and efficient logistics, keeps fees moderate and more stable in comparison with the high municipal costs in France. (CONAI, 2024)

FRANCE CASE STUDY

Municipalities contract waste management services and bear a significant share of financial and operational responsibility within EPR systems (Citeo & Adelphe, 2023). In 2023, In 2023, the total system costs amounted to €1,041 Million, of which €855 Million was paid as financial support to municipalities. The remaining €186 Million was borne by the municipalities (Citeo & Adelphe, 2023). Legally, there is an **80/20** cost split between PRO and municipalities.

In comparison, systems such as Germany and in Belgium use a full-cost model, where PROs cover all operational costs and administrative expenses, including collection, sorting, recycling, and public education, without public subsidies (Pruess & Garrett, 2025). In Belgium however, it is important to note that consumers also bear additional costs, as they must purchase plastic packaging, metal packaging (cans) and drink cartons (abbreviated to PMD) collection bags themselves. These PMD bags are typically 15–18 euro cents per bag (Bruxelles Propreté, 2025) leading to an estimated €20 million in extra annual consumer expenses, or about 5.6% of the system´s expenses. In comparison, in Germany the bags to collect packaging, referred to as 'Gelber Sack' (yellow bags) are free.

This full cost approach strengthens the polluter-pays principle and provides a direct financial incentive for producers to design more sustainable packaging. The full-cost model creates the right incentives not only for PROs but also for manufacturers to develop more sustainable packaging, as they have to bear the full costs of collection, sorting and recycling, thus consistently implementing the polluter pays principle.

2.2.2 Monopolistic, Quasi-Monopolistic and Competitive Models

A monopoly refers to market situations where a centralised PRO is established by legislation, whereas a quasi-monopoly refers to situations where competition would technically be legal, but due to historic developments or market entry barriers, there are no other PROs established or one hold over 90% of market share and the others are therefore insignificant. (Pruess, 2023). In addition, competitive EPR refers to market situation where multiple PROs are present. Research indicates that the market structure of an EPR system, including whether a monopoly, quasi-monopoly or competitive structure impacts on innovative capacity (Pruess, 2023). This includes competitive models in MS such as Germany, where EPR is provided by competing PROs, and there is typically competition for profit (Pruess, 2023). Interestingly, Austria has both for-profit PROs and a non-profit PRO in parallel. In non-profit systems, schemes are designed to fulfil legal EPR obligations, with any surplus reinvested into system improvements or minimising future fees.

In Figure 4 below, a timeline of EU EPR systems for packaging are shown. Whilst Germany began with a Monopolistic system for packaging, it later changed to a competitive model from 2003 onwards (Ahlers et al., 2021). The majority of MS use competitive systems including Germany, Austria, , Portugal, among various others are shown below in dark blue. In comparison, only a few use quasi-monopolistic EPR schemes, namely France, and Spain. However, Spain will soon be opening its markets further to allow greater competition.

Relatively few EU MS use a complete monopoly EPR structure, including Italy, Belgium and the Netherlands. In addition, whilst the Czech Republic is legally a competitive system, market entry barriers have hindered other PROs so far to obtain permission and hence to gain market share (European Commission, 2024). As such, it is considered a monopoly within the study and in the timeline below.

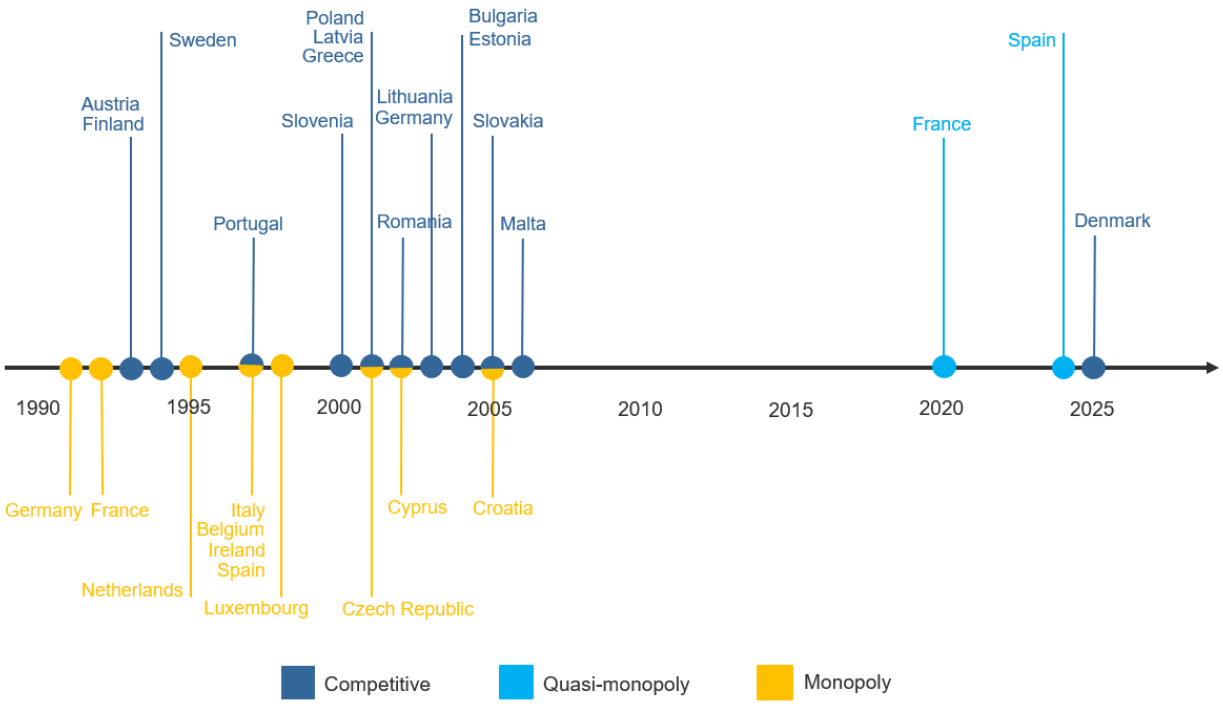

Figure 4: EPR Competitive and Non-Competitive Systems for Packaging Timeline

2.3 Key Trends and Developments

Under the EU Green Deal, the circular economy is a key pilar to support EU growth, including the potential for high-end recovery. Embedded within the EU Green Deal is the PPWR, which is a transformative shift in packaging regulation. In addition to a target for packaging placed on the EU market to be reusable or recyclable by 2030, it also includes that EU MS must implement DRS for aluminium and plastic beverage containers, to achieve a 90% collection rate by 2029 (Regulation (EU) 2025/40, 2024). More broadly, another focus in EPR innovation, has been a movement away simply meeting recycling and recovery targets, including a 2025 65% target, and a 70%

2030 target for packaging recycling in the upcoming PPWR (Regulation (EU) 2025/40, 2024). Instead, towards an increased focus on durability, reusability and, related Design for Environment (DfE) and waste hierarchy criteria through strategies such as eco-modulation (Anurodh Sachdeva et al., 2023). Innovation, including through Artificial Intelligence (AI) I and increased stakeholder engagement has also provided pathways for increased EPR performance. (European Commission, 2016)

GERMANY CASE STUDY
Municipalities can participate in tenders for collection and sorting, competing directly with the private waste management sector. Aside from this compensation, municipalities **do not hold a privileged position within the EPR sector for** lightweight and glass packaging. This shows an effective **method for including municipalities in EPR systems based on performance criteria.**

2.3.1 Eco-Modulation

Eco-modulation refers to a mechanism for fee differentiation, which ideally should reflect the true end-of life management costs for providers, and is often incentivised through the form of bonuses or maluses (penalties) to motivate improved product design (Anurodh Sachdeva et al., 2023). Eco-Modulation fees are based on design criteria, reflecting product characteristics , such as design for recycling or polymer composition, for example, mono-layer or multi-layer packaging, and performance as per the waste hierarchy (e.g., reusability, durability, reparability, recyclability) (Anurodh Sachdeva et al., 2023; Pruess, 2023). Eco-modulation was included in an amendment to the Waste Framework Directive in 2018, encouraging eco-design through the use of eco-modulated fees, and has now become a significant innovation of EPR design, with ongoing reforms toward eco-modulation in many EU countries (Frithjof Laubinger et al., 2021; Pruess, 2023). With the introduction of the PPWR, fee modulation will become mandatory, with producers paying fees based on the recyclability and recycled content of their packaging (Article 6) (European Union, 2025b).

At present, eco-modulation of EPR fees for packaging is heterogenous (Regulation (EU) 2025/40, 2024) and inconsistent, with fees modulated as per material and size in Austria, per recyclability and reusability in Belgium, and Italy, and others such as France, Spain and Greece adopting systems of bonuses and penalties (Ahlers et al., 2021; EUROPEN, 2025a). Illustrating the differences in eco-modulation adoption, countries such as France are "leaders" in eco-modulation, with comprehensive criteria such as recyclability, recycled content, and sortability to all packaging materials, and both bonuses for actions such as consumer awareness, and changes in packaging, as well as penalties for actions such as recycling disruptors, and packaging with no recycling route (European Commission, 2016). Further MS implementing eco-modulation include Portugal, including a 10% penalty for PET bottles with PVC label, as well as a bonus in the Netherlands for recyclable plastic packaging that has a positive market value (Frithjof Laubinger et al., 2021).

In Spain, eco-modulation has become mandatory as of 2024 and includes both fees and penalties as per technical attributes of packaging. Whilst the introduction of eco-modulation in Spain is a step forward, the overall pace of innovation in Spain is moderate rather than high (EEA, 2025b). Belgium also has eco-modulated fees in place, though direct incentives for innovation and eco-design remain limited (von Eye, 2024). While the PROs in Germany have developed a common model for amending Section 21 of the Packaging Act (VerpackG) for eco-modulation, this has not been implemented due to changes in Germany's government. Eco-modulation will be incorporated latest via the introduction of the PPWR in Germany (BKV, 2025).

In addition, the gradual implementation of eco-modulation—particularly for materials beyond plastic and composites—alongside the need to further increase the use of recyclate, highlights areas for continued development (Pruess, 2023) . While some argue that eco-modulation can increase complexity and compliance requirements, eco-modulation, can also be a key method to better reflect the end of life costs of packaging ((Anurodh Sachdeva et al., 2023) and increase cost-efficiency by providing a considerable innovation incentive, (Pruess, 2023).

2.3.2 Deposit Return Systems

Whereas an EPR system for packaging often collects, sorts and treats all household packaging, DRS concentrate on certain kinds of packaging, usually beverage containers, which can be returned to the retailer. With the introduction of the PPWR, DRS becomes mandatory as of by 2029, unless the MS can demonstrate a 90% collection rate for beverage bottles via other methods. In addition, the Single-Use Plastic Directive (SUPD) requires that 77% of single-use plastic beverage bottles (up to 3 litres) be collected separately by 2025, with implementation directly tied to compliance with targets (Directive (EU) 2019/904). As an example of good practice, the DRS in Germany has proven highly effective for single-use beverage containers, particularly PET bottles and aluminium cans, delivering exceptional return rates of up to 97.6% for PET bottles and nearly 98% for aluminium cans (European Aluminium, 2021). High performance has also been seen in Lithuania (92% return rate) a, Norway (89%) and Estonia (87%) (Picuno et al., 2025).

Currently, the absence of a nationwide deposit return system for example in France means that all packaging types, including high-value PET bottles and aluminium and tin cans, are managed within the main EPR framework, affecting both material flows and financial incentives. The reason is that in these countries, easily recyclable and valuable materials like PET are handled within the EPR system, while these materials are withdrawn from the German EPR system via the separate deposit route. This leaves the PROs with often composite materials that are difficult to recycle, which incur higher licensing costs for the overall system.

In Germany, the DRS is a system is well accepted by the population and as mentioned, the return rate is very high due to the relatively high deposit fees. For other European countries, The introduction of DRS could further improve closed-loop recycling for valuable streams (Pruess & Garrett, 2025), with MS such as Spain and France currently planning their implementation in anticipation of the PPWR (Le Figaro, 2025; Lang, 2024).

2.3.3 Innovation and Stakeholder Engagement

Innovation is increasingly important within EPR systems, including to fulfil increasingly ambitious EPR regulations, including a target for Article 3(39) packaging waste to be recycled by scale by 2035, as per developed methodology in 2030 (Regulation (EU) 2025/40, 2024). While centralised EPR may have advantages in which standardisation and administrative efficiency, innovation is fostered in competitive EPR, with PROs incentivised to improve their services to reduce license fees and helps attract new clients. This includes collaborative approaches on eco-design, improved recyclability of products or increased efficiency in the collection and sorting of waste (Ahlers et al., 2021).

Illustrating this increased innovation potential of competitive systems, the German EPR system, combining intense PRO competition with strong state control and ambitious recycling targets, is considered to be particularly innovative for packaging throughout Europe (Pruess, 2023). To further support riskier innovation within competitive EPRs, a coordination centre such as the ZSVR Germany, can foster joint PRO and stakeholder activities in areas such as consumer awareness raising, research on new recycling technologies and waste collection (Ahlers et al., 2021). In addition, to meet the increased PPWR requirements, PRO initiated partnerships, and increased operational integration, as well as research and innovation programmes with stakeholders, including industry, and waste management operators and contractors, can help PROs increase the innovation, sorting and recycling infrastructure, enabling scaled recycling, increased circularity, DfE, and creating a single market of secondary raw materials (EUROPEN, 2025a). Increased stakeholder engagement can also be achieved through mechanisms like Advisory Boards or EPR dialogue platforms, allowing stakeholders to express concerns and provide recommendations to the relevant PRO (Qudon et al., 2019)

Additionally, the use of digital tools can help streamline the EPR schemes, as well as to prevent free riding, including the use of Artificial Intelligence (AI) in collection and sorting, as well as compliance (EUROPEN, 2025a) (Hamandouche et al., 2025). Through greater stakeholder engagement and other methods such as AI and regulatory coordination, PROs can further increase innovation in this sector and move further towards a circular economy in the EU.

3 EU EPR Case Studies

The following chapter presents eight major players, with considerable political and economic influence in the EU, including competitive EPR structures such as Germany, and Austria, as well as monopolistic or quasi-monopolistic systems such as in Belgium, France and Italy. The different market structures are described in specific case studies. This section also covers key findings including comparisons on recycling rates, fee structures and costs, system design and governance, as well as innovation the various policy settings.

3.1 Germany

The German EPR system for household packaging waste is a leading example of a competition-based, full-cost approach to EPR. Its combination of a competitive market with clear legal requirements and robust regulatory oversight, as per the German Packaging Act (VerpackG), has resulted in consistently high recycling rates across key packaging materials in comparison with other EU countries (Stiftung Zentrale Stelle Verpackungsregister, 2025a). Before Germany entered its current competitive market structure, the system started as a monopoly under the Packaging Ordinance (Der Grüne Punkt - Duales System Deutschland, [Green Dot]). In 1998, an amendment was made to the Packaging Ordinance to allow competition, with full market entry of competitors by 2005.

In 2019, the German Packaging Act was enacted to replace the original Packaging Ordinance with stricter recycling targets and clear competition rules. As of 2025, a total of ten PROs are active on the market, with different market shares depending on the federal state and type of material (Stiftung Zentrale Stelle Verpackungsregister 2025b).

3.1.1 Recycling Rates

The PROs (Duales System) is responsible for collecting and recycling household packaging waste of different waste streams, including Paper, Paperboard and Cardboard, glass and plastic. The Dual System is currently composed of four relatively large and six small providers, enable both economies of scale and competitive pressure (Stiftung Zentrale Stelle Verpackungsregister, 2025b). High-value and easily recyclable single-use beverage bottles made of PET, as well as all single-use beverage aluminium cans are mostly captured by the DRS, removing these profitable fractions from the Dual System's material stream. In 2023, the Dual System achieved recycling rates of approximately 68.9% for plastic, 83.1% for glass, and 93.6% for PPC, placing Germany among the top performers in the EU for household packaging waste recycling (Stiftung Zentrale Stelle Verpackungsregister, 2025a, 2025c).

Notably, these achievements are realised despite the Dual System's responsibility for managing predominantly low-value, difficult-to-recycle packaging fractions, with higher-value materials covered under Germany's deposit return system. Germany's parallel deposit return system further enhances its overall recycling performance, delivering exceptional rates of up to 97.6% for PET bottles and nearly 98% for aluminium cans (European Aluminium, 2021; Gesellschaft für Verpackungsmarktfortschung, 2025).

Material	German Recycling Rates (2023)[3] [%]	PPWR EU Targets 2025 [%]
Plastic	**68.9** (excluding PET bottles) **97.6** (PET bottles through deposit refund scheme) **76.1** (weighted average recycling rate including PET bottles)	50
Glass	**88.5**	70
Paper, Paperboard and Cardboard (PPC)	**93.6**(Umweltbundesamt, 2024b)	75

Table 1: German Recycling Rates (Stiftung Zentrale Stelle Verpackungsregister, 2025a; Umweltbundesamt, 2024b; Yumda, 2024)

Packaging covered by the DRS achieves notably higher recycling rates than those within the Dual System. However, it is important to note that such packaging is often recorded separately compared to packaging managed through the dual system. This distinction can significantly impact the reported national recycling rates and complicate international comparisons. In addition, because of the DRS, German PROs deal with a disproportionate share of less valuable and more challenging plastic packaging, driving up the average fee per ton. Consequently, for a fair and reliable comparison between countries, it is necessary to explicitly consider the effects of the DRS and the respective national collection and accounting methods. Taking the recycling rates of the German DRS into account, including PET, the German system achieves a weighted average plastic recycling rate of 76.1%.

3.1.2 Fee Structure and Costs

The average cost per tonne within the Dual System includes a weighted average price of 640€/t price for plastic, with costs with the DRS average price of 437€/t. The higher price within the dual system is due to higher value, and easier to recycle plastic packaging being dealt with in the DRS, with the Dual System dealing with a wider range of materials, including those that are harder to recycle and have lower market value. By calculating a weighted average price per ton, the table highlights how the split between DRS and the Dual System influences overall cost efficiency and resource allocation within the German EPR framework.

The DRS 'cost per tonne' section refers to the average cost of collecting and recycling packaging managed under the DRS, which is significantly lower due to the high material value and established return logistics for beverage containers.

[3] Refers to total quantities of household packaging licensed with the PROs, as issued by the ZSVR and the Federal Environment Agency, not to total market quantities.

Material	Amount Collected per Year (Dual, excl. DRS) in [t (tonnes)]	Dual System Average (Avg.) Cost per Tonne [€/t]	Dual System Average Cost – Adjusted [€ /t]	DRS Amount Collected per Year [t][4]	DRS Cost per Tonne [€/t]	DRS Avg. Price per ton - Adjusted [EUR/t]
Plastic	1,189,000	737	640	400,000	503	437
Glass	1,889,300	36	31	-	-	-
PPC	1,982,600	152	132	-	-	-

Table 2: Detailed German Recycling rates by Dual System and DRS, (Gemeinsame Stelle dualer Systeme Deutschlands GmbH, 2025; Stiftung Zentrale Stelle Verpackungsregister, 2025c)

3.1.3 System Design and Governance

A strength of the German EPR model lies in its system design, namely its PRO-focused operational and financial responsibility, as per a full-cost approach. In the German EPR model, PROs bear all costs for the collection, sorting, recycling, administration, education campaigns, proportionate municipal costs and the financing of monitoring and enforcement through the Zentrale Stelle Verpackungsregister (Stiftung Zentrale Stelle Verpackungsregister, 2025b). The full internalisation of costs by PROs not only ensures the polluter-pays principle is upheld, but also that there is no public co-financing of packaging recycling. As producers must pay the complete financial burden of end-of-life management, they are under direct economic pressure to develop more recyclable packaging and reduce packaging weight. In Germany, PROs also own the collected recyclables, enabling them to optimise trading revenues and include these into EPR fee calculations; this also supports quality control through contracted sorting and recycling specifications, and stable access to secondary raw materials for clients through established sales channels. (EEA, 2022b).

Robust independent monitoring and enforcement mechanisms underpin the German system. The German Central Registry (Zentrale Stelle Verpackungsregister [ZSVR]), in cooperation with the Federal Environment Agency and local authorities, ensures strict compliance through regular audits, public reporting, and substantial fines for violations or sales bans for non-compliance. The ZSVR also demands high recycling targets and establishes a level playing field for PROs within Germany. An openly accessible, central producer register (LUCID) is present. This strong regulatory oversight is also considered a key factor in maintaining high recycling rates and system integrity in a highly competitive EPR market.

3.1.4 Innovation

Overall, Germany has led the EU through key innovations in the EPR system such as competitive tendering among PROs for collection and sorting, digital tools for packaging assessment, and harmonised recyclability criteria, as well as mandatory bale specifications for sorted materials to enable efficient processing and production of recyclate. The German EPR system is motivated towards innovation, with its competitive structure promoting increased efficiencies in collection and recycling technologies, as well as incentive systems for recycling-friendly packaging design. These innovations, as incentivised by Germanys competitive structure, have demonstrably led to cost reductions and higher service quality without compromising recycling performance, making Germany an

[4] In Germany, around 400,000 tonnes of PET and 1,140,000 tonnes of glass are collected each year via DRS, along with aluminium. The total cost of the DRS (including collection, logistics, sorting, processing, and administration) has been estimated at €800 million (Court of Auditors warns over costs of DRS - letsrecycle.com) for approximately 1.6 million tonnes of material, equating to an average of €503 per tonne. This estimate aligns with other sources, which report DRS operational costs ranging from €300 to €500 per tonne. Importantly, Germany does not incur handling fees for retailers, which are a significant cost factor in many other countries and help keep the overall system costs lower (https://www.reloopplatform.org/wp-content/uploads/2024/08/RELOOP_Factsheet_HandlingFees_2024.pdf).

important reference point for the further development of EPR systems in Europe (Ahlers et al., 2021). Further, the need for market differentiation from competitors in relatively homogeneous services such as packaging licensing also motivates PROs to innovate in supplementary customer offerings, such as online tools for assessing recyclability or consulting services.

The introduction of eco-modulated licence fees through regulation (updated §21 VerpackG) would further offer considerable potential for innovation, as manufacturers would be increasingly motivated to develop and launch more recyclable packaging solutions through targeted financial incentives. While systematic eco-modulation of fees has not yet been implemented, German PROs have previously developed several models for implementation which were ultimately not legislated (SPD & Bündnis 90/Die Grünen und FDP, 2021). Despite national barriers regarding the introduction of EPR eco-modulation, eco-modulation will be introduced regardless, due to the mandatory introduction under the PPWR.

Overall, Germany's experience offers valuable lessons. Namely, that competition can foster innovation and cost savings when strong independent oversight is present that demands high recycling targets and provides a level playing field for PROS. In addition, a full-cost approach, tied with operational control creates the right incentives for sustainable packaging management.

3.2 France

France's EPR system for packaging is governed primarily by the Environmental Code (Code de l'environnement), with the first EPR household packaging obligations introduced in 1993 (EEA, 2025b). Additional key reforms include the introduction of eco-modulation in 2012, and in 2020, an adoption of the anti-waste law for a circular economy (AGEC) which strengthens the framework of EPR and includes legal provisions related to packaging and eco-modulation (EEA, 2025a). All producers placing packaging on the French market must participate in the EPR system, regardless of size, though small quantities have simplified obligations (LOVAT, 2025).

Whilst the EPR system began as a monopoly, it was opened to become a competitive market in 2018 with the approval of Leko to enter the packaging EPR in 2018 (EEA, 2025b). However, despite openness to PRO market entrants, France's EPR system for packaging is presently a highly centralised quasi-monopoly, with Citeo as the dominant PRO holding over 95% market share and Léko as a minor entrant (5% market share). Market entry for PROs requires state approval, proof of financial and technical capacity, and compliance with strict regulatory standards (EUROPEN, 2025b). Competition between PROs is minimal, and most producers default to Citeo, choosing primarily based on compliance support rather than price or service differentiation

3.2.1 Recycling Rates

In 2023, recycling rates were 27% for plastic, 86% for glass, and 69% for PPC (Citeo, 2024). These rates are improving, especially for plastic, but do not currently meet the PPWR EU target for 2025 and are very low compared to the European frontrunners like Germany, with a plastic recycling rate of 68.9% (or 76.1% including PET), or Belgium with 60.8% below shows household packaging waste streams and their recycling rates.

Frances's plastics recycling rates are particularly low at 27% in 2023, which critically misses the 2025 PPWR target for plastics. This is an interesting revelation as in comparison with EU MS such as Germany and the Netherlands. France does not have a deposit refund system, meaning that more easily recyclable and higher value materials such as PET are included in the EPR system. This arguably provides the PROs in France with an advantage in comparison with EU EPR such as Germany with a DRS.

Material	French Recycling Rates (2023)[5] [%]	PPWR Targets 2025 [%]
Plastic	**27**	50
Glass	**86**	70
PPC	**69**	75

Table 3: French Recycling Rates (Citeo, 2024)

3.2.2 Fee Structure and Costs

PROs in France are financed through eco-modulated fees paid by packaging producers. These fees are differentiated by material, recyclability, and eco-design criteria (EEA, 2022a). Citeo lists its fees, also according to the eco-modulation in detailed publications that are publicly available[6]. For example, licensing fees for plastic bags and wraps range from €837 to €930/tonne, depending on the extent of eco-modulation, while PET bottles cost €381/ton. France's EPR system sets different fees by material and recyclability criteria, though municipalities bear a significant portion of collection and treatment costs not covered by PRO payments.

According to the 2023 Citeo-Adelphe Activity Report, the French EPR system for household packaging operates under a partial cost coverage model (Citeo & Adelphe, 2023). In 2023, the total costs to be covered for household packaging amounted to €1.041 billion. Of this, €960 million was paid in by producers as contributions, while €855 million was distributed to local authorities (communes) as financial support. This money is paid to the municipalities so that they can organize and operate the collection, sorting, and recycling of packaging waste. The remaining difference of approximately €186 million, or about 18% of the total costs, must be covered by the municipalities themselves. This clearly demonstrates that local authorities are responsible for a notable share of the expenses, which are then passed on to the residents of the municipalities (Citeo, A., 2023). This means the EPR fees also do not include the full-costs of EPR, as also in the case in other-partial cost systems such as Italy.

3.2.3 System Design and Governance

France's EPR system for plastic packaging is characterised by a centralised structure, with a single main PRO (CITEO) managing most obligations. In addition, mitigating the incorporation of the polluter pays principle, and impacting on incentivising producers to reduce costs, France operates a partial-cost system, as the PROs do not cover the full costs of the EPR system, with municipalities also taking a significant share of financial responsibility (Citeo & Adelphe 2023). In the French EPR system, operational responsibility for the collection and sorting of packaging waste lies with municipalities (collectivités locales), which organise and operate the collection and sorting of packaging waste. This includes commissioning service providers and the operation of recycling centres.

The PROs have no direct operational control over local waste management, but act as system managers and financiers (European Environmental Agency (EEA) 2022a). PROs have overall financial and management responsibility, including financing and managing the system, i.e., paying financial support to municipalities, and for monitoring and controlling the overall system, including setting conditions, standards, and reporting requirements. However, the PROs are unable to influence the collection and sorting efficiency to improve results, as these are the domain of municipalities.

[5] Refers to total market volumes as reported by CITEO. Source: Citeo (2024)
[6] See for example here: Le tarif 2024 Citeo (2023b) See for example here: Le tarif 2024 Citeo (2023b) https://cdn.citeo.com/mkt/CITEO_SERVICES/Guide%20du%20tarif_2024.pdf

The Ministry of Ecological Transition (Le ministère de la transition écologique) is the department that steers the policy of EPR sectors in France and is responsible for granting approvals to the eco-organisations that manage these sectors, defining the rules through specifications, setting collection and recycling targets, and supervising the proper functioning of EPR including regulation and enforcement of penalties. In addition, ADEME (French Agency for Ecological Transition) provides technical guidance, monitors performance, and publishes annual reports on EPR scheme outcomes. France scores highly on transparency, monitoring and enforcement, as well as integration in existing legislation (Pruess & Garrett, 2025).

3.2.4 Innovation

France is a European frontrunner in eco-modulation, applying detailed criteria across all packaging materials. France's eco-modulation system is one of the most comprehensive in Europe. Material coverage includes PPC, plastic, metals, and composites (Micheaux & Aggeri, 2021). Unlike Germany, France does not yet operate a nationwide deposit return system, although one is planned for certain streams (Le Figaro, 2025).

Overall, France's EPR system excels in areas where centralisation offers advantages, such as transparency, traceability, and enforcement, as centralised oversight ensures that reporting standards are met, and compliance is easier to monitor. However, France's system is less effective in terms of innovation and market-driven cost efficiency compared to more competitive models like Germany's, especially as financial coverage is only partial.

3.3 Italy

The Italian EPR system for packaging waste is monopolistic, coordinated by the National Packaging Consortium Consorzio Nazionale Imballaggi [CONAI], a legally mandated, non-profit, private PRO that works alongside several self-compliant and material-specific consortia (CONAI, 2014) All manufacturers, importers and distributors must take responsibility of their packaging regardless of entity, size, or turnover (CONAI, 2025a). The basic responsibilities of obliged entities are to register with CONAI, and pay an EPR fee that is calculated based on the type and quantity of the packaging being placed on the market (CONAI, 2024). They may also elect to independently manage their own packaging waste or implement a return system (CONAI, 2025b). After these two registration steps, entities must ensure proper management of the waste and provide periodic data and reports on the packaging being introduced to the market (CONAI, 2024).

3.3.1 Recycling Rates

Italy has made significant progress in the management and recycling of packaging waste in recent years. Continuous improvements in collection systems, investments in recycling infrastructure, and a strong regulatory framework have contributed to notable achievements across various material streams. In 2023, approximately 13.9 million tonnes of packaging waste were managed in Italy, with 10.47 million tonnes being effectively recycled and 1.33 million tonnes utilised for energy recovery (CONAI, 2024).

The table below provides a snapshot of Italy's household packaging recycling performance for 2023 (CONAI, 2024). In particular, the recycling of PPC achieved an impressive rate of 92.3%, reflecting the effectiveness of the country's collection and processing infrastructure for paper-based packaging. However, whilst high for PPC, and moderate for glass, meeting both PPWR 2025 targets, recycling rates are lower for plastic, with the 2023 figures not yet meeting the 2025 PPWR target.

Material	Italian Recycling Rates (2023)[7] [%]	PPWR Targets 2025 [%]
Plastic	**47.7**	50
Glass	**77.4**	70
PPC	**92.3**	75

Table 4: Italian Recycling Rates (CONAI 2024)

3.3.2 Fee Structure and Costs

Italy's EPR system for packaging, coordinated by CONAI, is characterised by a differentiated fee structure based on material type and recyclability, as overviewed in

Material	Band / Category	Italian EPR Fees (2024) [€/t]
Plastic	Band A1.1 Recycled without support (I&T)	24.00
	Band A1.2 Recycled with support (I&T)	90.00
	Band A2 Flexible PE (I&T)	220.00
	Band B1.1 HDPE Containers	224.00
	Band B1.2 PET Bottles	233.00
	Band B2.1 Rigid PP	441.00
	Band B2.2 Generally recycled (HH & I&T)	589.00

Table 5 below. The fees below apply to each ton of packaging placed on the Italian market, as declared by producers. The EPR fee is assessed on placed-on-market figures. Italy's centralized management through CONAI, together with economies of scale and efficient logistics, keeps fees moderate and more stable. However, it is important to note that Italy uses a partial-cost coverage model, with EPR fees covering at least 80% of the total costs for collection, sorting and recycling (CONAI, 2024). The use of a partial-cost system in Italy places an additional burden on the consumers which are not reflected in EPR fees and does not fully reflect the polluters pay principle.

Therefore, fees for packaging licencing do not cover the full costs, with around 16-20% of the costs passed on to local authorities, which are ultimately paid by waste disposal fees paid by residents (EEA, 2022f). In 2023, CONAI allocated €696 million to municipalities and public service managers to support the separate collection of packaging waste (CONAI, 2024). Additionally, €494 million was paid to operators for activities related to sorting,

[7] Refers to the recycling rate based on the total market volumes as reported by CONAI (2024).

recycling, and recovery, with other costs such as personnel costs, research and development at €99 million, leading to a combined operational cost of €1.289 billion.

Material	Band / Category	Italian EPR Fees (2024) [€/t]
Plastic	Band A1.1 Recycled without support (I&T)	24.00
	Band A1.2 Recycled with support (I&T)	90.00
	Band A2 Flexible PE (I&T)	220.00
	Band B1.1 HDPE Containers	224.00
	Band B1.2 PET Bottles	233.00
	Band B2.1 Rigid PP	441.00
	Band B2.2 Generally recycled (HH & I&T)	589.00

Table 5: Italian modulated EPR fees for plastic in 2024 (CONAI, 2024)

3.3.3 System Design and Governance

Operational responsibility and material ownership for Italy's EPR system is shared between producers, users, and local authorities. However, the system is managed primarily by CONAI, in a monopolistic market structure, which holds overarching responsibility for the organisation and coordination of packaging waste management (EEA, 2025). Italy's EPR system operates under a partial cost coverage model, with the EPR fee the main basis of financing is the, which is paid by producers, importers, and users of packaging through CONAI.

The EPR system in Italy is overseen by the Ministry of the Environment and Energy Security (Ministero dell'Ambiente e della Sicurezza energetica [MASE]), with technical support by the Italian Institute for Environmental Protection and Research (Istituto Superiore per la Protezione e la Ricerca Ambientale [ISPRA](CONAI, 2024). All producers must register in the national packaging consortium (CONAI), or otherwise, independently manage their own packaging waste, or implement a return system (CONAI, 2025b). Optimal Territorial Areas (OTA), generally represented by provinces, are responsible for overseeing compliance and for collecting fines (EEA, 2022f). CONAI coordinates with municipalities (via National Association of Italian Municipalities Associazione dei Comuni Italiani [ANCI]) and other self-compliant PROs (ANCI, 2024; EEA, 2022f).

3.3.4 Innovation

CONAI actively promotes innovation within household packaging through a variety of eco-design initiatives aimed at reducing the environmental impact of packaging across its lifecycle. One of the flagship programs is the "Call for Eco-design Projects – ECOPACK", which encourages companies to submit and implement innovative packaging solutions with improved recyclability, reduced material use, or lower environmental footprint (CONAI, 2024). In addition, CONAI provides the EcoD Tool—a digital platform that helps firms assess and improve the recyclability and sustainability of their packaging designs (CONAI, 2024). Eco-modulation is also a central feature of the Italian system, with EPR fees varying by packaging material and recyclability (CONAI, 2024). Currently, Italy has no mandatory DRS in place (EEA, 2025).

Overall, Italy's centralised EPR system brings advantages in standardization and administrative efficiency, however it lacks competitive pressure that can further drive innovation, especially those relating to cost efficiency. This is further impacted by the partial cost model, which means that EPR fees do not indicate the full cost of EPR, and push the costs of end-of-life management onto taxpayers.

3.4 Belgium

Belgium's EPR system for household packaging waste operates as a single-PRO, non-profit model operated by Fost Plus, without direct competition (Pruess & Garrett, 2025). The legal framework is provided by the Cooperation Agreement on the prevention and management of packaging waste (2020), concluded by the Brussels-Capital Region, Flanders and Wallonia, which transposes EU packaging requirements under the Packaging and Packaging Waste Directive (PPWD) and introduces additional national obligations (EEA, 2025a; von Eye, 2023).

Since 2021, the Cooperation Agreement applies material-specific minimum recycling rates nationwide, including glass 90%, paper & paperboard 90%, and plastics 50% by weight. Further plastics milestones of 65% by 2023 and 70% by 2030 are cited in recent assessments (EEA, 2025a; EEA, 2022d). The Interregional Packaging Commission (IRPC) acts as the regulator, overseeing accreditation, registration, audits and enforcement, with the ability to impose sanctions (including fines or revocation of accreditation) in cases of non-compliance (EEA, 2022d; von Eye, 2024).

3.4.1 Recycling Rates

Belgium's EPR system for packaging reached strong recycling rates as of 2023, with material-specific rates were particularly high in 2023 for glass (97.8%) and PPC (86.1%), surpassing the targets set by the PPWR, although PPC falls short of Belgium's national 90% target. The plastic recycling rate at 60.8% also surpassed the PPWR target for 2025, as illustrated below but does not meet Belgium's national target of 65% ((adelphi, 2025; EEA, 2022d). Whilst not all packaging materials met Belgium's own ambitious targets, Belgium's achievements against the PPWR targets are supported by Belgium's dense, urbanised population, and efficient door-to-door collection systems. Belgium's performance is also supported by the full-cost coverage model, which ensures stable financing that reflects the full costs of EPR, leading to investments in higher-quality collection and sorting infrastructure (Pruess & Garrett, 2025).

Material	Belgian Recycling Rates[8] (2023) [%]	PPWR Targets 2025 [%]
Plastic	**60.8**	50
Glass	**97.8**	70
PPC	**86.1**	75

Table 6: Belgian Recycling Rates (adelphi, 2025; EEA, 2022d)

3.4.2 Fee Structure and Costs

Fee levels vary significantly by material, reflecting differences in collection, sorting, and recycling costs. For 2025, the EPR fees per ton are as follows: glass at €96, PPC at €150.30, and plastic ranging from €270 to €1,950 depending on the polymer and packaging type (Fost Plus, 2025). These rates are recalculated every year, as based

[8] Refers to total quantities of household packaging licensed with the PROs, as reported by Fost Plus (2024), not to total market quantities.

on the real cost deficit for each material. This includes, as mentioned, all costs borne by the PRO. In addition, revenue from the sale of the materials, as well as macro-economic factors such as inflation and fluctuating materials prices on international markets impact significantly on rates (Fost Plus, 2023).

While it can be said that Belgium operates a mostly full-cost EPR system funded by producer fees (Pruess & Garrett, 2025), it is important to note that consumers also bear additional costs, as they must purchase PMD collection bags themselves (typically 15–18 euro cents per bag), (Bruxelles Propreté, 2025) leading to an estimated €8–10 million in extra annual consumer expenses. Considering that Fost Plus collected €336 million in fees in 2024, the estimated €20 million in revenue from bag sales represents around 6% co-financing by consumers. In contrast, in other full cost system like Germany, the Yellow Sack or Yellow Bin system (Gelber Sack/Gelbe Tonne) is provided free of charge to households, meaning there is no co-financing by end consumers.

3.4.3 System Design and Governance

Fost Plus has full financial and partial organisational responsibility (EEA, 2025a), with considerable operational responsibilities in close cooperation with local authorities and municipalities, including the capacity for the PRO to opt for different collection methods at the local level (Pruess & Garrett, 2025). Fost Plus promotes, coordinates and finances the separate collection, sorting and recycling of household packaging waste across the three Belgian regions, with the PRO reimbursing municipalities for their operational costs (von Eye, 2024). This includes managing the collection and recycling of household packaging by inter-municipalities, private waste management companies and recyclers, however, implementation, is conducted by local municipalities (EEA, 2025a). Technological specifications for packaging waste management are set by the PROs through contractual requirements for collection and sorting, such as PMD bag specifications and sorting plant standards. While municipalities are mostly responsible for collection, responsibility for meeting recycling targets falls to the PRO (von Eye, 2024).

In Belgium, Fost Plus, as a PRO, retains ownership of the collected packaging waste, even if sorting and recycling are carried out in facilities that have contracts with Fost Plus. This material ownership structure enables Fost Plus to finance its operations through material revenues and membership fees, while retaining control over the entire value chain. Unlike in systems where municipalities retain ownership of the material, Fost Plus's ownership of the collected materials allows it to exercise quality control and use the proceeds from the sale of recycled material to finance the system (von Eye, 2023).

The Interregional Packaging Commission (IRPC) remains the central regulatory authority for EPR, responsible for accreditation, supervision, and enforcement (EEA, 2022d). The IRPC can impose fines, or prosecute if PROs fail to meet their obligations (EEA, 2022d). However, as per the European Environment Agency, while responsibilities are clearly defined and support mechanisms for municipalities are in place; there are no direct consequences for the responsible municipal authorities if national targets are not met. (EEA, 2022d).

3.4.4 Innovation

Belgium applies eco-modulation with lower fees for easily recyclable materials and higher for those that are difficult or impossible to recycle (European Environmental Agency 2022). Whilst the Flemish government proposed the introduction of DRS in 2022 (Steffens, 2022), Belgium currently does not have a national deposit return system. However, it does have a voluntary deposit system for certain types of reusable packaging, such as glass bottles for drinks (EEA, 2025a). Regardless of national debate on the topic (Tugran, 2024), the SUPD target of 90% for single-use plastic bottles may force the introduction of a DRS if the target is not met. Although collection rates are high, already meeting the SUPD collection 2025 rate at 78% in 2023 (von Eye, 2023).

Fost Plus invests in modernising sorting infrastructure to support new recycling markets, including for more complex plastic fractions (Fost Plus, 2024). Belgium's monopolistic and full-cost PRO model provides consistent service and relatively high recycling rates. However, due to its monopolistic structure it can provide fewer market-based incentives for continuous innovation in collection, sorting, or packaging design.

3.5 Spain

Spain's EPR system for packaging has historically operated as a quasi-monopoly, with the market dominated by two main non-profit PROs: Ecoembes, a non-profit PRO responsible for lightweight packaging, including plastic packaging and PPC, and Ecovidrio, which manages glass packaging (EEA, 2022c). Each PRO has specialized in its respective material stream, meaning that, for decades, there was no real competition between PROs, as each held a distinct material monopoly in its area. Spain's new waste and packaging legislation (Royal Decree 1055/2022) introduces several major changes to the EPR regime. The scope of EPR has been broadened to cover all packaging types, including commercial and industrial packaging from 2025, rather than just household packaging (Comisión Nacional de los Mercados y la Competencia, 2024).

PROs also now require only a single authorisation from the Autonomous Community where they are headquartered, which is valid for the entire country, replacing the previous system of multiple regional authorisations. The first new PRO to act on the Royal Decree 1055/2022 is Procircular, a for-profit PRO which was launched in 2024 (LEKO, 2023), representing Spain's active shift away from a monopoly and towards a competitive EPR system for household packaging.

In 2024, the new competitor had almost no market share, which changed in 2025. The results and full implications of market liberalization are not yet reflected in the data, so the findings of the study reflect Spain's formerly established monopoly structure.

3.5.1 Recycling Rates

As seen in the table below, Spain's has comparably medium environmental performance, with household packaging factions such as glass packaging (72.3%), and PPC packaging (78.3%), and plastic (51.5%). These rates are exceeding the respective EU targets for 2025 (EEA, 2025b; Eurostat, 2025a).

Material	Spanish Recycling Rates[9] (2022[10]) [%]	PPWR Targets 2025 [%]
Plastic	**51.5**	50
Glass	**72.3**	70
PPC	**78.3**	75

Table 7: Spanish Recycling Rates (Eurostat, 2025a)

3.5.2 Fee Structure and Costs

EPR fees must be modulated based on product characteristics such as durability, repairability, reusability, recyclability, and hazardous substance content, adopting a life-cycle approach. For light materials, each packaging component is charged separately according to its material, and composite packaging is assessed by the predominant material. In 2019, these producer contributions accounted for about 85% of Ecoembes' revenue, with the remaining 15% coming from the sale of recycled materials (Ahlers et al., 2021).

In 2019, approximately 36.5% of Ecoembes' total expenses around €577.7 million were dedicated to reimbursing local authorities for separate collection, translating to about €138 per ton collected (Ahlers et al., 2021). Recent years have seen significant increases in EPR fees, with Ecoembes raising rates by an average of

9 Refers to total quantities of household packaging licensed with the PROs, as reported by Ecoembes, not to total market quantities.
10 More recent figures are not available for Spain.

25% in both 2020 and 2021, particularly for flexible plastic, whose contributions nearly doubled (Ahlers et al. 2021). In 2024, the average price for producers per ton of plastic amounted to 901€, 49€ for glass and 138€ for Paper and Cardboard (Recyda, 2025). Stakeholders have raised concerns about the opacity of both the reporting of collection and recycling data and the calculation of fees (Ahlers et al., 2021).

Spain operates a total of 97 sorting and treatment facilities for packaging waste, most of which are publicly owned and operated either directly by local authorities or indirectly by private companies through concession contracts. This fragmented structure with many smaller plants contrasts with other European countries and leads to significant disadvantages. The limited size of the individual plants prevents economies of scale, which are particularly important in the sorting and treatment of packaging waste, as modern sorting technologies require high investment costs that only pay off with larger throughput volumes. In addition, the decentralized structure makes it difficult to implement uniform standards. (Comisión Nacional de los Mercados y la Competencia, 2024). This could be a cost driver which, together with the monopoly position of the PROs and fragmentation among municipalities, results in relatively high costs for producers in Spain, while recycling rates lag behind those of the European frontrunners.

3.5.3 System Design and Governance

Overall, producers are required to pay EPR fees to quasi-monopolistic PROs, which are calculated based on the type and weight. The PROs finance EPR system with PROs covering the full costs of separate collection, transport, and treatment of packaging waste while also accounting for revenues from reuse, recycling, and unclaimed deposits (Comisión Nacional de los Mercados y la Competencia, 2024). However, collection of recycling for lightweight packaging is typically carrier out by the local entities, whilst in the case of glass the vast majority of agreements grant collection to Ecovidrio. (Comisión Nacional de los Mercados y la Competencia, 2024).

The Royal Decree 1055/2022 introduced stricter EPR enforcement, with clear sanctions for non-compliance, and extends EPR obligations to e-commerce platforms to address free riding. Spain's EPR system relies on coordinated action among national, regional, and local authorities, alongside PROs. The Ministry for the Ecological Transition and the Demographic Challenge (MITECO) is responsible for national policy, system coordination, and chairs the Coordination Commission on Waste, which brings together autonomous communities (Comunidades Autónomas), otherwise referred to as local authorities, and representatives to ensure harmonized implementation and information sharing (EEA, 2022c).

In Spain, the competences on waste management mainly fall on the regional authorities (Comunidades Autónomas) (EEA, 2022c). Autonomous Communities authorize and supervise PROs, enforce EPR obligations, and oversee regional waste management. (Comisión Nacional de los Mercados y la Competencia, 2024)Local authorities are responsible for providing and operating waste collection systems, including separate collection for packaging waste, and must set local waste charges that reflect actual management costs (Comisión Nacional de los Mercados y la Competencia, 2024).

3.5.4 Innovation

Spain's EPR system currently applies differentiated fees based on packaging material. The new decree mandates that producer fees must be modulated, not just by weight and material as previously done, but also by considering the environmental characteristics of the packaging (Comisión Nacional de los Mercados y la Competencia, 2024). The decree requires a product life-cycle approach to fee modulation, encouraging producers to design packaging that is easier to recycle, contains fewer hazardous substances, and is more reusable or durable (Comisión Nacional de los Mercados y la Competencia, 2024). In addition to eco-modulation, Spain's EPR system for packaging has made notable strides in innovation, particularly through the activities of Ecoembes. Ecoembes operates a dedicated Innovation Centre focused on developing new solutions for packaging design, sorting, and recycling (Ahlers et al., 2021; Ecoembres, 2024). The center also supports R&D projects in collaboration with universities, technology institutes, and private companies, aiming to improve recyclability, reduce material use, and fosters eco-design (Comisión Nacional de los Mercados y la Competencia, 2024). In addition, the anticipated introduction of a deposit-return system for beverage containers if the SUPD separate collection targets foreseen firstly by 2023 or secondly by 2027 are not met, may stimulate further innovation in the coming years (Comisión Nacional de los Mercados y la Competencia, 2024).

However, transparency remain areas for improvement, including concerns regarding the fee structures (Ahlers et al., 2021). Whilst using a full-cost model, Spain's innovation potential is somewhat constrained by its historically monopolistic market structure (Comisión Nacional de los Mercados y la Competencia, 2024). The future will show whether the market opening that has taken place can lead reduction in costs due to the new competitive environment for the established PROs.

3.6 The Netherlands

The EPR system for packaging in the Netherlands is established under the Packaging Management Decree 2014 and related regulations, which set mandatory EPR obligations and targets (EEA, 2025c). At national level, the scheme operates with a single PRO, Verpact, which in 2024 resulted from the merger of the Packaging Waste Fund (Afvalfonds Verpakkingen) with its implementation bodies (Verpact, 2023). Producers finance the system via a Packaging Waste Management Contribution, while a deposit return system covers plastic beverage bottles and metal cans (EUROPEN, 2025b; Verpact, 2023).

3.6.1 Recycling Rates

In 2023, the Netherlands reported an overall packaging recycling rate of 75%, with a combined recycled-or-reused share of 88% (Verpact, 2023). By material, reported rates were plastic 49%, glass 81%, and PPC 89% (Verpact, 2023). These outcomes exceed the 2025 EU targets for glass (70%) and PPC (75%), while plastics were close to the 2025 target (50%). The overall EU targets are 65% (2025) and 70% (2030) (Verpact, 2023).

For plastic beverage bottles, the DRS collection rate was 74% in 2023 (Verpact, 2023). Under the Single-Use Plastics Directive, Member States must achieve 77% separate collection by 2025 and 90% by 2029 for plastic beverage bottles (Directive (EU) 2019/904).

Material	Dutch Recycling Rates (2023)[11] [%]	PPWR EU Targets 2025 [%]
Plastic	**51.9** *(weighted average recycling rate including PET bottles)*	50
Glass	**81**	70
PPC	**89**	75

Table 8: Dutch Recycling Rates (Verpact, 2023)

3.6.2 Fee Structure and Costs

The Dutch packaging EPR system operates on a full-cost model, with all system expenses covered by producers through the Packaging Waste Management Contribution (PWMC) (Verpact, 2023). Plastic packaging fees depend on pack characteristics, with Verpact applying eco-modulation measures to encourage design-for-recycling (Verpact, 2025a). In addition, DRS applies to 0.5 liter PET bottles and aluminium/steel cans, with a €0.15 deposit introduced for cans in April 2023 alongside existing bottle deposits (Verpact, 2023).

The average costs for plastic (considering DRS costs), glass and PPC are respectively €701/ton, €103/ton, and €19/ton (Recyda, 2025). The average costs for plastic (considering DRS costs), glass and PPC are respectively €701/ton, €103/ton, and €19/ton (Recyda, 2025).The rates charged are calculated to reflect Verpact's costs per material type for collection, sorting, processing, marketing, and general system expenses. These also cover monitoring, litter prevention, and funding for the Netherlands Institute for Sustainable Packaging (Kennisinstituut Duurzaam Verpakken, KIDV), which provides advice and research on sustainable packaging and

[11] Recycling rate based on the total amount of household packaging placed on the market in the Netherlands.

innovation (Verpact, 2023). In 2023, the average costs were reported as €701 per tonne for plastic (including DRS costs), €103 per tonne for glass, and €19 per tonne for paper and paperboard (Recyda, 2025).

In 2023, the not-for-profit system's total reported cost to producers was €500 million (excluding deposits), with all costs financed through fees (Verpact, 2023). A cost breakdown for 2022 indicated that revenues were lower than actual costs, resulting in an operational deficit of €12 million, which was offset by reserves from previous years, leaving a positive balance of €1 million (Verpact, 2025b).

3.6.3 System Design and Governance

The Dutch EPR system for packaging operates under a single-PRO model, with Verpact as the authorised PRO. Producers and importers that place packaging on the Dutch market are required to register with Verpact and pay the Packaging Waste Management Contribution (PWMC), which finances the costs of collection, sorting, and recycling (EEA, 2025; Freeman, 2025; Verpact, 2025b).

Municipalities hold legal responsibility for the collection of household packaging waste. They organise service models, procure logistics and sorting providers, and report quantities collected. Municipalities receive financial compensation from Verpact to cover the costs of these services (EEA, 2025; Freeman, 2025; Verpact, 2025b). Private companies may be commissioned by municipalities or, in specific cases, by the PRO to carry out collection and treatment operations (Verpact, 2025b).

Governance oversight lies with the Ministry of Infrastructure and Water Management (Rijkswaterstaat), which receives producer reports, and the Human Environment and Transport Inspectorate (ILT), which is responsible for compliance control and enforcement (EEA, 2025; Human Environment and Transport Inspectorate, n.d.).

3.6.4 Innovation

In 2024, Verpact introduced a revised plastic fee modulation scheme ("Fee Modulation Plastic 2.0"), which applies from 2025. This mechanism grants discounts of up to €0.50/kg for plastic packaging that meets specified design-for-recycling criteria, such as the use of appropriate colours or incorporation of post-consumer recyclate (Verpact, 2025a). The 2024 merger consolidated functions of the former Packaging Waste Fund (Afvalfonds Verpakkingen) and related implementation entities, including the Netherlands Institute for Sustainable Packaging into Verpact (Verpact, 2023). KIDV continues to provide research, advice, and guidance on sustainable packaging design and innovation within the system.

In governance terms, producers remain obliged to report placed packaging and compliance data to the competent authority, while ILT oversees enforcement (Human Environment and Transport Inspectorate, n.d.).

3.7 Austria

Austria operates a competitive, multi-PRO EPR system for packaging with nationwide coverage, anchored in the Abfallwirtschaftsgesetz (AWG 2002) and the Verpackungsverordnung. Municipalities and municipal associations organise household collection; once materials are delivered to the contracted system, ownership and compliance responsibility transfer to the PROs. System oversight rests with the Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (BMK), while the Verpackungskoordinierungsstelle (VKS) serves as the central coordination/clearing body (EEA, 2022).

Following market opening in 2015, multiple authorised PROs (including Altstoff Recycling Austria – ARA) operate under common rules and VKS coordination. Financing follows the full-cost coverage principle: producers, via PROs, fund the reasonable costs of collection, sorting and recycling, including compensation for packaging appearing in residual municipal waste. Approval, reporting and enforcement are defined in law and federal guidance (BMK, 2025; Umweltbundesamt, 2024a).

3.7.1 Recycling Rates

As table 9 shows, Austria's overall packaging recycling rate in 2023 was 26.9% for plastic, 79.6% for paper & cardboard and 83.3% for glass. (BMK, 2025). For EU-wide comparability, the EEA 2025 Austria profile (applying the harmonised post-2020 rules) reports 66% total and 25% plastic for 2022 and notes that Austria meets the 2025 targets for total packaging, paper/cardboard and glass, while plastic (and aluminium) remain below their material-specific targets (EEA, 2025a).

Since the 2025 targets, EU reporting applies stricter, harmonised rules (including adjusted rates for plastic/wood and accounting at the output of recycling), which can lower reported rates compared with older series. To raise capture and recycling rates, Austria has: (i) introduced a deposit-return system for single-use PET bottles and metal cans from 1 January 2025 (deposit €0.25, 0.1–3.0 L) and (ii) harmonised household collection so that plastic and metals are collected together nationwide from 2025, following Länder pilots in 2023 (RIS, 2023).

Material	Austria recycling rate[12] (2023) [%]	PPWR EU target 2025 [%]
Plastic	**26.9**	50
Glass	**83.3**	70
PPC	**79.6**	75

Table 9: Austrian recycling rates (2023) with EU targets (2025) (BMK, 2025)

3.7.2 Fee Structure and Costs

Austria's packaging EPR follows the principle of full cost coverage. Producers, through their PROs, finance the reasonable costs of household packaging collection, sorting and recycling and they also compensate municipalities for packaging that appears in residual waste streams. These requirements are set out in the legal framework and confirmed in independent assessments and briefings (Gesamte Rechtsvorschrift für Abfallwirtschaftsgesetz 2002/2025; Rechnungshof Österreich, 2022b).

Fee levels are set by each authorised PRO, which introduces competition and some price variation by material and stream. For 2025 compliance, fee schedules used in this study indicate indicative ranges of about €930–990 per tonne for plastic and about €97–102 per tonne for glass. These examples reflect producer-facing tariffs published by PROs and are consistent with Austria's competitive set-up (ARA, 2025; Reclay Österreich, 2025).

At the system level, disclosures show around €205 million in annual expenditure for collection, sorting, treatment, municipal compensation, coordination (VKS), overheads and R&D in 2022, financed by producer fees. This aligns with the full cost coverage principle and the non-profit tariff logic declared by the main PRO (ARA, 2025).

3.7.3 System Design and Governance

Austria's packaging EPR system is based on shared responsibilities between municipalities and PROs. Municipalities and municipal associations organise kerbside and bring-point collection for households, covering paper, glass, plastic and metals. Collected materials are then transferred to licensed PROs, which assume legal ownership and compliance responsibility at the point of delivery. PROs finance sorting, recycling, reporting and treatment in line with national and EU targets (Rechnungshof Österreich, 2022b; VKS, 2025).

[12] The total amount on which this recycling rate is based is the amount of household packaging placed on the market in Austria.

The Verpackungskoordinierungsstelle (VKS) serves as the central clearing body, allocating packaging volumes to PROs, ensuring market fairness and overseeing audit processes. The BMK retains regulatory oversight and approves PRO licences, while the Umweltbundesamt provides technical monitoring, data collection and compliance control (BMK, 2025; Umweltbundesamt, 2024a). Governance is anchored in a clear legal framework (AWG 2002; Verpackungsverordnung), which establishes licensing, reporting and compliance requirements (Gesamte Rechtsvorschrift für Abfallwirtschaftsgesetz 2002/2025).

Austria's market was liberalised in 2015, ending the previous quasi-monopoly of ARA. Today, several competing PROs (e.g. ARA, Reclay Österreich, Interseroh, Bonus Holsystem) operate under VKS coordination. Competition has created some fee differentiation but all PROs must provide nationwide coverage and fulfil the same obligations (ARA, 2025; Reclay Österreich, 2025).

In fact, the situation in Austria is similar to that in Germany: after the market was opened up to competitors, the former monopolist remains very dominant, with over 50% market shares. In 2016, the EU Commission imposed a fine of €6 million on ARA for preventing competitors from accessing the Austrian market for the disposal of household packaging waste between 2008 and 2012. This situation has since changed, but market dominance remains and hinders competition, as the Austrian Court of Auditors has noted. (Rechnungshof Österreich, 2022a)

3.7.4 Innovation

Austria combines regulatory oversight with incremental system innovation. The Pfandverordnung (2023) introduced a nationwide deposit-return system for one-way PET bottles and metal cans, effective from 1 January 2025 (deposit €0.25 per unit). This measure is expected to increase capture rates, reduce litter and deliver higher-quality recyclate (RIS, 2023). In parallel, since 2023 all light plastic packaging has been collected nationwide and from 2025 plastic and metals are jointly collected in the yellow bag/bin. These changes simplify sorting for households and are designed to improve feedstock quality for recycling plants (BMK, 2025).

PROs have also invested in technical and organisational innovations. ARA reports projects on polymer-to-polymer recycling and digital tracking of recyclate streams, while Reclay Österreich has launched initiatives to integrate recycled content into new packaging and to expand secondary raw material markets (ARA, 2022). Pilot projects supported by BMK and industry stakeholders test smart collection systems and digital platforms to improve traceability, aligning with Austria's broader circular economy strategy (BMK, 2025).

Eco-modulation of fees is not yet systematically applied. Current tariffs remain mainly weight- and material-based, with limited differentiation (e.g. composites vs. mono-materials). The Rechnungshof (2022) noted that Austria's current fee structures provide limited incentives for eco-design. According to BMK's Statusbericht 2025, Austria is preparing steps towards stronger modulation in line with the forthcoming EU Packaging and Packaging Waste Regulation (Rechnungshof Österreich, 2022b).

3.8 Czech Republic

Czech packaging legislation allows for the establishment of multiple PROs and the law explicitly foresees the possibility of competition (Parlament České republiky, 2001). Despite this framework, only one PRO, EKO-KOM, has been authorised to date, resulting in a market monopoly. In 2024, the European Commission expressed concerns about the authorisation regime, pointing to "significant entry barriers for rival companies". These include authorisation requirements that are difficult to meet, such as strict contractual and financial conditions, as well as the possibility for EKO-KOM to review and comment on application files of potential new entrants (European Commission, 2024).

3.8.1 Recycling Rates

In 2023, an estimated 99% of the population had access to colour-coded bring-points or kerbside bins, with costs covered by EKO-KOM as the authorised PRO (EKO-KOM, 2024). Collection responsibility remains with municipalities, which contract private companies for collection and sorting services. Municipalities and contractors retain ownership of the collected material until sale to recyclers. A DRS for PET bottles and

aluminium cans was introduced in law in 2023 and is scheduled to become operational in 2026. It is expected to increase beverage plastic collection rates to around 90% and relieve pressure on municipal collection systems (European Topic Centre on Circular economy and Resource Use, 2024). Currently, PET bottles and aluminium cans remain within the EPR system.

Material	Czech Recycling Rates 2023[13] [%]	PPWR EU Targets 2025 [%]
Plastic	**52,4**	50
Glass	**77,6**	70
PPC	**97,9**	75

Table 10: Czech Recycling Rates (Ministerstvo životního prostředí, 2023)

3.8.2 Fee Structure and Costs

The Czech packaging EPR system is designed as a full-cost model, with EKO-KOM covering the expenses of waste management operations. The organisation does not directly handle packaging waste but finances municipal collection, sorting and recycling activities (EKO-KOM, 2024). In 2024, 96.8% of EKO-KOM's costs were allocated to collective compliance. Of this, 58.3% was transferred to municipalities to support collection networks and littering payments and 32.8% was directed towards sorting, recovery and recycling. Verification and control of packaging and waste streams accounted for 4.5% of expenditures, education and communication activities for 2.6%, and administrative costs for 1%. Municipal remuneration is based mainly on the quantities of packaging waste collected. Reported producer fees in 2024 were approximately €77 per tonne for glass, €208 per tonne for paper, €635 per tonne for PET and €922 per tonne for plastic composites (PRO Europe, 2024).

3.8.3 System Design and Governance

As of 2024, more than 21,000 producers were registered with EKO-KOM and 6,202 municipalities were covered (EKO-KOM, 2024). Municipalities hold legal responsibility for collection, including service design, procurement of logistics providers and reporting of collected weights. They retain ownership of collected materials until handover to recyclers, with any revenues accruing to municipalities. EKO-KOM's role is limited to financing and compliance oversight. The organisation is owned by ten shareholders (six beverage companies and four packaging manufacturers) and governed by a nine-member board of directors. It also operates a stakeholder advisory body ("Rada pro dialog") to support dialogue with industry and stakeholders (EXPRA, 2024). The Ministry of the Environment oversees the system, while the Czech Environmental Inspectorate carries out compliance checks. Penalties for non-compliance or free riding range from CZK 50,000 to CZK 10 million (€2,000–410,000) (EEA, 2022e).

As mentioned above, there are significant barriers to market entry for potential competing PROs, even if the packaging law in Czechia would explicitly allow for that. Considering the recycling rates for plastics (52,4%), which is the most challenging waste stream and compare them with the relatively high prices in Czechia, also when compared to the country's purchasing power, it suggests that with enhanced competitive pressure, there could be opportunities for cost optimization and performance improvements.

3.8.4 Innovation

Innovation within the Czech EPR system has been supported primarily through regulatory requirements rather than competition between PROs. National recycling targets are aligned with EU Packaging and Packaging Waste

[13] The total amount on which this recycling rate is based is the amount of household packaging licensed by EKO-KOM.

Regulation (PPWR) requirements but no additional targets have been adopted nationally (EEA, 2022e). Between 2015 and 2019, the overall packaging recycling rate declined to 71.2% but has since increased by 3.8 percentage points. Plastic recycling rates have remained largely stable since 2015. Fee differentiation (eco-modulation) is limited compared to countries such as France or Italy. Nevertheless, EKO-KOM applies differentiated fees by polymer type, distinguishing between transparent PET, composite materials and between beverage/non-beverage as well as soft/rigid plastics (PRO Europe, 2024). For materials such as paper and glass, a fixed rate per tonne is applied.

In 2023, the nationwide Waste Management Information System 2 (WMIS2) was launched by the Ministry of the Environment of the Czech Republic, consolidating registers into a single real-time platform accessible to municipalities, contractors, the Ministry of the Environment and EKO-KOM. The system automates reporting, flags anomalies and reduces administrative burden, thereby improving data transparency and supporting the planned deposit system rollout (EKO-KOM, 2024). EKO-KOM also implements a wide communication programme addressing producers, municipalities and the general public through national media, online platforms, and educational initiatives. Since 1998, it has operated a school-based programme and has supported outreach projects such as special sorting bags, promotional campaigns and recycling initiatives at cultural events[14] (EXPRA 2024).

[14] See e.g. www.jaktridit.cz or www.samosebou.cz

4 Efficiency and Performance

4.1 Analytical Framework

This chapter presents and analyses the results of a quantitative comparison matrix of EPR system performance in the eight analysed European countries. The assessment uses standardised performance indicators within a common evaluation framework. The approach enables robust comparison across diverse structural, regulatory and economic contexts and it identifies performance differences between monopolistic and competitive models.

The analysis shows that no single indicator captures overall performance. Countries perform differently across material flows and system costs. These differences must be interpreted considering contextual factors, including the level of cost coverage by PROs, geography and national purchasing power, which affects observed prices. To ensure comparability, both quantitative data and qualitative characteristics are converted into standardised scores.

The comparison matrix evaluates performance across four categories:

1. **Environmental performance**
2. **Cost and economic efficiency**
3. **System design and governance**
4. **Innovation capacity** (technological, organisational, and eco-design improvements)

Each category includes a series of four indicators (see Table 11) which will be assessed individually.

Category	Indicator	Description
Environmental performance	Collection Coverage (household packaging)	Percentage of households having access to waste collection services
	Recycling Rate (Plastic)	Ratio of the quantity recycled compared to the quantity placed on the market / licenced amount as determined by the national authorities
	Recycling Rate (Glass)	
	Recycling Rate (PPC)	
Cost and economy efficiency	EPR Cost efficiency (Plastic)	Calculated cost-effectiveness indicator, see below
	EPR Cost efficiency (Glass)	
	EPR Cost efficiency (PPC)	
	Total System Cost Coverage	Share of total system costs covered by PRO fees (as opposed to municipalities, taxpayers, or other sources)

System design and governance	Collection Responsibility	Who takes care of waste collection and sorting, to what extent does the PRO cover the entire value chain
	Collected material ownership	Who owns the collected material
	Monitoring/Enforcement	Existence and effectiveness of enforcement mechanisms (e.g. inspections, penalties, compliance monitoring)
	Data Transparency	Data transparency regarding prices and quotas
Innovation	Innovation Potential	How EPR systems drive technological and operational improvements.
	Eco-Modulation	Degree to which PRO fee structures (eco-modulation) incentivise sustainable packaging and recyclability
	Consumer Awareness/Education	Extent and effectiveness of consumer education campaigns run by PROs
	Innovation for Eco-Design	Incentivisation of sustainable packaging development through EPR systems and minimum standards

Table 11: Performance categories and indicators

Our analysis applies differentiated weighting to better reflect the priorities of the assessment. Specifically, we assign greater importance to environmental performance and cost efficiency, each accounting for 30% of the total score, while system design and governance, as well as innovation capacity, are each weighed at 20%. This lower weighting reflects the more qualitative and inherently subjective nature of these criteria, as assessments of system design and innovation often rely on interpretative judgments rather than strictly quantitative data. As such, their influence on the overall score is moderated to ensure a balanced and objective evaluation.

The indicators are each assigned quantitative and qualitative characteristics, which are then converted into the score of 1 (low) to 5 (high) points. For certain indicators related to environmental performance and cost efficiency, these scores are further multiplied by a specific factor giving more weight to plastic compared to glass, paper and cardboard, as plastic generally present greater challenges and complexities in recycling.

The scores are added together to arrive at a final score for each individual country. This score can be understood as a measure of overall performance of one country's system.

4.2 Environmental performance

Under the category of environmental performance, we include the collection and recycling rates for the main material flows: household plastic packaging waste, glass packaging waste, and PPC packaging waste. Data are

provided by the respective national authorities (e.g. PROs or competent environmental agencies such as the German Environment Agency). Only data for household packaging waste are considered.

Collection rate

The collection rate of household packaging waste represents a crucial parameter for assessing the effectiveness of national EPR systems. Across all eight countries examined, the collection infrastructure demonstrates comprehensive coverage, with collection rates approaching or reaching 100% in nearly all cases. This universal access ensures that virtually all households are included in the packaging waste management system, thereby maximising the potential for material recovery and recycling. Given the consistently high performance and full system coverage, all assessed countries have been awarded the maximum score of five points for this indicator.

Recycling rates

Naturally, the national EPR systems are measured in particular by one standard quantitative indicator, namely the proportion of packaging waste that is recycled, in accordance with the definitions in Directive 94/62/EC on packaging and packaging waste and the EU Waste Framework Directive (2008/98).

The performance analysis reveals significant variation in recycling achievement across European EPR systems, with clear patterns emerging between different system structures and national approaches. Germany presents a specific methodological challenge due to the coexistence of EPR and a DRS. Deposit systems for PET bottles, aluminium, and tin cans achieve very high return rates, with PET bottles and aluminium cans reaching up to 97.6% (Gesellschaft für Verpackungsmarktfortschung, 2025). These materials are collected separately from the EPR packaging system, reflecting the effect of comparatively high deposit fees and the homogeneous quality of the collected streams. In countries without deposit systems, these materials are processed within the regular EPR system. For comparability, we therefore adjust the recycling rate to reflect the share of materials recycled through the DRS.

Table 12 presents the scoring scheme for the three materials.

Score	Plastic [%]	Glass [%]	PPC [%]
5 Points	65 or above	85 or above	90 or above
4 Points	60–64	80–84	87–89
3 Points	55–59*	75–79*	84–86*
2 Points	45–54	65–74	75–84
1 Point	Below 45	Below 65	Below 75

Table 12: Performance scoring for plastic, glass and PPC recycling rates

*Meets 2025 EU recycling target for the material

The scoring thresholds differ between materials because glass and PPC are generally easier to collect and recycle, often achieving higher recycling rates compared to plastic. As a result, higher benchmarks are set for glass, and PPC, in comparison with plastic, as also seen in the higher recycling targets from the EU.

Country	Germany	France	Italy	Belgium	Spain	Nether lands	Austria	Czech Republic
Plastic Recycling Rate [%]	76.1 (weighted average)	27.0	47.7	60.8	51.5	51.9 (weighted average)	26.9	52.4
Glass Recycling Rate [%]	83	86.0	77.4	97.8	72.3	81.0	83.3	77.6
PPC Recycling Rate [%]	93.6	69.0	92.3	86.1	78.3	89.0	79.6	97.9

Table 13: Recycling rates for different household waste streams in European countries

Looking at plastic packaging, Germany consistently demonstrates the highest environmental performance, achieving 68.9% recycling rates for plastic through the dual system. (Stiftung Zentrale Stelle Verpackungsregister, 2025a). If PET quantities are included (which are collected via the separate deposit system), the weighted rate is even higher at 76.1%. These are the highest plastic recycling rates in Europe. The 2012 German Circular Economy Act required a 65% rate, while the EU is only aiming for 50% in 2025 and 55% in 2030 for plastic packaging.

Belgium demonstrates the second-highest plastic recycling performance at 60.8% (Fost Plus, 2024), proving that monopolistic systems can achieve good environmental outcomes when supported by adequate financing and regulatory oversight. The country benefits from Fost Plus's comprehensive coverage model and its compact, densely populated geography that facilitates efficient collection systems. Czech Republic follows with a 52.4% recycling rate (EEA, 2022e), whilst Spain (51.5%) and the Netherlands (51.9%) maintain moderate performance levels. Italy shows solid progress at 47.7%, supported by CONAI's consortium-based approach and sophisticated eco-modulation mechanisms. France presents a low performance at just 27%. (Citeo & Adelphe, 2023) A surprisingly low figure despite integrating all PET bottles into the EPR system.

Glass recycling demonstrates generally strong performance across European systems, with most countries achieving rates above 80%, largely due to glass's inherent recyclability and established collection infrastructure. Belgium leads with an exceptional 97.8% recycling rate, showcasing the effectiveness of comprehensive system coverage. France follows closely at 896%, demonstrating that the country's EPR system performs significantly better for glass than for plastic. The Netherlands (81.0%) and Austria (83.3%) maintain solid performance levels, whilst Germany achieves 83%, Italy (77.4%), Czech Republic (77.6%), and Spain (72.3%) show more moderate glass recycling rates, indicating room for improvement in collection efficiency and system optimization.

Paper, paperboard, and cardboard recycling reveals the most impressive overall performance across the surveyed countries, with several nations achieving rates above 90%. Czech Republic leads with an outstanding 97.9% recycling rate, followed closely by Germany at 93.6% and Italy at 92.3%, demonstrating the maturity of paper recycling systems and the material's high recyclability. France presents the lowest PPC recycling rate at 75.8%, though this still represents a respectable performance level. The consistently high PPC recycling rates across most countries reflect well-established collection systems, mature recycling infrastructure, and the economic value of recovered paper fibres in manufacturing processes.

Country	Collection Rate	Plastic recycling rate	Glass recycling rate	PPC recycling rate	Total (Out of 20)
Germany	5	5	5	5	20
France	5	1	5	1	12
Italy	5	2	3	5	15
Belgium	5	4	5	3	17
Spain	5	2	2	2	11
Netherlands	5	2	4	4	15
Austria	5	1	4	2	12
Czech Rep.	5	2	3	5	15

Table 14: Comparison matrix for environmental performances

Table 11 presents the first part of the advanced matrix, showing the environmental performance scores for each country. It includes scores for household packaging collection as well as recycling rates for plastic, glass, and paper/cardboard. All countries achieve full marks for collection, demonstrating comprehensive system coverage. However, there are marked differences in recycling performance, especially for plastic, where only Germany and Belgium score highly. Germany leads overall with the highest total score, while France, Spain, and Austria are held back by low plastic recycling rates.

In the final assessment for plastic, glass, and paper/cardboard, we apply a material-specific factor to reflect the relative challenge of recycling each material. This factor is based on the 2025 EU packaging waste directive targets which are 50% for plastic, 70% for glass, and 75% for paper and cardboard, and it is calculated as the inverse of the target percentage (e.g. a factor of 2 for plastic, 1.43 for glass, and 1.33 for paper/cardboard). This approach ensures that more challenging materials, such as plastic, have a proportionally greater influence on the overall assessment.

4.3 Cost and Economic Efficiency

Cost efficiency is used here as an indicator of the economic performance of EPR systems. It is defined as the ratio of the recycling rate achieved to the adjusted cost per tonne incurred to achieve it:

$$Cost\ Efficiency = \frac{Recycling\ Rate\ (\%)}{Adjusted\ Cost\ per\ Tons\ (\frac{€}{tons})}$$

This indicator captures both environmental and economic dimensions. A higher value indicates that a system either achieves a given recycling rate at lower costs or achieves higher recycling rates at comparable costs.

License fees are used as a proxy for costs, as they ultimately reflect the costs incurred by PROs. In practice, detailed cost data are often unavailable, particularly in competitive systems, where trade secrecy limits disclosure. For this reason, licence fees for a standard set of packaging items were collected. In competitive systems, such as Germany, a weighted average fee was calculated based on market share.

To ensure comparability across countries, raw cost data were adjusted using purchasing power parities (PPP). For countries with a DRS (Germany and the Netherlands), cost weighting is proportional to the volume handled within each system. In Germany, for example, the dual system processes almost 1.2 million tonnes of plastic at an adjusted cost of €640/t, while the DRS processes around 400,000 tonnes at €437/t adjusted. The weighted average cost of €589/t reflects the actual cost structure across the two systems. The same exercise has been carried out for the Netherlands which applies the deposit scheme only 0.5 Liter PET bottles and aluminium cans (not included in the study). For Austria, which only introduced a DRS in 2025, materials collected, and DRS-related costs have not been included, as no full-year data are yet available.

Furthermore, in countries such as Italy, France, and Belgium, the licence fees collected by PROs do not typically cover the full operational costs of the system. A portion of these costs is subsidised by municipalities. For example, in Italy, this supplementary amount represents approximately 20% of total costs, while in France was 17.9% in 2023. In Belgium, households are required to purchase PMD bags which equates to an additional 10.6% of total costs. These supplementary costs are often excluded from the official budget figures. For the purposes of this analysis, these percentages have been added to the licensing fee for each country, and the final figures have been adjusted accordingly.

EPR Cost Efficiencies

The point scales for cost efficiency in plastic, glass, and PPC are differentiated to reflect the unique cost structures and recycling challenges of each material stream.

Score	Plastic	Glass	PPC
5 Points	>0.10	>4	>2.5
4 Points	0.08 – 0.10	2.5 – 4.0	1.5 – 2.5
3 Points	0.06- 0.08	1.5 – 2.5	0.7 – 1.5
2 Points	0.04 – 0.06	0.5 – 1.5	0.5 – 0.7
1 Point	< 0.04	<0.5	<0.5

Table 15: Performance scoring for cost efficiency rates

Each scale is tailored to the actual range of efficiency values observed for that material in the eight countries, ensuring meaningful distinctions between high and low performers. This approach provides fair benchmarking and encourages targeted improvements within each material type. Using a single scale across all materials would not capture the real differences in recycling systems and costs.

When analysing efficiency indicators for plastic recycling, Germany emerges as a clear performance leader, followed by Italy.

Country	Average Plastic Recycling Rate [%]	Adjusted Average Price [€/t]	Cost Efficiency
Germany	76.1	589	**0.129**
France	27.0	893	**0.030**
Italy	47.7	533	**0.090**
Belgium	60.8	1,310	**0.046**
Spain	51.5	979	**0.053**
Netherlands	51.9	701	**0.074**
Austria	26.9	592	**0.045**
Czech Rep.	52.4	708	**0.074**

Table 16: Cost efficiency in the eight countries for plastic packaging collection

The cost efficiency analysis reveals dramatic performance differences that correlate strongly with system structure and competitive dynamics. Germany emerges as the efficiency leader. This exceptional performance results from the combination of high recycling rates (76.1% for plastic) achieved at weighted average costs of €589/ton. The competitive structure among ten PROs creates continuous pressure for cost optimisation whilst maintaining environmental performance standards.

Italy achieves solid cost efficiency delivering 47.7% plastic recycling rates at adjusted costs of €533/ton. The Netherlands achieves 51.9% recycling rates with a combination of curb side collection (PMD) and DRS, though with higher specific costs. Germany, the only other country in the study with a DRS operating alongside PET, demonstrates both a higher collection rate and greater cost efficiency compared with the Netherlands.

Systems with monopolistic structures or limited competition face significant cost efficiency challenges. Spain shows relative low efficiency (0.053) despite achieving 51.5% recycling rates, constrained by high adjusted costs of €979/ton that reflect insufficient cost optimisation incentives within the historic Ecoembes monopoly structure. France achieves 0.030 relative efficiency, combining low recycling rates (27%) with very high adjusted costs of €893/ton. This poor performance reflects both partial cost coverage limitations and the lack of competitive pressure for system optimisation.

Belgium presents a particular challenge for cost efficiency analysis, achieving only 0.046 relative efficiency despite a good recycling performance of 60.8%. The country's very high adjusted costs of €1,310/ton reflect comprehensive national coverage delivered through monopolistic structures without competitive cost pressure. This case illustrates the trade-offs between system coverage reliability and cost efficiency that characterise different structural approaches.

Country	Average Glass Recycling Rate [%]	Adjusted Average Price [€/t]	Cost Efficiency
Germany	88.5	31	**2.637**
France	86.0	26	**3.312**
Italy	77.4	19	**4.020**
Belgium	97.8	69	**1.668**
Spain	72.3	54	**1.351**
Netherlands	81.0	77	**1.058**
Austria	83.3	92	**0.908**
Czech Republic	77.6	83	**0.932**

Table 17: Cost efficiency in the eight countries for glass packaging collection

Looking at waste glass, we see Italy in the lead, followed by France. In Italy, the recycling rate is relatively low at only 77%, while the majority of the countries considered score above 80%, including Germany, France, Belgium, the Netherlands, and Australia. Nevertheless, Italy scores well here due to its comparatively low licensing costs. In Germany, prices are comparatively high, which may also be due to the special separate collection system used in the country. It is evident that Italy (or rather the monopolist CONAI) operates a cost-efficient system here, especially for glass and PPC material flows. However, it should also be noted that PRO in Italy only bears 80% of the total costs, while the rest is borne by the municipalities, unlike in countries with a full-cost model. The licensing costs therefore represent only 80% of the true costs of the entire system.

In some countries the higher costs for glass waste collection are largely due to the extensive networks of bottle banks present in the country, which are located close to households and serviced frequently to ensure cleanliness and convenience. This high frequency and density of collection points require significant logistical effort and resources. Additionally, the system mandates the separate collection of glass by colour (clear, green, and brown) which adds further complexity and cost but delivers better material quality for recycling.

Country	Average PPC Recycling Rate [%]	Adjusted Average Price [€/t]	Cost Efficiency
Germany	93.6	132	**0.707**
France	69.0	331	**0.209**
Italy	92.3	55	**1.671**

Belgium	86.1	120	**0.718**
Spain	78.3	139	**0.564**
Netherlands	89.0	14	**6.408**
Austria	79.6	177	**0.450**
Czech Republic	97.9	227	**0.432**

Table 18: Cost efficiency in the eight countries for PPC

The cost efficiency analysis for paper and cardboard highlights significant differences across countries, shaped by system structure, competitive dynamics, and coverage models.

The Netherlands stands out as the clear efficiency leader, combining an exceptionally high recycling rate (89.0%) with the lowest adjusted average price €19/ton, resulting in a remarkable cost efficiency score of 6.408.

Italy also demonstrates strong cost efficiency, achieving a high recycling rate (92.3%) at a comparatively low adjusted cost €44/ton, yielding a cost efficiency of 2.089.

Germany and Belgium both show robust recycling rates (93.6% and 86.1%, respectively), but their cost efficiency scores (0.707 for Germany and 0.718 for Belgium) are moderated by higher adjusted prices (€132/ton for Germany, €120/ton for Belgium). In Germany, curbside collection of paper and frequent service points contribute to logistical complexity and higher costs.

Spain, Austria, and the Czech Republic present lower cost efficiency scores (0.564, 0.450, and 0.432, respectively), each facing challenges from higher adjusted prices and only moderate recycling rates. Spain and Austria operate with higher collection costs, which limit overall system efficiency despite reasonable recycling performance.

Total system cost coverage

In addition to cost efficiency, the analysis considers total system cost coverage. This indicator measures the extent to which all operational costs (collection, sorting, recycling, administration) are covered by producer fees. Full coverage (100% of the costs) means that the system operates entirely through producer contributions, without municipal or state subsidies. In France, for example, licence fees cover only 82% of total costs, with the remaining 18% if the costs covered by municipalities.

A full cost coverage system is generally considered better than a shared-cost system for several reasons. Full cost coverage ensures that producers are fully responsible for the environmental and financial impacts of packaging waste, creating a strong incentive for innovation and waste reduction. It also provides greater financial stability and predictability for the system, as it does not rely on variable municipal or state subsidies. This approach supports the “polluter pays” principle, encourages efficiency, and reduces the risk of underfunding or shifting costs to taxpayers. In contrast, shared-cost systems could dilute producer responsibility, reduce incentives for improvement, and potentially making system financing less transparent and reliable.

In the matrix, a score of 5 points is awarded when the total system cost is fully covered by producer fees, as is the case in countries like Germany. In Belgium, however, citizens must pay for PMD bags, so the system is not fully covered by producer fees and it has been scored with 4 points. If the coverage is only partial (such as in France and Italy, where producers cover respectively 82% and 80% of the costs), the score is reduced to 3 points.

The final Matrix for the cost efficiency section (Table 12 provides a comparative overview of EPRs’ cost efficiency and system funding across eight European countries. It assesses each country’s performance in three material

streams (plastic, glass, and PPC) by assigning points based on cost efficiency, with higher points indicating higher efficiency.

Country	EPR cost efficiency for Plastic	EPR cost efficiency for Glass	EPR cost efficiency for PPC	Total system cost coverage	Total (Out of 20)
Germany	5	4	3	5	17
France	1	4	1	3	9
Italy	4	5	4	3	16
Belgium	2	3	3	4	12
Spain	2	2	2	5	11
Netherlands	3	3	5	5	16
Austria	2	2	1	5	10
Czech Rep.	3	2	1	5	11

Table 19: Comparison matrix for cost efficiency

For EPR cost efficiency for plastic, Germany stands out with the highest score of 5, indicating the highest efficiency (lower cost per outcome) according to the applied scale. For glass, Italy and France scores highly here. For paper/cardboard, the Netherlands and Italy both achieve the highest score of 5, reflecting higher efficiency compared to their peers.

When it comes to total system cost coverage, all countries except France and Italy score 5 points, meaning these countries fully cover system costs through producer fees and demonstrate the strongest producer responsibility level.

Looking at the total scores, Italy and the Netherlands both achieve the second highest overall score of 16, reflecting a combination of lower material efficiency (higher costs) and full cost coverage by producers. Germany also performs strongly, with a total score of 17, due to high-cost coverage and relatively high scores across the material streams.

The same material-specific factor, based on the inverse of the 2025 EU recycling targets (e.g. 2 for plastic, 1.43 for glass, 1.33 for paper/cardboard), is also applied to cost efficiency indicators in the final assessment, ensuring that more challenging materials have a proportionally greater impact.

4.4 System Design and Governance

Collection Responsibility

This indicator refers to operational responsibility for collecting packaging waste. This can lie with PROs (direct responsibility), with municipalities under PRO financing (shared responsibility), or in hybrid models with different responsibilities depending on material stream or geographical region. When PROs retain operational responsibility, they can build highly specialized, optimized systems with direct financial incentives to maximize recyclate quality and efficiency, whereas municipalities are local service delivery generalists without competitive pressure or material expertise who fragment the system and lose the economies of scale.

In the matrix evaluation, five points are awarded if PROs hold full organisational and financial responsibility over the collection as it is the case in Austria and Germany. Three points for operational split: municipalities collect while PROs finance. Most of examined countries apply this system, including Italy, Belgium, Spain and the Netherlands. One point is awarded if the municipality collects and the PRO pays less than 50% of the costs.

Material Ownership

Similarly, this indicator determines who holds legal and economic control over collected packaging waste. PRO ownership enables direct control over recycling quality and revenues, whilst municipal ownership assigns PROs primarily a financing role. This ownership structure significantly influences incentive systems and recycling quality.

- PROs can use material proceeds directly to reduce fees, thereby creating immediate cost advantages for producers
- Quality control: Strict enforcement of sorting and recycling specifications through contractual obligations on service providers
- establishment of stable customer relationships for secondary raw materials and strategic market development
- PRO retains complete control over material quality and quantities reduces uncertainties in the recycling chain

Points in the rating are awarded according to the type of material ownership. Since full material access for PROs represents an organisational advantage for system efficiency, full points are awarded for this. If the municipality or another local authority collects and owns the materials, then later on sells or transfers the ownership rights to the PRO, as it is the case in Belgium, three points are awarded. In case the municipalities collect and retain ownership of the material, one point is awarded.

Germany demonstrates the most advanced implementation of PRO material ownership across European EPR systems. All ten competing PROs maintain complete ownership of collected recyclables, creating direct financial stakes in recycling outcomes. This ownership structure allows PROs to internalize recycling revenues directly—in 2023, the dual systems generated an estimated €180-220 million in material revenues, which were reinvested to reduce EPR fees for participating companies. (EEA, 2022b)

The advantages of Germany's material ownership model extend beyond revenue generation. PROs can establish and enforce quality standards through binding specifications for sorted materials, ensuring consistent recyclate quality that meets industry requirements. This facilitates the development of strategic market relationships through long-term customer contracts, which can stabilize recycling markets and enable more effective investment planning. Competition between PROs for optimal recycling revenues drives innovation in sorting quality and market development, where PROs that establish superior recycling partnerships can offer more competitive fees and gain market share.

Belgium's Fost Plus represents a hybrid model that balances strategic control with operational delegation. Fost Plus maintains oversight of the entire recycling chain through long-term contractual arrangements while delegating collection and sorting operations to municipalities and private service providers. Such a system works in a similar way then in the most European countries: the Municipalities collect and sort the waste, then transfer the ownership to the PRO upon delivery for recycling. (EEA, 2022d)

Italy's CONAI system features a complex consortium-based material ownership model where material-specific consortia (COMIECO for paper, COREPLA for plastic) share ownership responsibilities. The system shows significant regional variations between northern and southern Italy. It maintains a strong integration into established recycled material markets that leverage Italy's existing industrial recycling infrastructure. (EEA, 2022f)

France exemplifies the performance limitations inherent in shared material ownership through its Citeo system. Operating primarily as a financing organization, Citeo distributed approximately €855 million to municipalities in 2023 while exercising limited direct control over materials. Over 35,000 municipalities independently organize collection, sorting, and often recycling operations, creating fragmented recycling relationships where various municipal actors develop separate customer partnerships. (EEA, 2022a)

This structure creates several performance implications. Limited revenue internalization means recycling revenues remain largely with municipalities without directly reducing EPR fees for producers. Suboptimal quality control results from Citeo's indirect influence over sorting and recycling standards, which can only be exercised through financing conditions. Innovation barriers emerge due to limited direct incentives for technology investments resulting from restricted revenue sharing arrangements. The discussed partial cost coverage model (82%) combined with the limited material ownership contributes to suboptimal investment incentives and explains France's below-average cost efficiency performance for plastic.

Spain and the Netherlands also operate systems with limited PRO material control mechanisms. Ecoembes finances municipal systems without comprehensive material control, whist Verpact, in the Netherlands, focuses on cost optimization rather than revenue maximization. These approaches limit the potential for integrated value chain optimization and comprehensive system performance improvements. (EEA, 2022c, 2022g).

Monitoring and Enforcement

This describes mechanisms for controlling EPR compliance and sanctioning violations. Effective systems combine regular audits, data verification, and penalties to prevent free-riding behaviour and ensure system integrity. The stricter the monitoring and enforcement, the higher the number of points awarded.

Italy operates under a robust regulatory framework with state supervision by the Ministry of the Environment and Energy Security (MASE), featuring clear enforcement mechanisms through regular audits, administrative penalties ranging from approximately €2,600 to €15,500, and technical supervision by ISPRA (the national environmental agency) which ensures data validation and compliance monitoring. This level receives 5 points. Germany's EPR system features a similarly robust monitoring and enforcement mechanism through the independent Central Agency Packaging Register (ZSVR), which ensures strict compliance via regular audits, public data reporting, a public open access registry and substantial penalties of up to 200,000 euros plus sales bans for non-compliance.

Data Transparency

This indicator assesses the extent to which EPR systems provide open, verifiable, and comprehensive reporting on key performance metrics including recycling rates, material flows and prices for producers. Transparent data systems enable stakeholders to identify improvement areas and ensure accountability in achieving environmental objectives. Moreover, the level of data transparency significantly influences public trust, and the possibility and quality of regulatory oversight.

Regular publication of detailed material flow data, recycling rates, and cost breakdowns facilitate system benchmarking and best practice identification. Points in the rating are awarded according to the comprehensiveness and accessibility of data reporting. Full points are awarded for systems with independent oversight bodies that publish detailed, verified data across all performance indicators and have a clear cost transparency for producers and the public. This is the case in France, where all costs (including for the applied eco-modulation) for licensing, total costs of the EPR system with expenditure on public education campaigns, waste collection and sorting are shown, as well as the key indicators achieved in terms of recycling rates.

Three points are given for systems with regular public reporting, though some shortcomings remain. In Germany, for example, there is high-quality and regular publication of material flow and recycling data, along with detailed

technical reporting. However, the competitive nature of the EPR system creates limitations in financial transparency, particularly regarding producer fees and other cost-related information. Because PROs compete with one another, detailed financial data is not disclosed to the same extent as in monopolistic.

One point is awarded for inadequate reporting with restricted public access or limited scope.

Country	Collection Responsibility	Collected Material Ownership	Monitoring and Enforcement	Data transparency	Total (Out of 20)
Germany	5	5	5	3	18
France	3	3	5	5	16
Italy	3	3	5	5	16
Belgium	3	3	5	5	16
Spain	3	3	3	1	10
Netherlands	3	3	5	3	14
Austria	5	3	5	3	16
Czech Republic	1	1	3	5	10

Table 20: Comparison matrix for system design and governance

4.5 Innovation

The fourth relevant subcategory assesses the innovative strength of the respective national systems. Here, too, four indicators were assessed, which will be briefly explained subsequently. Innovation in the European EPR systems is measured using a differentiated qualitative assessment framework that takes into account various dimensions of development.

Innovation Potential

This key indicator measures how EPR systems drive technological and operational improvements. In competitive systems like Germany, 10 competing PROs continuously invest in sorting technologies and digital tools to gain market advantages. PROs with superior technology can offer lower fees, creating direct financial incentives for innovation. In monopolistic systems like France, innovation depends on regulatory pressure, leading to systematic but potentially slower improvements. Whereas, in competitive systems such as Germany, regulatory pressure is applied, for example through ambitious recycling quotas, in order to strengthen innovation. It is necessary to create a level playing field for the PROs to compete on. The indicator evaluates whether systems create sufficient incentives—through competition, regulation, or hybrid approaches—to drive continuous improvement in collection efficiency, sorting quality, and recycling technologies.

Germany emerges as an innovation leader, scoring high across most criteria. Key innovation drivers include competitive tendering among PROs, digital tools for packaging assessment, and harmonised recyclability criteria.

Italy demonstrates good innovation potential, particularly in eco-design promotion and consulting services. CONAI's flagship ECOPACK programme encourages companies to submit innovative packaging solutions with improved recyclability, whilst the EcoD Tool provides a digital platform for packaging assessment.

Belgium represents a model of incremental innovation within a centralised structure. Whilst the monopoly-based system ensures system stability and high recycling rates, it provides fewer incentives for market-driven innovation compared to competitive systems. Belgium scores three points for R&D/Innovation Potential, with investments focusing on modernising sorting infrastructure and supporting new recycling markets for complex plastic fractions. The system's transparency and stable financing enable large-scale upgrades and pilot projects, such as digital deposit return schemes, but innovation remains largely incremental rather than systemic. France exhibits strong regulatory innovation through comprehensive eco-modulation whilst facing limitations from its centralised structure. The Citeo system excels in transparency, monitoring, and consumer education, scoring high in these areas. France's innovation is primarily driven by regulatory requirements rather than competitive pressures, resulting in strong central oversight but limited market-driven technological advancement. (Pruess & Garrett, 2025)

Spain demonstrates moderate innovation potential constrained by its historically monopolistic market structure. Ecoembes operates a dedicated Innovation Centre focused on advanced sorting technologies, artificial intelligence applications, and digitalization initiatives . (Comisión Nacional de los Mercados y la Competencia, 2024) However, the limited competition has reduced innovation pressures compared to Germany's competitive environment. Spain scores low for transparency due to stakeholder concerns about data verification and reporting opacity, which limits innovation effectiveness. (Ahlers et al., 2021)

Based on the efficiency analysis and case study patterns, the remaining countries—Austria, Netherlands and Czech Republic—represent systems in various stages of development with emerging innovation characteristics: Austria demonstrates a fragmented approach with multiple PROs, but still with a large market dominance of a single player and not well established competition (Rechnungshof Österreich, 2022a). The country's system fragmentation between multiple PROs without adequate coordination limits systematic innovation development, despite moderate cost structures. The Netherlands show focus on cost minimisation rather than innovation optimization through its Afvalfonds system. The emphasis on cost control over quota optimization suggests limited systematic innovation investment, though the country maintains moderate recycling performance. Czech Republic represents a developing market showing increasing sophistication in recycling partnerships and growing investments in sorting and recycling technologies. Both countries demonstrate market maturation dynamics with regulatory stabilisation and development of uniform quality standards. (Hermann et al., 2025)

The analysis reveals three distinct innovation performance clusters:

- **High Innovation Systems** (Germany, Italy): Characterised by either competitive pressure (Germany) or strong eco-design promotion (Italy), these systems demonstrate systematic innovation investment, and technological advancement.
- **Moderate Innovation Systems** (Belgium, France, Spain): These systems show incremental innovation driven primarily by regulatory requirements rather than competitive pressures. Innovation tends to be centrally coordinated but less dynamic than market-driven systems.
- **Developing Innovation Systems** (Austria, Netherlands, Czech Republic): These countries show emerging innovation characteristics with increasing market sophistication but lack the systematic innovation drivers found in leading systems.

Eco-modulation

Eco-modulation represents the variation of fee structures and their ability to provide incentives for sustainable packaging design. It means in core that producers have to pay reduced packaging fees based on sortability, recyclability, or environmental friendliness, while packaging products that are difficult to recycle and cannot be reused must pay higher fees. This is intended to provide manufacturers with a market-based incentive to bring more environmentally friendly packaging to market. Some countries have highly differentiated eco-modulation, while others only apply it to one material stream (usually plastic) or do not apply eco-modulation at all. (Sachdeva et al., 2021)

The PPWR stipulates that the financial contributions to be paid by manufacturers as part of EPR must in future be modulated according to ecological criteria - in particular recyclability and the proportion of recycled materials. To this end, the European Commission will define harmonised criteria and performance levels for recyclability as well as the modalities for assessing and presenting these properties (Regulation (EU) 2025/40, 2024)

Points in the rating are awarded according to the comprehensiveness of the eco-modulation implementation. Full points are awarded for systems with extensive criteria covering different waste streams and significant fee differentiation. Three points are awarded if eco-modulation is in development. While systematic eco-modulation of fees has not yet been implemented in Germany, individual PROs have commonly developed several models for implementation which still need to be codified into legislation. The new EU Packaging and Packaging Waste Regulation will make eco-modulation mandatory, creating a regulatory framework that will drive implementation across all member states. One point is awarded for minimal or purely material-based fee differentiation without eco-modulation under discussion or planning. France leads the way here with comprehensive criteria for recyclability, recycled content, and sortability, which are reflected in differentiated fee structures. The situation is similar in Italy, which applies a sophisticated eco-modulation system that differentiates fees not only by material type but also by recyclability and environmental performance, thus creating strong incentives for sustainable packaging design. (CONAI, 2024)

Consumer education

This indicator assesses the extent to which EPR systems develop and implement comprehensive consumer awareness and education programs to promote proper waste separation, increase participation rates, and enhance overall recycling quality. Consumer education encompasses public information campaigns, educational materials, behavioural change initiatives, and communication strategies designed to improve citizen engagement with the EPR system. These programs are crucial, because consumer education on waste separation significantly influences collection quality, contamination rates and overall system performance. It ensures that packaging waste reaches the appropriate collection streams in properly sorted and clean condition.

Points in the rating are awarded according to the scope, intensity, and measurable impact of consumer education initiatives. Full points are awarded for systems with comprehensive, multi-channel education campaigns, measurable behaviour change outcomes, and systematic integration of consumer awareness into system operations. Three points are given for active campaigns with regular communication but limited impact measurement or coordination. One point is awarded for minimal or no educational efforts with basic information provision and limited systematic approach to consumer engagement.

France, Belgium, Germany, and the Netherlands exhibit strong consumer education through centralized or coordinated campaigns by organizations such as Citeo, Fost Plus, and the German PROs, with comprehensive public information initiatives that have contributed to high awareness levels and established recycling behaviours across the population. Italy and Austria maintain regular educational campaigns and school programs, often in partnership with local authorities and consortia, though systematic impact measurement is less developed. Spain and the Czech Republic invest in public awareness through national campaigns and school initiatives (such as Ecoembes' "Amarillo, Verde y Azul" and EKO-KOM's "Tonda Obal"), but face challenges regarding consistent behaviour change and integration with collection system outcomes.

Innovation for eco-design

This indicator examines how EPR systems encourage companies to integrate sustainable design principles at the early stages of packaging development, rather than addressing waste management solely at the end-of-life phase. Effective systems provide producers with practical resources including design guidelines, material databases, and technical consultation services to support the development of recyclable packaging. This approach represents a fundamental shift in EPR strategy - moving beyond traditional end-of-pipe waste management toward proactive prevention and circular design principles.

Points in the rating are awarded according to the comprehensiveness and effectiveness of eco-design promotion mechanism. Full five points are awarded for systems with comprehensive technical design guidelines, active R&D support programs, collaborative innovation platforms, and demonstrated market transformation toward

sustainable packaging through design standards. Three points are given for systems with developing design guidance and basic technical support for recyclability improvement. One point is awarded for minimal or no further support of eco-design.

France exhibits comprehensive eco-design innovation through Citeo's technical guidance programs that provide detailed design recommendations based on packaging size and composition assessments, coupled with active research and development initiatives that have influenced packaging design across multiple material streams and established industry best practices. (Citeo, 2023a). Italy operates advanced eco-design promotion through CONAI's material-specific consortia that provide extensive technical guidance and implement collaborative innovation programs with packaging producers, creating systematic approaches to design optimization based on industrial recycling capabilities rather than theoretical assessments (CONAI, 2024).

Belgium's Fost Plus demonstrates targeted eco-design support through technical advisory services and collaborative partnerships with packaging producers, though with less systematic innovation programming compared to the comprehensive approaches in Germany and France. Eco design is strongly enforced in Germany because the Packaging Act (VerpackG) mandates strict recyclability criteria for packaging, backed by annual standards and robust oversight from regulatory authorities. The system's innovation strength is evidenced by the fact that 81.5% of household plastic packaging can now be classified as highly recyclable, a result attributed to technological advances, improved sorting technology, and the use of recycling-friendly materials. (Gesellschaft für Verpackungsmarktfortschung, 2024). In Belgium and Austria, eco design and design for recycling are required and promoted, but enforcement is less strict than in Germany and France. Both countries focus more on guidance and incentives, with stronger legal enforcement expected under upcoming EU regulations.

Country	Innovation Potential	Eco-Modulation	Consumer Awareness / Education	Innovation for Eco-Design	Total (Out of 20)
Germany	5	3	5	5	18
France	3	5	5	5	18
Italy	5	5	4	5	19
Belgium	3	3	5	3	14
Spain	3	3	4	3	13
Netherlands	4	5	4	5	18
Austria	5	1	4	3	13
Czech Republic	2	3	3	1	9

Table 21: Comparison matrix for Innovation

4.6 Comparative matrix analysis

The comparative matrix analysis provides a clear and accessible way to see how different European countries perform with their EPR systems for packaging. By scoring eight countries across four main areas (environmental results, cost efficiency, system design, and innovation), the analysis paints a nuanced picture of strengths and weaknesses.

The table 22 below presents the final scores for each country, calculated using the weighted approach: 30% is assigned to environmental performance and cost efficiency, while 20% is allocated to system design and governance, and innovations. Within the categories of environmental performance and cost efficiency, indicators associated with recycling rate and cost efficiency have been multiplied by a material-specific factor (2 for plastic, 1.43 for glass, and 1.33 for paper and cardboard) to reflect the relative difficulty of recycling these materials, as described in Chapter 3.

	GERMANY	FRANCE	ITALY	BELGIUM	SPAIN	NETHER LANDS	AUSTRIA	CZECH REP.
Environmental performance	8.6	4.6	6.0	7.2	4.4	6.0	4.6	6.0
Cost and economy efficiency	7.4	3.6	7.0	4.9	4.4	6.6	4.0	4.6

System design and governance	3.6	3.2	3.2	3.2	2.0	2.8	3.2	2.0
Innovations	3.6	3.6	3.8	2.8	2.6	3.6	2.6	1.8
TOTAL	**23.3**	**15.1**	**20.0**	**18.1**	**13.3**	**19.0**	**14.4**	**12.5**

Table 22: Weighted scores for the eight countries

What becomes immediately apparent is that there is no single "best" system or country. Germany stands out for its high environmental performance and cost efficiency. This is associated with the high plastic recycling rates, which are highly above the average. Italy and the Netherlands also perform very well, proving that both competitive systems and monopolistic ones can deliver strong results. On the other hand, countries like France and Austria have more trouble, particularly with plastic recycling, despite having different types of systems.

When it comes to how much recycling is achieved for the money spent, Germany again leads, followed by Italy and the Netherlands. Belgium, while reaching high recycling rates, spends more per tons, which suggests that a single-organisation system can be reliable but is not always the most cost-effective. This highlights that it's not just about whether a system is competitive or monopolistic.

A key finding is that the best-performing systems are those where the organisations in charge (the PROs) have real control over the entire process, from collecting waste to sorting and recycling it. If PROs only act as financial backers, rather than managers, results are generally weaker. It's also important that producers pay the full cost of the system, which makes everyone more invested in making recycling work well. Innovation is another area where competition can help. In Germany, for instance, the presence of several competing PROs drives them to find new and better ways to recycle and reduce costs. However, monopolistic systems can also innovate if they are well regulated and have the right incentives. Where systems are fragmented or have only partial competition, innovation tends to lag behind.

Figure 5 offers a visual snapshot of all these findings. It shows, for each country, how they score in the four areas: environmental performance, cost efficiency, system design and governance, and innovation. The bars in the figure make it easy to see that no country is the absolute best in every category. Germany and Italy, for example, have consistently high scores, but even they have areas for improvement. Other countries show more mixed results, with some high and some low scores across the categories.

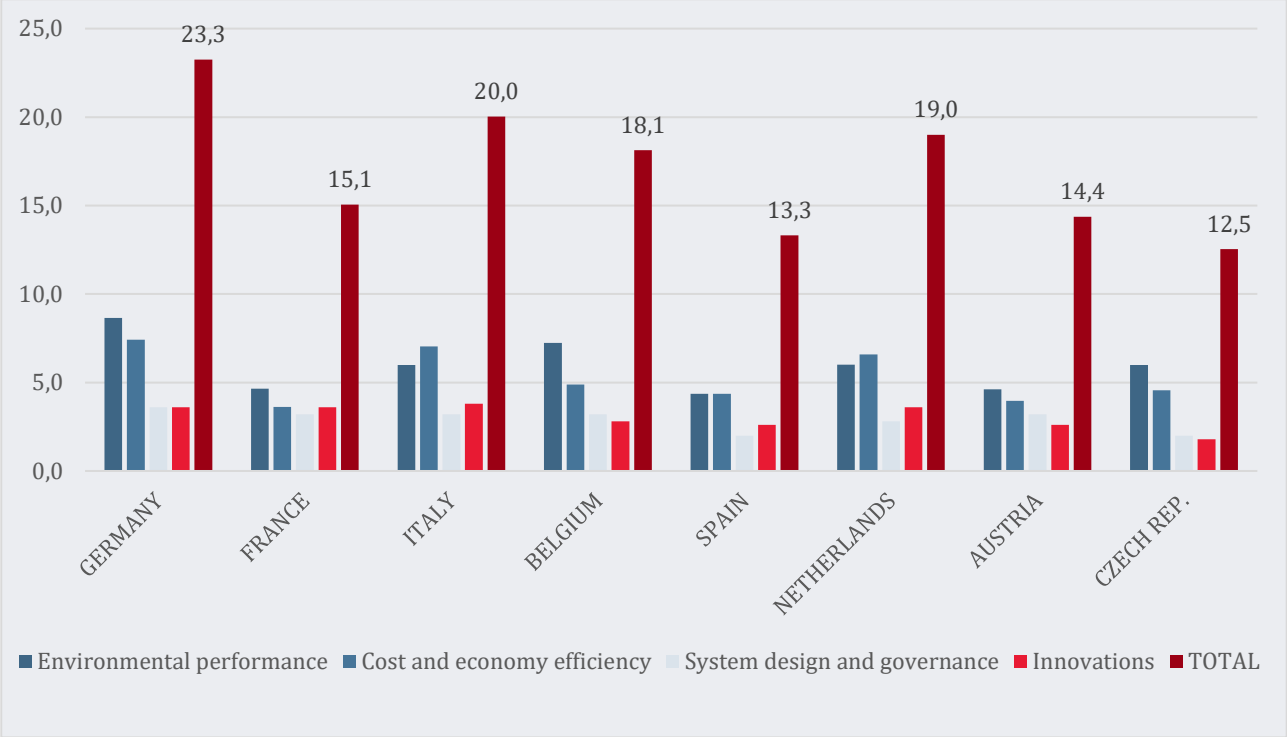

Figure 5: EPR efficiencies comparison based on comparative matrix results

The main lesson from this analysis and from Figure 5 is that there is no one-size-fits-all solution. Both competitive and monopolistic systems can succeed, but only if they are well designed, professionally managed, and have the right incentives and oversight.

4.7 Impact of Monopolistic and Competitive EPR Models

This section compares the impact of different EPR market structures in the eight countries examined in the previous sections. The table 23 below categorises each country's system according to its market model.

Competitive EPR	Quasi-Monopolistic EPR	Monopolistic EPR
Germany	France	Italy
Austria	Spain	Belgium
		Netherlands
		Czech Republic[15]

Table 23: Overview of EPR market models across the eight European countries

Instead of seeing monopolistic and competitive systems as a simple either-or choice, this analysis shows that Europe's EPR systems are too complex and varied for such a straightforward comparison. Many systems that are legally open to competition, like France, function as quasi-monopolies because one PRO controls over 90% of the market, so the benefits of competition are hardly visible in practice.

The traditional debate between monopoly and competition in EPR systems has overlooked a crucial dimension: whether PROs primarily assume only financial or also operational responsibility. This distinction fundamentally shapes how EPR systems function and perform. The competitive-operational model, exemplified by Germany,

[15] There is effectively only one PRO in the Czech Republic (EKO KOM), even though others would be legal. No other PRO has been approved for the market to date, and it is suspected that there are impermissibly high barriers to market entry European Commission (2024).

features multiple PROs competing for market share while assuming full operational responsibility. PROs organize collection, sorting, and recycling activities directly, own the collected materials, and bear all associated costs without public subsidies. This creates direct accountability for performance and material quality, as PROs must optimize the entire value chain to remain competitive and profitable.

In contrast, the monopolistic-financial models operate primarily as a financial intermediary, as seen in France. Here, PROs collect fees from producers and redistribute funds to municipalities or other operators who maintain operational control. While this can achieve broad coverage and coordination, it may create distance between financial responsibility and operational accountability, potentially weakening incentives for efficiency and innovation. Many systems combine elements of both approaches in mixed models. Italy's CONAI system, for instance, operates as a monopoly but with varying degrees of operational involvement across different material streams. This hybrid approach attempts to capture the coordination benefits of monopolistic structures while maintaining some operational accountability.

Environmental performance analysis reveals complex patterns that support the importance of operational responsibility and material ownership over pure market structure. The data demonstrates that systems where PROs assume direct operational control and material ownership consistently achieve superior performance across challenging material streams. Germany's competitive system achieves exceptional plastic recycling rates of 76.1%, significantly outperforming all other examined countries despite handling the most challenging material fractions after high-value fractions are captured by the deposit system. This performance advantage becomes more pronounced when considering that German dual systems process mixed plastic, composites, and contaminated materials, the most technically demanding aspects of plastic recycling. The gap between Germany (76.1%) and the next-best performer Belgium (60.8%) suggests that operational responsibility and material ownership create substantial performance advantages, together with those attributable to competitive pressure.

German PROs assume direct control over collection logistics, sorting specifications, and recyclate marketing, enabling end-to-end optimisation and quality control. This operational integration allows PROs to build highly professionalized systems with volume aggregation and economies of scale that are essential for successful material recovery, particularly for challenging plastic fractions. Examining France's performance, we see the limitations of EPR models with solely financial responsibility. Despite operating the most sophisticated regulatory eco-modulation system in Europe, France achieves only 35.9% plastic recycling - less than half of Germany's rate. This underperformance occurs because PROs primarily transfer funds to municipalities for collection and sorting, lacking direct control over operational performance and material quality. Municipalities, while effective at local service delivery, are not material management specialists and often lack the technical expertise and economies of scale necessary for optimizing high-value, homogeneous recycling streams required for ambitious recycled content targets.

Belgium's exceptional glass recycling performance of 97.8% (Fost Plus, 2024)- the highest among all examined countries - demonstrates that monopolistic structures can achieve outstanding results when combined with operational responsibility and strong governance frameworks. However, Belgium's success appears also connected to factors beyond its monopolistic structure, including high population density, strong local coordination, and operational accountability rather than the absence of competition per se.

Monopolistic-financial systems face inherent cost efficiency challenges. Without competitive pressure and direct operational control, these systems exhibit limited incentives for continuous cost optimization. The transfer of operational responsibility to municipalities often leads to fragmentation and loss of economies of scale. Municipal collection systems typically lack the specialized expertise and investment capacity necessary for optimizing material recovery from increasingly complex waste streams. Since municipalities are the sole service provider in their territories, they face no competitive pressure to improve cost efficiency or service quality, potentially leading to system stagnation and cost increases over time. The material ownership dimension proves particularly important for innovation incentives. When PROs own collected materials, they have direct financial motivation to maximize recyclate value through quality improvements and market development. This ownership structure enables PROs to provide professional secondary materials supply to producers, ensuring fair access to high-quality recyclate necessary for meeting recycled content obligations.

If we look at Austria, where the glass and paper and cardboard recycling rates were moderately high (83.3% and 79.6% respectively), the plastic recycling rate is very low by European standards at 26.9%. Cost efficiency is also

in the low performance range, slightly better than in France and Belgium, but behind Italy and Germany. There is competition in Austria, but the situation is similar to that in Germany a few years ago. Competition was introduced in 2015, and it sometimes takes many years for competitors to establish themselves. Currently, the leading PRO's market share for plastic is still 60%. Austria performs poorly compared to Germany, even though a competitive system is in place there (Hermann et al., 2025). The evidence suggests Austria has not achieved the full operational integration that characterizes Germany's success. German PROs control the entire value chain from collection to sorting and recycling and own collected materials, enabling end-to-end optimization. Austria's system appears to retain more municipal involvement in collection and operational control, limiting PROs' ability to optimize material flows and quality. Germany's success is underpinned by the Central Agency Packaging Register, which provides robust oversight while maintaining competitive dynamics. Austria lacks an equivalent independent oversight body with comparable authority and resources. The Austrian Court of Audit concluded in 2022 that "fair competition is still not in place" indicating persistent structural barriers to effective competition (Rechnungshof Österreich, 2022a). The European Commission's 2017 fine against ARA for "hindering competition and abusing its dominant market position" demonstrates that anti-competitive practices continued well after the supposed market opening. This suggests inadequate regulatory enforcement compared to Germany's stringent oversight mechanisms.

The evidence suggests that operational responsibility and material ownership represent more fundamental performance drivers than market structure alone. Belgium achieves the EU's highest glass recycling rate of 97.8% and strong performance across other materials despite its monopolistic structure. Conversely, France's quasi-monopolistic system (Citeo 95%, Leko 5%) struggles with plastic recycling performance despite regulatory sophistication, achieving only 27 % compared to Germany's 76.1%.

When PROs control the entire value chain from collection to recyclate marketing, they can optimize for material quality, volume efficiency, and cost effectiveness. This end-to-end responsibility creates results that go beyond market structure considerations. However, competition provides additional performance benefits when combined with operational responsibility. The German experience demonstrates how competitive pressure drives continuous innovation, cost efficiency, and service quality improvements beyond what might be achieved through operational responsibility alone. The combination of competition and operational control creates a dynamic system where market forces drive performance while operational accountability ensures effective implementation.

5 Conclusion and Recommendations

5.1 Conclusion

This study looks at packaging EPR policy setups and market structures in the EU. It examines the performance of various systems. Extensive data on recycling rates, licensing costs, and numerous other performance indicators were compiled in four categories: environmental performance, cost and economic efficiency, system design and governance, and innovation. By calculating an efficiency index and assigning numerical values to qualitative and quantitative indicators, performance across different countries was measured. The comparative analysis of nine European EPR systems reveals that no single indicator adequately captures system performance, and direct comparisons between countries must account for several significant structural, economic, and policy differences. Countries exhibit dramatically different performance patterns across material streams, cost structures, and operational approaches, which makes simplified rankings misleading. This complexity becomes particularly evident when looking at plastic recycling performance, which represents the most challenging material stream for EPR systems. The data shows strong variation, with Germany achieving 76.1% plastic recycling rates while France manages only 27%, representing a 49.1 percentage point performance gap between European neighbours.

The performance hierarchy reveals clusters that highlight fundamental differences in packaging EPR system design and implementation. As stated, Germany leads, followed by Belgium at 60.8%. These systems represent fundamentally different structural approaches - competitive versus monopolistic - yet both achieve superior plastic recycling outcomes through comprehensive operational responsibility and strong governance frameworks. The moderate performer cluster includes Czech Republic (52.4%), Spain (51.5%), and Netherlands (49.0%). Countries that meet minimum EU targets but falling significantly short of leading practices. The underperforming group encompasses France (27%), Italy (47.7%) and Austria (26.9%). Systems that struggle with plastic recycling despite some achieving strong performance in traditional waste streams like glass and paper.

Cost efficiency analysis shows that Germany achieves high values across all metrics, demonstrating how competitive pressure combined with operational responsibility of PROs and material ownership through the whole value chain are conditions for success. Germany achieves the best rate with 589€ per tonne costs while delivering 76.1% recycling rates, establishing the reference point for cost-effective plastic recycling. Italy follows with a 0.59 efficiency ratio, processing plastic at 604€ per tonne while achieving 47.7% recycling rates, demonstrating solid performance within the CONAI consortium structure. The Netherlands achieves 0.074 efficiency through Afvalfonds' cost-focused approach, though higher specific costs of 701€ per tonne reflect system limitations. Spain shows relative efficiency of only 0.053 despite achieving 51.5% recycling rates, constrained by high adjusted costs of 901€ per tonne that reflect insufficient optimization incentives within the historic Ecoembes monopoly structure. Belgium presents a particular challenge with 0.049 efficiency ratio, achieving 60.8% recycling performance at very high costs of 1,533€ per tonne. France achieves also a 0.030 efficiency, combining low recycling rates with high adjusted costs of 893€ per tonne, demonstrating the limitations of systems lacking both competitive pressure and operational integration.

The evidence indicates that both market structure and operational responsibility are critical performance determinants, with their interaction creating distinct performance patterns rather than either factor alone driving outcomes. These findings challenges simplistic assumptions about monopolistic or competitive effectiveness, because a comprehensive system design is favourable, where specialized material management competencies drive optimization, rather than general municipal service provision.

Competitive-operational systems, exemplified by Germany, demonstrate how the combination of competition among ten PROs with full operational responsibility and material ownership creates the highest performance outcomes. German PROs assume direct control over collection logistics, sorting specifications, and recyclate marketing, enabling end-to-end optimisation and quality control. This structure creates continuous innovation

pressure while ensuring accountability for operational results, producing both high recycling rates and cost efficiency through professional material management rather than fragmented municipal approaches.

Monopolistic-operational systems, represented by Belgium, demonstrate that operational responsibility can drive strong performance even without competitive pressure when combined with professional material expertise. Belgium achieves 97.8% glass recycling - Europe's highest rate - through comprehensive system coverage and operational accountability. This success occurs through specialized waste management competencies rather than reliance on municipal generalist approaches, suggesting that operational professionalization can partially substitute for market pressure under appropriate governance conditions.

Financial-municipal systems, exemplified by France, show the limitations when PROs primarily transfer funds to municipalities for collection and sorting, lacking direct control over operational performance. Despite operating sophisticated regulatory frameworks, France achieves only 27% plastic recycling because municipal service providers, while competent in local service delivery, lack the specialized material management expertise and optimization incentives necessary for advanced recycling operations. This separation between financial responsibility and operational control creates accountability gaps that undermine system performance regardless of regulatory sophistication.

Material ownership proves to be a critical but underappreciated performance driver that enables PROs to capture value improvements and reinvest them in system enhancement while ensuring professional supply chain development for high-quality recyclate. Germany's comprehensive PRO material ownership model allows all ten competing PROs to maintain complete ownership of collected recyclables, creating direct financial stakes in recycling outcomes and enabling professional management of secondary material markets. This ownership structure enables PROs to capture recyclate revenues and reinvest them into system improvements, creating self-reinforcing performance enhancement cycles that benefit both environmental and economic outcomes. Additionally, PRO material ownership ensures professional development of consistent, high-quality secondary material supplies, which are essential for meeting ambitious recycled content requirements. The absence of material ownership constrains performance potential by preventing PROs from capturing value improvements and limiting their ability to influence recycling quality. When municipalities independently organize collection and recycling operations across thousands of jurisdictions, this prevents the economies of scale, professional material expertise, and quality control necessary for optimal plastic recycling performance and reliable secondary material supply chains.

Innovation capacity varies significantly with system structure and competitive dynamics, with market-driven advancement generally outperforming regulatory mandates in driving technological progress. Germany's competitive system drives market-based innovation where 10 competing PROs continuously invest in sorting technologies to gain market advantages, with PROs offering superior technology translating this directly into lower fees and market success. This creates a race-to-the-top dynamic where technological advancement directly translates into market advantages. These optimization approaches consistently exceed regulatory minimums.

Monopolistic systems can achieve innovation through regulatory pressure rather than market dynamics, but this requires sophisticated governance frameworks and active oversight, often resulting in meeting minimum requirements rather than exceeding them. At the same time, competitive systems also need a strong legal basis and incentives, e.g., ambitious recycling targets, which stimulate competition. Central government oversight that creates a level playing field for potential competition is just as important as a transparent producer register, robust government control, and fines for non-participation, that deal with the free-rider problem.

Full cost coverage emerges as an essential enabling condition regardless of system structure, as it creates proper accountability relationships between decision-making authority and financial responsibility. German and Belgium PROs[16] bear all operational and administrative expenses, while France requires 18% municipal co-financing and Italy requires 20% municipal contributions. A full internalization creates proper accountability structures where PROs have direct financial motivation for system optimization and continuous improvement. Partial cost coverage models may weaken performance incentives by socializing costs, reducing the direct relationship between PRO decisions and financial outcomes. When municipalities bear portions of system costs without corresponding professional material management capabilities, this creates moral hazard situations that

[16] apart from the necessary purchase of garbage bags in Belgium, which provides a small counter-financing by consumers

limit optimization incentives and fragment responsibility for performance outcomes. Full cost coverage ensures that organizations with operational authority also bear complete financial responsibility for their decisions, aligning incentives for both environmental performance and economic efficiency.

5.2 Policy Recommendations

The PPWR entered into force on 11 February 2025 and its general date of application is 18 months after that, Oktober 2026 (European Commission, 2025b). Member States prepare to implement, and policymakers face critical decisions about how to guide national EPR system design. The comparative analysis of nine European EPR systems reveals significant performance variations that cannot be explained by economic development alone, with Germany achieving 76.1% plastic recycling rate while France manages only 35.9% despite both representing wealthy economies with sophisticated regulatory frameworks.

The evidence demonstrates that neither competitive nor monopolistic structures alone determine EPR success. Germany's competitive system with ten competing PROs achieves a very good performance through competition, full operational responsibility and material ownership, while Belgium's monopolistic system also delivers strong results through comprehensive operational control. Conversely, France's quasi-monopolistic system struggles with fragmented municipal implementation despite sophisticated regulatory frameworks. Austria operates within a competitive system as well, but with poor performance in terms of cost efficiency and plastic recycling rates. Despite being a competitive system, competition is still in its beginning, and the corresponding effects are not yet taking effect there. (Rechnungshof Österreich, 2022a)

An important factor for success is the operational control of PRO across the entire value chain. When PROs assume direct control over collection logistics, sorting specifications, and recyclate marketing, they enable end-to-end optimization. Belgium achieves high recycling rates in glass and PPC through similar operational accountability within a single-PRO structure. France's model, however, primarily transfers funds to thousands of municipalities for collection and sorting, creating accountability gaps that undermine performance regardless of regulatory sophistication.

The comparative analysis reveals four critical design elements that drive EPR performance regardless of market structure:

Figure 6: Four Critical Design Elements

Member States should prioritize operational models that ensure PROs maintain direct control over collection, sorting, and recycling operations rather than merely financing municipal services. Both competitive and monopolistic structures can succeed when designed around these core principles, with the choice depending on national circumstances and institutional capabilities. The EU should develop implementation guidance that emphasizes performance outcomes rather than prescriptive structural requirements. Harmonised criteria should focus on operational effectiveness, full cost internalization, and material ownership rights while allowing

Member States flexibility in choosing competitive or monopolistic approaches based on national circumstances. EU policy should safeguard a level playing field rather than imposing one-size-fits-all solutions. Monopolistic systems may be suitable for introduction due to their simplicity and can later be opened up to competition in order to strengthen the positive effects of competition, such as cost reduction and innovation. A successful example for this approach can be found in the German case.

6 Annexes

6.1 Annex 1, Average licensing price of 10 typical household packaging items

This overview presents 2024 licence prices converted to a per ton basis. For all countries except Germany, the prices are sourced from the RECYDA database. For Germany, the figures are weighted averages for household packaging waste streams (plastics, glass, and paper/cardboard), calculated using PRO market shares and based on prices communicated directly by German PROs. (Gemeinsame Stelle dualer Systeme Deutschlands GmbH, 2025).

No.	Typical Packaging Type	g/ml	Austria EUR/ton	Belgium EUR/t	France EUR/t	Germany EUR/t	Italy EUR/t	Netherlands EUR/t	Poland EUR/t	Spain EUR/t	Czech Republic EUR/t
1	Snack pouch (PP)	150	**959,18**	**1836,73**	**836,7**	**736,53**	**81,63**	**1081,63**	**469,39**	**1142,86**	**612,24**
2	Frozen food bag, (PE)	1000	**955,06**	**1376,40**	**842,7**		**589,89**	**1039,33**	**646,07**	**1067,42**	**617,98**
3	Yoghurt pot large (PP & alu)	500	**809,34**	**638,13**	**482,5**		**412,45**	**871,60**	**622,57**	**809,34**	**607,00**
4	Yoghurt pot small (PP & alu)	200	**795,03**	**795,03**	**608,7**		**397,52**	**397,52**	**608,70**	**782,61**	**596,27**
5	Sliced Meat Package (plastic)	100	**203,49**	**3008,72**	**1031,98**		**654,07**	**1206,40**	**566,86**	**741,28**	**770,35**
6	Dry Food Pouch (plastic)	500	**939,76**	**1855,42**	**939,76**		**650,60**	**1036,14**	**650,60**	**1180,72**	**939,76**
7	Milk carton (cardboard and plastic)	1000	**100,0**	**620,00**	**340,00**	**740,61**	**136,67**	**840,00**	**463,33**	**583,33**	**363,33**
8	Jam jar (glass, steel)	425	**106,94**	**68,98**	**25,00**	**36,20**	**15,28**	**105,09**	**93,98**	**56,48**	**75,46**
9	Wine Bottle	750	**104,17**	**68,26**	**17,22**		**14,91**	**101,65**	**92,83**	**42,00**	**76,03**
10	Cardboard box for dry rice	500	**175,00**	**118,75**	**268,75**	**152,21**	**43,75**	**18,75**	**218,75**	**137,50**	**206,25**

Table 24: Licensing costs in selected countries for typical packaging items.

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