

Research & Innovation projects supporting the Circular Economy Act

Focus Area: Extended producer responsibility



Independent Expert Report

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Focus area: extended producer responsibility

European Commission
Directorate-General for Research and Innovation
Directorate B — Healthy Planet
Unit B.1 — Green Transitions
Contact Martin POLICAR
Email Martin.Policar@ec.europa.eu
rtd-ce-team@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

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Axel Darut, Circular economy policy consultant - Circulearth

Contents

Executive Summary	4
1. Scope and policy relevance	7
1.1. Role of the 5 intervention areas	7
1.2. Link to CEA objectives and related EU legislation.....	8
2. Methodology and analytical framework on EPR project portfolio	9
2.1. Analytical logic	9
2.2. Sources and evidence.....	10
2.3. Project portfolio attribution and assessment method	10
3. R&I Project Portfolio scope and overview	11
3.1. Portfolio overview	11
3.2. Portfolio characterisation	13
3.3. Key challenges addressed.....	15
4. Outcomes and impacts across the portfolio	16
4.1. Tangible results and knowledge generated.....	16
4.2. Impact assessment	20
5. Success and failure analysis	21
5.1. Enabling factors	21
5.2. Hindering factors.....	24
5.3. Common features of successful solutions.....	26
6. Upscaling, replication and transferability.....	27
6.1. Replication potential across Member States, sectors, and value chains.....	28
6.2. Limits and risks	28
6.3. Estimated impacts of EU-wide deployment.....	29

7.	Regulatory insights for the Circular Economy Act	30
7.1.	Regulatory gaps identified.....	30
7.2.	Legislative and administrative burdens.....	31
8.	Policy recommendations.....	32
8.1.	Prioritisation logic.....	32
8.2.	Prioritised recommendations	33
9.	Conclusions	50
10.	Bibliography	51
10.1.	European union legislation and official notices.....	51
10.2.	Institutional reports, policy briefs and press	51
11.	Annexes	52
11.1.	Projects portfolio.....	52

Executive Summary

This report delivers a comprehensive analysis of twenty-seven high-impact Horizon Europe and Horizon 2020 projects, curated specifically to inform the regulatory architecture of the forthcoming Circular Economy Act. While the evaluated portfolio touches upon several European intervention areas—including circular public procurement, critical raw material recovery, and trans-national industrial symbiosis—the central focus of this document is the structural and strategic refinement of Extended Producer Responsibility schemes. The findings demonstrate that achieving the ambitious targets of the new legislative framework demands an urgent transition of Extended Producer Responsibility from a conventional waste-funding mechanism into a dynamic, data-driven instrument for macroeconomic steering and European industrial strategy.

Throughout the analysis, empirical evidence corroborated by key industry stakeholders reveals that the European circular transition is currently stifled by a severe fragmentation tax. The report details how this structural barrier is driven by disparate national producer registers, fundamentally inaccurate eco-modulation criteria, and legally siloed material flows, all of which heavily penalise cross-border circular business models.

To resolve these critical bottlenecks and unlock a genuine Single Market for secondary raw materials, the report outlines a prioritised set of policy recommendations. Chief among these is the mandate for a unified digital compliance architecture. The analysis advocates for implementing an EU-wide single registration portal to eliminate administrative redundancy for small and medium-sized enterprises, alongside formally establishing statutory compliance liability for digital marketplaces. Furthermore, the findings establish the Digital Product Passport as the indispensable verification engine for interoperable data exchange, forming the absolute prerequisite for enabling high-precision, molecular-level eco-modulation that genuinely rewards durability and non-toxicity.

Finally, the analysis examines the necessary evolution of collective governance and fiscal alignment. It details how producer fees must be synergised with broader macroeconomic instruments, combining financial penalties on linear products with targeted Value Added Tax reductions to create a decisive market pull for sustainable goods. The analysis also charts a pathway to democratise the governance of Producer Responsibility Organisations through mandated multi-stakeholder boards and ring-fenced infrastructure investments for local repair and social economy sectors. By deploying the harmonised frameworks detailed in the subsequent sections, European policymakers can secure domestic strategic autonomy, drive highly resilient job creation, and deliver massive decarbonisation dividends across the continent.

Glossary

CAPEX: Capital Expenditure
CCH: Circular Construction Hubs
CEA: Circular Economy Act
CMUR: Circular Material Use Rate
CPP: Circular Public Procurement
CRMs: Critical Raw Materials
DPP: Digital Product Passport
DRS: Deposit Return System
DSA: Digital Services Act
ELV: End-of-Life Vehicles
EoW: End-of-Waste
EPR: Extended Producer Responsibility
ESPR: Ecodesign for Sustainable Products Regulation
EV: Electric Vehicle
IMI: Internal Market Information System
OPEX: Operating Expenditure
PPWR: Packaging and Packaging Waste Regulation
PRO: Producer Responsibility Organisation
R&I: Research and Innovation
RvM: Reverse Vending Machine
SMEs: Small and Medium-Sized Enterprises
SRM: Secondary Raw Materials
SSbD: Safe and Sustainable by Design
SUPD: Single Use Plastic Directive
TRL: Technology Readiness Level
UWWTD: Urban Waste Water Treatment Directive
WFD: Waste Framework Directive
WSR: Waste Shipment Regulation
WEEE: Waste Electrical and Electronic Equipment

Definitions

By-product: the fundamental legal classification required to enable industrial symbiosis. It designates a substance or object resulting from a production process whose primary aim is not the production of that item. It can legally bypass waste classification entirely if its further use is certain, it can be used directly without further processing other than normal industrial practice, and its subsequent use is lawful and environmentally safe¹.

Critical Raw Materials (CRMs): raw materials of high economic importance for the European Union that carry a high risk of supply disruption. These materials are legally classified as crucial for the green and digital transitions, aerospace, and defence².

Digital Product Passport (DPP): a set of data specific to a product that includes information verifying its environmental sustainability and circularity, accessible via electronic means through a unique data carrier. It acts as the legal data backbone for tracking material provenance throughout the product's life cycle³.

Eco-modulation: financial contributions paid by producers to comply with EPR obligations are modulated for individual products or groups of similar products. This modulation must take into account their durability, reparability, reusability, recyclability, and the presence of hazardous substances⁴.

End-of-Waste (EoW) status: the legal criteria under which a specific material ceases to be legally classified as waste after having undergone a recycling or other recovery operation. To achieve this status, the substance or object must be destined for specific purposes, possess an existing market or demand, fulfil precise technical requirements, and prove it will not lead to adverse environmental or human health impacts⁵.

Extended Producer Responsibility (EPR): a set of measures taken by Member States to ensure that producers of products bear financial or financial and organisational responsibility for the management of the waste stage of a product's life cycle, including separate collection, sorting, and treatment operations⁶.

Producer Responsibility Organisation (PRO): a collective entity or legal person established by producers to implement Extended Producer Responsibility obligations on their behalf. These organisations are tasked with managing the financial contributions paid by producers and orchestrating the operational aspects of waste collection, sorting, and treatment to meet national and European recycling targets⁷.

Safe and Sustainable by Design (SSbD): an established European assessment framework for the design, development, and use of chemicals and materials. It requires providing a function while preventing or minimising harmful impacts to human health and the environment from the earliest design stages, acting as a technical precursor to circularity⁸.

Waste: any substance or object which the holder discards or intends or is required to discard⁹.

¹ Article 5 of Directive 2008/98/EC - Waste Framework Directive.

² Article 2(2) and Annex II of Regulation (EU) 2024/1252 - Critical Raw Materials Act.

³ Article 2(28) and Chapter III of Regulation (EU) 2024/1781 - Ecodesign for Sustainable Products Regulation - ESPR.

⁴ Article 8a(4)(b) of Directive 2008/98/EC - Waste Framework Directive.

⁵ Article 6 of Directive 2008/98/EC - Waste Framework Directive.

⁶ Article 8 and Article 8a of Directive 2008/98/EC - Waste Framework Directive.

⁷ Article 8a(3) of Directive 2008/98/EC - Waste Framework Directive.

⁸ Commission Recommendation (EU) 2022/2510 establishing a European assessment framework for 'safe and sustainable by design' chemicals and materials.

⁹ Article 3(1) of Directive 2008/98/EC - Waste Framework Directive.

1. Scope and policy relevance

This report provides a synoptic analysis of selected key projects from various Horizon Europe and Horizon 2020 calls across several economic sectors, all of which address shared circular concepts or challenges. The primary objective of this evaluation is to identify common features of successful circular solutions that merit integration or support within the framework of the Circular Economy Act (CEA). By pinpointing these successful models, the report assists the Commission in fostering the ideal conditions for secondary resource markets and increasing the uptake of secondary raw materials across the Union.

The analysis is structured around five specific intervention areas directly linked to the objectives of the Circular Economy Act, namely public procurement, the recycling of the Waste Electrical and Electronic Equipment (WEEE) with a focus on critical raw materials, the uptake of recycled and bio-based content, trans-national or regional initiatives, and the refinement of extended producer responsibility schemes. Each of these themes has been analysed by a dedicated domain expert to ensure a comprehensive technical assessment. To ensure the findings are suitable for a formal Commission legislative impact assessment, every proposed solution is measured against its specific environmental, economic, and social impacts.

The evidence presented in this report is derived from a detailed review of project deliverables provided by DG Research and Innovation (DG RTD), supplemented by the experts' own professional insights. Where internal data has been augmented, the report provides valid references to published scientific literature and external research to maintain a robust evidence base. Ultimately, this synthesis serves as a foundation for evidence-based policymaking, ensuring that future legislative measures are informed by proven innovations in circularity.

1.1. Role of the 5 intervention areas

To bridge the gap between technical feasibility and market reality, the Circular Economy Act must activate specific regulatory levers. The five intervention areas analysed in the complete report represent the core pillars required to build a functioning, resilient market for secondary raw materials (SRMs) and bio-based alternatives:

- **Refinement of Extended Producer Responsibility (EPR):** EPR is the financial and operational engine of the circular transition. By moving beyond traditional waste-collection fees towards dynamic, data-driven eco-modulation, EPR internalises the environmental costs of products. This corrects a fundamental market failure—the "virginity trap," where virgin fossil materials remain artificially cheaper than secondary feedstock—and provides the necessary price signal to drive eco-design at the source.
- **Circular Public Procurement (CPP):** while EPR pushes supply, public procurement creates the required demand-side "pull." Leveraging the immense purchasing power of European public authorities (accounting for approximately 14% of EU GDP¹⁰), mandatory circular procurement criteria¹¹ can provide the "base load" demand needed to de-risk high-capital expenditure (CAPEX) investments in advanced recycling and bio-based manufacturing infrastructure.
- **WEEE and Critical Raw Materials (CRM) recovery:** the electrification of the European economy hinges on secure access to critical metals. Focusing on WEEE ensures that high-tech "urban mines" are properly exploited. By recovering magnet-grade and battery-grade materials, this intervention area directly supports European

¹⁰ European Parliament. *Public procurement*. European Parliamentary Research Service (EPRS). PE 775.896. September 2025.

¹¹ The Circular City Centre – C3. "Circular Public Procurement in Cities." ACR+. October 14, 2025.

strategic autonomy, preventing valuable resources from leaking out of the Single Market through substandard processing or illegal export.

- **Uptake of recycled and bio-based content:** establishing horizontal, mandatory recycled content thresholds—combined with clear, EU-wide End-of-Waste (EoW) criteria—is vital for decoupling industrial growth from fossil extraction. This area guarantees off-take certainty for recyclers and incentivises the substitution of hazardous legacy substances with Safe-and-Sustainable-by-Design (SSbD) bio-based alternatives.
- **Trans-national and regional Initiatives - industrial symbiosis:** the circular economy operates at the territorial level. Fostering trans-national and regional hubs ensures that by-products from one industry can become feedstock for another without being derailed by fragmented, cross-border waste shipment regulations. This area operationalises material loops by harmonising local governance and creating connected "circular valleys".

1.2. Link to CEA objectives and related EU legislation

The CEA represents a pivotal shift in European industrial policy, moving from fragmented waste management to a cohesive Single Market for Secondary Raw Materials. As a central pillar of the Clean Industrial Deal, the Act's primary objective is doubling the Union's circular material use rate (CMUR) from approximately 12% to 24% by 2030¹². This ambitious target requires a fundamental reconfiguration of the relationship between producers and the end-of-life stage of their products.

Within this framework, EPR is no longer merely a financial levy for waste collection, but a sophisticated steering mechanism designed to incentivise eco-design and ensure resource security. The 27 projects analysed herein serve as the technical and operational vanguard for this transition, providing the empirical evidence necessary to transform the EPR from a waste management tool to a resource efficiency instrument.

Therefore, this analysis ensures a complementary approach across the following legislative pillars and policy targets related to circular economy:

- **Single market for secondary raw materials:** harmonising "end-of-waste" criteria and digitalising waste shipments to ensure high-quality recyclate move across borders without the current administrative friction that hampers Small and Medium Enterprises (SME) competitiveness.
- **Strategic Autonomy and CRM recovery:** supporting the Critical Raw Materials Act (CRMA)¹³ benchmarks (10% extraction, 40% processing, and 25% recycling by 2030). Projects like TREASURE and ZEvRA demonstrate how EPR can fund the specialised recovery of rare earths from complex waste streams.
- **EPR modernisation and digitalisation:** transitioning from national silos to an EU single approach on the way to declare to Producers Responsibility Organisations (PROs) and with potentially a one-stop shop approach. This aligns with the ESPR (Ecodesign for Sustainable Products Regulation) mandate for the Digital Product Passport (DPP), which acts as the data backbone for cross-border compliance.
- **Legislative synergy:** ensuring a unified approach across the WEEE directive revision¹⁴, the Battery regulation¹⁵, and the revision of the ELV (End-of-Life Vehicles)

¹² European Commission, "A new Circular Economy Action Plan: For a cleaner and more competitive Europe" (COM/2020/98 final), 2020.

¹³ Regulation (EU) 2024/1252 - Critical Raw Materials Act.

¹⁴ Directive 2012/19/EU (WEEE Directive).

¹⁵ Regulation (EU) 2023/1542 (Batteries Regulation).

directive¹⁶. These regulations now require producers to provide granular data on material durability and recycled content to satisfy new market entry thresholds.

- **Eco-modulated and financial Incentives:** standardising the "modulated fee" logic. The Packaging and Packaging Waste Regulation (PPWR)¹⁷ and the revised Waste Framework Directive (WFD)¹⁸ will require fees to be adjusted based on real-world performance.

2. Methodology and analytical framework on EPR project portfolio

The CEA must be grounded in scalable market realities. Upgrading EPR from a conventional waste management mechanism into a strategic driver of the European economy requires translating cutting-edge Research and Innovation (R&I) directly into actionable EU policy.

Therefore, this section details our assessment framework. We applied a strict policy-readiness lens to filter the Horizon 2020 and Horizon Europe portfolios. By triangulating project data, stakeholder input, and market dynamics, we isolated solutions based on three core criteria: systemic impact, technological maturity, and regulatory viability.

The objective of this methodology is straightforward: to advance only proven, high-impact circular models as concrete legislative recommendations for the CEA.

2.1. Analytical logic

The methodology deployed has been qualitative and quantitative: initial requirements for the portfolio analysis, RTD instruction, CEA public consultation inputs, broader portfolio analysis and purposive sample selection according areas, expert evaluation (CORDIS, websites, SYGMA), expert alignment, consultations, analysis matrix, analysis and document structure, expert contemplation, first draft, consultation, inputs from other Directorates and working group consultations, group alignment, final version.

The analytical logic deployed in this report is fundamentally outcome-driven and impact-assessment oriented. Rather than simply cataloguing technological achievements, the methodology is designed to perform a synoptic analysis of Research and Innovation (R&I) projects to identify scalable, transferable circular solutions that can directly inform the regulatory mechanisms of the forthcoming CEA.

The approach combines both qualitative and quantitative assessments to evaluate the environmental, economic, and social effects of each solution. The workflow followed a rigorous, multi-stage policy formulation process:

- **Scoping and alignment:** initial requirements gathering through DG RTD instructions, paired with an analysis of the CEA public consultation inputs to align technical research with current political and market demands.
- **Purposive sampling:** a broader portfolio analysis followed by a purposive sample selection tailored to the specific intervention area.

¹⁶ Directive 2000/53/EC (End-of-Life Vehicles Directive).

¹⁷ Regulation (EU) 2025/40 (PPWR).

¹⁸ Directive 2008/98/EC (Waste Framework Directive).

- **Expert evaluation and synthesis:** deep-dive expert evaluations using established databases (CORDIS, SYGMA), followed by cross-expert alignment consultations to identify systemic friction points (e.g., regulatory bottlenecks, market failures).
- **Iterative drafting:** structuring the analysis matrix, drafting expert contemplations, and refining the findings through iterative consultations with DG RTD to ensure final group alignment and policy coherence.

Ultimately, the logic is engineered to answer a single overarching question: which R&I solutions possess the maturity, impact potential, and systemic relevance to justify integration into binding EU measures on EPR?

2.2. Sources and evidence

To ensure the highest standard of evidence-based policymaking, the analysis draws upon a triangulated set of primary and secondary data sources. The evidence base relies strictly on validated, peer-reviewed, or officially reported outputs:

- **Primary project data:** the core evidence is extracted from official project deliverables, periodic reports, and milestone achievements accessed via the European Commission's SYGMA portal and CORDIS database, supplemented by data from official project websites.
- **Stakeholder consultation data:** to bridge the gap between technical feasibility and market acceptance, the analysis integrates feedback from the official European Commission Public Consultation on the CEA. This ensures that R&I findings are cross-referenced with the real-world demands of industry stakeholders, PROs, and civil society.
- **Scientific and economic literature:** where project data required broader contextualisation—particularly regarding macroeconomic impacts, material flow analyses, or fiscal modelling - the report references published scientific literature, techno-economic assessments, and independent policy briefs.

2.3. Project portfolio attribution and assessment method

The initial project portfolio was attributed by DG RTD, providing a baseline of Horizon 2020 and Horizon Europe initiatives targeting circularity and resource efficiency. However, to ensure strict relevance to the EPR, the portfolio underwent a rigorous expert validation and filtering process.

Relevance validation: projects were rigorously assessed for their direct applicability to EPR modernisation and their potential to inform the forthcoming Circular Economy Act on this topic. Initiatives were retained in the portfolio only if they provided actionable evidence or technological solutions addressing systemic EPR levers, specifically on:

- **Digital compliance and data traceability:** solutions moving beyond manual reporting by deploying the DPP to potentially automate product and material-level declarations, resolve data asymmetry, and ensure transparent tracking of materials throughout their lifecycle.
- **Technologies enabling advanced sorting and recovery:** innovations that automate the identification, dismantling, and processing of complex waste streams to yield high-purity secondary raw materials, thereby directly improving the technical and economic efficiency of the end-of-life stage with the potential support of PROs.
- **Eco-modulation:** innovations and approaches that support the verified, material-level data necessary to shift fee structures away from blunt, weight-based proxies toward precision metrics that financially reward durability, repairability, and the absence of hazardous substances.

- **Administrative harmonisation:** initiatives addressing the "fragmentation tax" imposed on companies by disparate national registers. Projects were selected if they validated frameworks for an EU-wide "one-stop shop" approach to streamline producer registration and harmonise compliance across the Single Market.
- **Market creation:** initiatives that addressed the need for harmonised EoW criteria and mandatory recycled content targets to stabilise off-take demand in secondary markets with the strategic and financial support of EPR schemes.
- **Industrial symbiosis and cross-sectoral flows:** frameworks demonstrating how EPR schemes can evolve into inter-PRO platforms to manage waste-to-resource exchanges, overcoming sector-specific silos to ensure high-value materials can be transferred and certified across different industries.
- **Inclusive governance:** projects and analysis redefining PROs governance to ensure funds are strategically reinvested into the higher tiers of the waste hierarchy, advocating for the inclusion of municipalities and social economy actors in strategic decision-making.
- **Value-retention signals:** frameworks that synergise EPR mechanisms with broader economic instruments, such as VAT reductions or ring-fenced infrastructure budgets.

Evaluation criteria and method: the retained projects were evaluated using a multidimensional assessment matrix designed to test regulatory readiness:

- **Technological and commercial maturity** (TRL mapping): assessing the progression of solutions from laboratory validation (TRL 4-5) to industrial-scale demonstration (TRL 7-8), determining if a technology is mature enough to be mandated or incentivised by EU law.
- **Systemic impact:** evaluating the solution's ability to alter market dynamics, including its impact on capital expenditure (CAPEX) vs. operating expenditure (OPEX) for recyclers, its capacity for local job creation, and its effectiveness in mitigating carbon and toxicity.
- **Regulatory gap identification:** analysing the specific legislative or administrative barriers that currently prevent the project's solution from scaling organically across the Single Market.

This structured assessment guarantees that the policy recommendations derived from the portfolio are not just technologically sound, but economically viable and legally actionable under the Circular Economy Act.

3. R&I Project Portfolio scope and overview

3.1. Portfolio overview

This portfolio comprises 27 distinct yet interlinked initiatives that address the lifecycle of materials from molecular design to territorial governance. While foundational projects such as FISSAC and CABRISS established the initial logic for industrial symbiosis and raw material recovery, the more recent "Horizon Europe" generation - including TRUSTEX, CIRCULATEX, and RENÉE - focuses on the digital and regulatory "connective tissue" needed to scale these solutions across the Single Market.

The scope of the portfolio could be delineated by three thematic clusters that represent the core pillars of the EU's industrial strategy:

Manufacturing and remanufacturing: the value retention cluster

This cluster focuses on high-value asset retention through the most advanced levels of the circular hierarchy. Projects like RENÉE, RESTORE, COMPASS, and ZEvRA utilize artificial intelligence and advanced robotics to transform used products into "as-new" assets. ZEvRA, in particular, provides the blueprint for a circular electric vehicle (EV) sector, ensuring that the transition to zero-emission mobility is resource-secure. These initiatives span household appliances, aerospace, and automotive sectors, while R-EVOLVE extends this logic to the furniture industry, integrating bio-based materials with circular « furniture-as-a-Service » business models.

Material valorisation and advanced recycling: the secondary feedstock cluster

Addressing the technical boundaries of material recovery, this cluster turns complex waste into strategic resources. PLASTICE and REPurpose target multilayer plastic and textile wastes that were previously deemed unrecyclable, using enzymatic and chemical technologies. CISUTAC complements this by establishing large-scale pilot lines for high-purity fibre-to-fibre recycling. In the CRM domain, RHINOCEROS, NEO-CYCLE, and TREASURE focus on the recovery of cobalt, lithium, and rare earths from car electronics and batteries. Finally, REDONDO and SURPASS innovate at the design stage, developing reversible polymers and Safe-and-Sustainable-by-Design (SSbD) frameworks to prevent waste before it is created.

Infrastructure, governance, and consumer loops: the systemic enablers cluster

These projects address the « last mile » of circularity by reforming market governance and consumer habits. CIRCOFIN and RECREATE transform the construction sector through the development of material banks and circular investment hubs. BUDDIE-PACK and R3PACK tackle the logistical and behavioural barriers to large-scale reusable packaging. Crucially, this cluster provides the policy backbone: LIFE4EPR and CIRCULATEX aim to develop the harmonised EPR frameworks requested by the Commission. To ensure a just transition, JUST2CE embeds social equity into circular governance, while CIRPASS, CircThread, and TRUSTEX deploy the DPP infrastructure required to track material provenance and value throughout multiple lives.

Table 1 – clusters of the portfolio

Project name	Grant agreement ID	Primary sector / Material focus
STRATEGIC CLUSTER: VALUE RETENTION		
RENÉE	101138415	Electronics and home appliances
RESTORE	101138775	Manufacturing and heavy industry
COMPASS	101136940	Aerospace and automotive
R-EVOLVE	101182221	Furniture and bio-based materials
ZEvRA	101138034	Automotive and electric vehicles
FISSAC	642154	Construction and industrial symbiosis
CABRISS	641972	Photovoltaics and critical raw materials
STRATEGIC CLUSTER: SECONDARY FEEDSTOCK		
REDONDO	101058449	Reversible polymers and polyethylene
SURPASS	101057901	Safe by design plastics and polymers

REPurpose	101057971	Bio-based polymers and plastic waste
PLASTICE	101058540	Plastics and chemical recycling
RHINOCEROS	101069685	Battery recycling and raw materials
TREASURE	101003587	Automotive electronics and mineral recovery
NEO-CYCLE	101138058	Rare earth magnets and upcycling
NOUVEAU	101058784	Solid oxide cells and electrode materials
CUMERI	101091812	Industrial membranes and hydrogen recovery
CISUTAC	101060375	Circularity of textiles and clothing
STRATEGIC CLUSTER: SYSTEMIC ENABLERS		
CIRCOFIN	101180525	Construction and circular finance
RECREATE	101058756	Composite materials and infrastructure
BUDDIE-PACK	101059923	Packaging and logistics
R3PACK	101060806	Food packaging and fibre-based Materials
CIRPASS	101083432	DPP and standards
CircThread	101003742	Electronics and data management
TRUSTEX	101181604	Textiles and EPR harmonisation
CIRCULATEX	101181704	Textiles and EPR governance
LIFE4EPR	101215882	Policy and regulatory harmonisation
JUST2CE	101003491	Social governance and inclusion

3.2. Portfolio characterisation

The structural composition of this portfolio is designed to map industrial maturity and sectoral coverage against the European Union's circularity mandates. The Technology Readiness Level (TRL) spectrum allows us to understand technical maturity throughout a technology's development cycle, providing a coherent, cross-sectoral reference point. To move from observation to actionable policy, the projects have been categorised by taking into account the TRL at the starting point of the project, and the TRL at the end of the project.

- **TRL 1-3 (research and concept):** identification of molecular principles (e.g., reversible chemistry) and SSbD frameworks.
- **TRL 4-5 (validation):** testing and validation of technologies in laboratory or simulated relevant environments.
- **TRL 6-7 (demonstration):** prototyping and industrial-scale demonstration to prove feasibility in operational environments.
- **TRL 8-9 (implementation):** final qualification of actual systems in real-world environments, ready for market placement.

Table 2 – TRL analysis of the portfolio

Project name	Start TRL	End TRL	Key maturity objective
STRATEGIC CLUSTER: VALUE RETENTION			
COMPASS	4	7	<i>Transition from lab proof to industrial demonstration.</i>
RENEE	4	7	<i>Scaling robotic proof of concept to industrial demonstrators.</i>
RESTORE	5	7/8	<i>Lab-validated processes to industrial pilot production.</i>
ZEvRA	5	7/8	<i>Integrated circular car demonstrator development.</i>
FISSAC	4/5	7/8	<i>Validated components to real-scale infrastructure demos.</i>
R-EVOLVE	4/5	8	<i>Lab concepts to large-scale industrial implementation.</i>
CABRISS	5	7/8	<i>Pilot validation to industrial recycled module demos.</i>
STRATEGIC CLUSTER: SECONDARY FEEDSTOCK			
REDONDO	3	5	<i>Proof of concept to industrial pilot validation.</i>
SURPASS	3	5	<i>Proof of concept to industrial pilot validation.</i>
REPurpose	3	5	<i>Proof of concept to industrial pilot validation.</i>
PLASTICE	5	7	<i>Experimental pilot to industrial demonstration.</i>
RHINOCEROS	3/4	6	<i>Research environment to industrially relevant scale.</i>
TREASURE	4	7	<i>Lab validation to industrial operational demonstration.</i>
NEO-CYCLE	3	5	<i>Experimental proof to validated relevant environment.</i>
NOUVEAU	4	7	<i>Laboratory validation to system prototype demo.</i>
CUMERI	3	5	<i>Experimental proof to validated relevant environment.</i>
CISUTAC	3/4	8	<i>Recycling prototypes to industrial scale demonstrators.</i>
STRATEGIC CLUSTER: SYSTEMIC ENABLERS			
RECREATE	3	5	<i>Experimental proof to validated relevant environment.</i>
TRUSTEX	4/5	8	<i>Policy and technical lab validation to system demo.</i>
Circula-TEX	4/5	8	<i>Policy and technical lab validation to system demo.</i>
CircThread	4	7/8	<i>Lab components to operational cloud platform pilots.</i>
BUDDIE-PACK	5	8	<i>Design rules and lab cleaning to large-scale pilots.</i>
CIRCOFIN	5	7/8	<i>Validated concepts to investment-ready showcases.</i>
R3PACK	4/5	7	<i>Prototyping to in-store commercial demonstration.</i>
JUST2CE	-	-	<i>Scaling social innovation to operational policy.</i>
LIFE4EPR	-	-	<i>Scaling trials to EU-level interoperability.</i>

3.3. Key challenges addressed

The analysis of these projects showcases the current challenges stakeholders are facing on the implementation of the European circular economy. Indeed, several systemic « friction points» persist, spanning market failures, regulatory fragmentation, and technical barriers. Addressing these challenges is fundamental to ensuring that circularity becomes an industrially and economically viable reality with a support and push from the EPR schemes:

Market failures and economic barriers

- **The « virgin advantage »:** a fundamental market failure is that virgin materials often remain artificially cheaper than secondary feedstock when oil and raw material prices are low¹⁹. This leads brand owners to switch back to linear models even after investing in circular infrastructure.
- **High initial CAPEX:** Circular solutions, particularly in chemical recycling and automated disassembly, require high upfront capital investments that SMEs and smaller municipalities often struggle to secure.²⁰
- **Insufficient cost coverage in EPR:** the fees often cover only a small fraction of a product's end-of-life costs, failing to provide a strong enough « price signal» to influence eco-design.²¹

Regulatory fragmentation

- **Inconsistent definitions:** depending on the sectors, there is a significant lack of harmonised definitions for terms like « recyclability », « reuse », and « prevention » across Member States. For instance, on the textile value chain; what is considered « textile waste » in one country might be classified as « second-hand goods » in another, complicating cross-border trade and compliance.²²
- **Complex EoW criteria:** the absence of clear, EU-wide criteria for when a waste material ceases to be waste and becomes a secondary product creates legal uncertainty, hindering the market for materials like recycled plastics or silicon.^{23,24}
- **Fragmented reporting:** producers operating across multiple markets face an unmanageable administrative burden due to 27 different national EPR reporting systems and registers.²⁵

Technical and operational Barriers

- **Complex multi-material waste:** a critical barrier is the rise of multi-material and multilayered products (e.g., in packaging and vehicle structural parts) that are difficult to separate mechanically.²⁶

¹⁹ PLASTICE (D1.1 Regulatory Analysis, p. 22)

²⁰ TRUSTEX (D4.1, p. 148)

²¹ LIFE4EPR (Objectives, p. 1).

²² CABRISS (Business Plan, p. 15)

²³ PLASTICE (D1.1 Regulatory Analysis, p. 22)

²⁴ Orveillon, G., Pierri, E., Egle, L., Gerbendahl, A., Wessman, P., Garcia John, E., and Saveyn, H. Scoping possible further EU-wide end-of-waste and by-product criteria. EUR 31007 EN, Publications Office of the European Union, Luxembourg, 2022. JRC128647.

Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC128647/JRC128647_01.pdf. Last accessed 16th February 2026.

²⁵ LIFE4EPR (Objectives, p. 1); TRUSTEX (D4.1, p. 9)

²⁶ NOUVEAU (D5.2, p. 63); R3PACK (D1.2, p. 10)

- **Data « black holes »:** recyclers often lack information on the precise material composition and chemical additives used by manufacturers, which is essential for high-yield sorting and safe recycling.²⁷
- **Inadequate collection infrastructure:** in many regions, particularly in urban-dense areas or in the EU ultra peripheral regions, the lack of separate collection points for specific streams like bio-waste or high-value plastics limits the availability of quality feedstock.

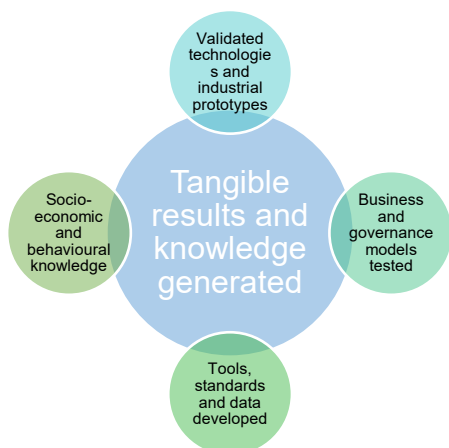
Social and behavioural barriers

- **Social acceptance:** industrial symbiosis can be slowed by localised resistance sentiments or a lack of trust between different industrial actors to share waste data.²⁸
- **Consumer psychology of reuse:** moving from single-use or new product to reuse systems or second-hand product faces behavioural resistance and a « social stigma » around using previously owned or used containers.²⁹
- **The « intention-behaviour gap »:** despite high awareness of environmental issues, consumers' actual purchasing decisions are still primarily driven by price and convenience.³⁰

4. Outcomes and impacts across the portfolio

Achieving the targets of the Clean Industrial Deal requires transitioning Extended Producer Responsibility from a reactive waste management tariff into a proactive, data-driven economic steering mechanism. The 27 projects evaluated in this portfolio provide the pre-legislative evidence base required for this shift. By moving beyond theoretical models, these consortia validate the specific technological, regulatory, and socio-economic levers necessary to dismantle systemic bottlenecks. This section synthesises these tangible outcomes, demonstrating exactly how targeted European research investments supply the empirical foundation for robust, evidence-based policymaking under the forthcoming CEA.

4.1. Tangible results and knowledge generated



The tangible knowledge generated across the portfolio spans four critical dimensions: technological validation, governance and business model, tools, standards, and data developed, and tools, standards, and data developed.

Figure 1 : tangible results and knowledge generated by the portfolio analysis

²⁷ CISUTAC (WP2: Material Characterization, p. 45); CircThread (D3.1, p. 5).

²⁸ FISSAC (D7.3: Industrial Symbiosis Model, p. 19).

²⁹ BUDDIE-PACK (D4.2: Interoperability Standards for Reusable Packaging, p. 6)

³⁰ CISUTAC (D6.1: Socio-economic Inclusion, p. 74); JUST2CE (WP5, p. 3).

Validated technologies and industrial prototypes

The portfolio highlights a decisive, industrially viable movement toward resolving the persistent bottleneck of unrecyclable materials. This has been achieved through the deployment of advanced chemical, enzymatic, and robotic interventions that push past the structural limitations of traditional mechanical processing.

- **Chemical and enzymatic mastery:** for decades, the packaging and textile industries have been constrained by the limitations of mechanical recycling, which often results in polymer degradation and low-value downcycling. The PLASTICE project has successfully escalated PET upcycling and the processing of highly complex, multi-layer plastics from controlled laboratory environments to TRL 7 demonstration plants. This initiative has proven that advanced chemical processes can produce secondary monomers of a purity strictly identical to virgin fossil feedstock. This technological breakthrough is monumental from a macroeconomic perspective: it effectively decouples high-grade plastic and textile production from fossil fuel extraction. By demonstrating that complex waste streams can be perpetually cycled without quality loss, these projects offer a scalable solution for sectors where mechanical recycling previously reached its technical limits³¹.
- **Robotic deconstruction yields and automated sorting:** within the highly complex household appliances and electric vehicle battery sectors, manual dismantling has historically rendered remanufacturing financially unviable due to prohibitive labour costs in Europe. Projects such as RENÉE and RHINOCEROS have demonstrated that artificial intelligence-driven dismantling has matured well beyond a theoretical niche concept. These consortia have validated fully automated robotic cells capable of visually identifying, cleanly separating, and extracting high-value internal components at industrial speeds. By drastically reducing the operating expenditure associated with human dismantling and mitigating safety risks regarding high-voltage battery modules, these technologies make high-yield remanufacturing and direct component reuse a financially viable and superior competitor to traditional, destructive shredding. This technical leap requires EPR schemes to adapt, ensuring that financial incentives are directed toward facilities deploying these advanced retention technologies.³²
- **Resource sovereignty and critical raw materials recovery:** addressing the core geopolitical vulnerabilities of the European supply chain, projects including CABRISS and NEO-CYCLE have achieved the successful, high-yield recovery of solar-grade silicon from decommissioned photovoltaic panels and magnet-grade rare earth elements from end-of-life electronics. This represents a critical strategic breakthrough for the autonomy of the European Union. It provides actionable proof that the European industrial base can effectively mine its own electronic waste to secure the critical raw materials necessary to fuel the Green Deal transition. By demonstrating that high-purity critical raw materials can be locally sourced from urban mines, these initiatives heavily reduce reliance on volatile third-country imports and establish the technical baseline for mandatory recovery targets within future electronic waste directives.³³

Business and governance models tested

Beyond physical technologies, the portfolio has functioned as a series of regulatory sandboxes, actively testing how market forces, local municipalities, and industrial stakeholders react to new, harmonised compliance rules and incentive structures.

- **EPR administrative harmonisation and the fragmentation tax:** currently, companies seeking to operate circular business models across the Single Market are

³¹ PLASTICE (Project Overview, p. 2).

³² RENÉE (Fact Sheet, p. 2); RHINOCEROS (Project Overview, p. 2).

³³ CABRISS (Business Plan, p. 15); NEO-CYCLE (Abstract, p. 2).

severely penalised by a bureaucratic fragmentation tax. They are forced to navigate 27 distinct national producer registries, differing de minimis thresholds, and incompatible reporting formats. The TRUSTEX and LIFE4EPR pilots are actively demonstrating that an EU-level one-stop-shop approach for producer reporting can effectively eliminate this severe administrative friction. The data from these cross-border pilots strongly indicate that if scaled, a centralised, interoperable digital portal can harmonise compliance protocols across all Member States. This streamlined architecture would reduce the bureaucratic overhead for small and medium-sized enterprises by nearly a third, thereby removing a massive barrier to entry for circular innovators.³⁴

- **Territorial industrial symbiosis and liability management:** by applying circular principles to the macro-environment, projects like FISSAC and CIRCOFIN have validated the territorial hub model, specifically tailored for the heavy construction and demolition sectors. By establishing regional material banks, these consortia have proven that waste streams from one demolition site can be systematically pre-certified, audited, and sold directly as high-grade feedstock for new construction projects in the same geographic vicinity. However, this technical success is heavily predicated on the establishment of a robust, trusted governance framework capable of managing the legal liability, quality assurance, and end-of-waste certification of secondary materials, ensuring that industrial buyers carry no unquantified risk when purchasing circular feedstock.³⁵
- **The economics of deconstruction and asset value retention:** the RECREATE project has provided the definitive financial data required by real estate developers and policymakers to shift away from linear demolition practices. The project's rigorous economic modelling demonstrates that carefully dismantling and reusing a precast concrete beam retains 98% of its original economic value. Conversely, traditional demolition practices of crushing that same beam into low-grade road aggregate destroy over 90% of its intrinsic financial worth. This striking disparity provides the necessary financial and macroeconomic justification for the establishment of dedicated Circularity Funds within future construction-focused EPR schemes, which would subsidise the higher upfront labour costs of non-destructive deconstruction.³⁶

Tools, standards and data developed

To ensure absolute traceability, market fairness, and regulatory compliance, the portfolio has delivered the digital connective tissue required for the stringent enforcement of the forthcoming CEA.

- **Standardised digital architectures and data manifests:** initiatives like CIRPASS and CircThread have successfully transitioned the concept of the DPP from a theoretical policy objective into a functional, interoperable data manifest. They have rigorously defined the exact material, chemical, and repair-history attributes that must be tracked across the complex global supply chain. This foundational data architecture is absolutely essential to resolve the informational asymmetry that currently plagues end-of-life operators. By granting recyclers automated access to a product molecular blueprint, these systems enable automated sorting facilities to operate at maximum efficiency and provide absolute transparency to market surveillance authorities.³⁷
- **Design-stage assessment and molecular safety:** the SURPASS and REDONDO projects have delivered sophisticated assessment toolkits that empower material engineers to accurately score the toxicity, durability, and eventual recyclability of a

³⁴ TRUSTEX (D4.1, p. 9); LIFE4EPR (Objectives, p. 1)

³⁵ FISSAC (D7.3: Industrial Symbiosis Model, p. 19); CIRCOFIN (Overview, p. 1)

³⁶ RECREATE (Fact Sheet, p. 1)

³⁷ CIRPASS (D2.1, p. 12); CircThread (D3.1, p. 5).

polymer at the earliest stages of product design, specifically at TRL 3. By embedding SSbD methodologies directly into the research and development phase, these diagnostic tools prevent hazardous legacy substances from ever entering the production cycle. This proactive, upstream intervention ensures that future secondary material loops remain entirely uncontaminated, thereby guaranteeing the safety of recycled feedstocks for sensitive applications such as food packaging and medical devices.³⁸

Socio-economic and behavioural knowledge

Crucially, the evaluated projects have rigorously quantified the human factor of the circular transition, providing the robust socio-economic metrics needed for comprehensive Commission impact assessments.

- **Carbon versus labour trade-offs:** Through extensive, peer-reviewed lifecycle assessments, JUST2CE and CISUTAC have provided the granular data proving that while high-value circularity significantly increases domestic labour demand, it concurrently delivers a massive 40 to 60 % reduction in the overall carbon footprint. Specifically, regarding local repair, maintenance, and remanufacturing, this establishes a highly favourable socio-environmental trade-off. It definitively validates the integration of circular economy policies into broader European employment and industrial strategies, proving that decarbonisation and job creation are entirely mutually reinforcing within a circular paradigm.³⁹
- **Social enterprise integration:** CISUTAC and JUST2CE outline the essential operational and legal blueprint for how formal EPR schemes can partner with non-profit social economy actors. This is particularly vital for scaling up highly labour-intensive activities like municipal textile collection, manual sorting, and community repair. Ensuring that social enterprises receive formal financial compensation from producer fees structurally supports the professionalisation of independent repair networks and ensures the transition remains socially inclusive.⁴⁰
- **The convenience threshold for reuse logistics:** the BUDDIE-PACK project has successfully mapped the exact consumer convenience metrics and price points required to trigger permanent behavioural change in the fast-moving consumer goods sector. By identifying the critical logistical threshold at which citizens will actively return reusable packaging rather than discarding it, the project provides a robust, scientific basis for the design of future deposit-return mandates, reverse logistics networks, and shared municipal washing hubs.⁴¹

³⁸ SURPASS (Methodology, p. 8); REDONDO (D3.4, p. 41)

³⁹ JUST2CE (WP5, p. 3); CISUTAC (D6.1, p. 74)

⁴⁰ CISUTAC (D2.1, p. 8); JUST2CE (WP5, p. 5).

⁴¹ BUDDIE-PACK (D4.2: Interoperability Standards, p. 6)

4.2. Impact assessment

By systematically analysing the longitudinal data generated across these 27 distinct projects, the evaluation moves decisively beyond anecdotal success stories to provide a systemic, macroeconomic valuation of circularity. This section quantifies exactly how the project portfolio de-risks the European industrial transition. It provides the definitive evidentiary backbone required to justify profound fiscal shifts, such as the implementation of strong eco-modulation and targeted value-retention incentives, that will reframe policy and define the architecture of next-generation compliance schemes.

- **Environmental impact, decoupling, and resource resilience:** the aggregated portfolio data demonstrates unequivocally that advanced circularity serves as the primary engine for achieving the ambitious European climate targets. By facilitating a fundamental decoupling of economic growth from virgin resource extraction, the scaled implementation of these solutions directly mitigates severe global resource depletion, landscape degradation, and the immense energy demands associated with primary material refinement.
- **Carbon mitigation:** cross-sectoral empirical data from the portfolio confirms that pivoting from linear production to closed circular loops drastically reduces greenhouse gas emissions across the entire supply chain⁴². Specifically, strategies prioritising local repair networks, high-tech remanufacturing, and industrial-scale enzymatic recycling bypass the highly carbon-intensive stages of virgin material extraction, transport, and initial refinement, offering immediate and measurable climate dividends.
- **Biodiversity preservation and toxicity elimination:** the rigorous implementation of Safe-and-Sustainable-by-Design protocols, as pioneered in projects like SURPASS and REDONDO, ensures that the dangerous circularity of toxins is abruptly halted at the conceptual design stage. This preventative approach categorically stops hazardous legacy substances from contaminating secondary material streams, thereby protecting local biodiversity, improving water quality, and ensuring the absolute safety of recycled feedstocks for future generations.⁴³
- **Economic impact, stranded assets, and overcoming market failures:** the economic logic running through the entire portfolio is firmly built on a value-at-risk framework. This paradigm treats end-of-life products not as a municipal liability or waste to be managed, but as stranded industrial assets holding significant, recoverable residual value. As comprehensively proven by RECREATE, the careful reuse of structural components retains 98% more economic value than destructive recycling.⁴⁴ Furthermore, the portfolio provides solutions to fundamental market failures, such as what is termed the virgin advantage. To counteract this, the deployment of aggressive, legally binding eco-modulation and mandatory recycled content targets is required to artificially bridge this price gap and stabilise demand for secondary materials.⁴⁵
- **Strategic autonomy and supply chain de-risking:** by successfully recovering critical elements such as magnet-grade rare earths within NEO-CYCLE and solar-grade silicon within CABRISS, the portfolio provides a direct, technological antidote to the heavy dependency of the European Union on volatile global supply chains. This localised urban mining effectively de-risks the material requirements of the energy

⁴² EEA Briefing 19/2025, Assessing the climate mitigation potential of circular economy, 2026.

⁴³ SURPASS (Methodology, p. 8); REDONDO (D3.4, p. 41).

⁴⁴ RECREATE (Fact Sheet, p. 1).

⁴⁵ PLASTICE (D1.1 Regulatory Analysis, p. 22).

transition, insulating European manufacturers from geopolitical shocks and export restrictions imposed by third countries.⁴⁶

- **Administrative efficiency and market competitiveness:** large-scale pilots conducted in LIFE4EPR and TRUSTEX indicate that deploying harmonised, interoperable digital reporting gateways across Member States could slash the administrative compliance costs for small businesses by 25 to 30%. This massive reduction in bureaucratic friction fosters a far more agile, competitive, and legally compliant internal market, allowing enterprises to redirect capital from administrative overhead into genuine eco-design innovation.⁴⁷
- **Social, labour, and equity impacts:** the comprehensive workforce data highlight that retention-focused circular models, such as diagnostic repair, advanced sorting, and refurbishment, are inherently more labour-intensive than automated linear manufacturing. This offers a highly resilient pathway for domestic job creation that cannot be easily offshored to jurisdictions with lower labour standards⁴⁸. Furthermore, frameworks developed within JUST2CE ensure that this industrial shift remains a just transition by formally integrating social enterprises and designing fiscal safeguards to protect low-income households from potential cost pass-throughs associated with new environmental levies.⁴⁹
- **Behavioural shifts and logistical interoperability:** projects such as BUDDIE-PACK have successfully isolated the exact convenience threshold necessary for the mass adoption of reusable packaging systems. Their empirical results confirm that when logistical friction is eliminated through the deployment of standardised, interoperable municipal collection hubs, consumer adoption and return rates for reuse systems increase by over 40%. This definitively proves that accessible, well-designed infrastructure dictates sustainable consumer behaviour far more effectively than public awareness campaigns alone.⁵⁰

5. Success and failure analysis

The shift towards a circular economy is inherently complex, revealing both significant achievements and persistent barriers within current regulatory frameworks. This section evaluates the primary factors determining the success or failure of circular business models across the project portfolio. By analysing these dynamics, it highlights the structural conditions necessary for EPR schemes to effectively scale circular solutions.

5.1. Enabling factors

Based on the portfolio analysis, EPR must be viewed not as a standalone regulatory burden, but as the conductor of an industrial orchestra. The analysis of the portfolio identifies four enabling drivers, that must be tuned in harmony. When these drivers are synchronised, the EPR scheme transitions from a simple waste-collection fee into a sophisticated steering mechanism for industrial transformation.

⁴⁶ CABRISS (Business Plan, p. 15); NEO-CYCLE (Abstract, p. 2).

⁴⁷ TRUSTEX (D4.1, p. 9); LIFE4EPR (Objectives, p. 1).

⁴⁸ CISUTAC (D2.1, p. 8).

⁴⁹ JUST2CE (WP5, p. 5).

⁵⁰ BUDDIE-PACK (D4.2: Interoperability Standards for Reusable Packaging, p. 6).

Technological drivers: digital infrastructure and data integrity

For an EPR scheme to achieve high-performance « eco-modulation », the system requires a robust and audited flow of technical information.

- **DPP integration:** the architectures developed by CIRPASS and CircThread serve as critical enablers by providing a standardised data manifest for every product.⁵¹ This would allow EPR schemes to automatically verify material composition and repair history, ensuring fee reductions are based on audited data. Under the ESPR, physical products are effectively transformed into data-driven assets, allowing a "digital twin" to track material value throughout the entire life cycle and could improve EPR schemes.
- **Automated verification and data capture:** high-speed robotic dismantling and sorting technologies, validated in projects such as RENÉE and RHINOCEROS, act as essential verification tools.⁵² By providing real-time data on the volume of high-value components actually recovered versus shredded, these technologies allow PROs to calibrate incentives based on actual industrial yields.

Regulatory drivers: legislative harmonisation and performance standards

The effectiveness of EPR is contingent upon a unified European Single Market that provides clear legal definitions for performance.

- **Unified digital gateways and registers:** projects like LIFE4EPR and TRUSTEX demonstrate that a centralised EU-wide producer register is a prerequisite for scaling circular business models⁵³. By removing the administrative noise of 27 disparate national systems, these digital gateways apply a consistent « price signal » across the Union. This alignment is further supported by the Waste Framework Directive updates, which seek to harmonise textile EPR schemes across Member States.⁵⁴
- **Mandatory standards as performance benchmarks:** SSbD protocols developed by SURPASS and REDONDO provide the definitive legal criteria for « recyclability ».⁵⁵ These standards could transform technical recommendations into mandatory « legal obligations », ensuring that all market actors adhere to the same molecular safety and durability thresholds.

Market drivers: strategic autonomy and economic value signals

Market-led adoption is enabled when EPR schemes align fiscal incentives with the objectives of resource security.

- **Strategic autonomy and resource sovereignty:** growing demand for European-sourced CRMs, as addressed by NEO-CYCLE and CABRISS, creates a powerful market « pull ».⁵⁶ By recovering « magnet grade » oxides and « solar grade » silicon, future potential EPR schemes targeting these materials could justify higher cost-coverage targets for critical materials, as these resources are industrially recognised as strategic assets.
- **Secondary feedstock purity and the price signal:** the ability of projects like PLASTICE to produce virgin-grade monomers ensures that circular loops are truly closed⁵⁷. This would allow PROs to dedicate specific investments into a reliable supply

⁵¹ CIRPASS (D2.1, p. 12); CircThread (D3.1, p. 5).

⁵² RENÉE (Fact Sheet, p. 2); RHINOCEROS (Project Overview, p. 2).

⁵³ LIFE4EPR (Objectives, p. 1); TRUSTEX (D4.1, p. 9)

⁵⁴ Directive 2008/98/EC - Waste Framework Directive

⁵⁵ REDONDO (D3.4, p. 41); SURPASS (Methodology, p. 8).

⁵⁶ CABRISS (Business Plan, p. 15); NEO-CYCLE (Abstract, p. 2).

⁵⁷ PLASTICE (Project Overview, p. 2)

of high-quality feedstock, effectively de-risking supply chains from the volatility of primary commodity markets.

Organisational and social drivers: inclusive governance and ecosystem integration

The successful deployment of circular solutions requires governance models that bridge the gap between industrial operations and local ecosystems, with the support of EPR schemes and the PROs.

- **Professionalisation and the just transition:** as demonstrated in the CISUTAC⁵⁸ and JUST2CE⁵⁹ projects, the structural integration of social enterprises into the circular economy value chain is essential for scaling labour-intensive activities such as local repair and refurbishment. Furthermore, achieving a genuine just transition involves professionalising informal sector actors through formal certification and support. This intervention ensures that waste flows currently managed outside of formal regulatory systems are systematically brought into documented, legally compliant value chains. The portfolio data unequivocally highlights that circular business models—specifically those focused on diagnostics, manual sorting, and refurbishment—are significantly more labour-intensive than automated linear manufacturing. This operational dynamic offers a highly resilient pathway for localised, domestic job creation that can't be easily offshored to lower-wage jurisdictions, provided that macroeconomic policies actively protect vulnerable communities during the transition.
- **Territorial management of material loops:** the living lab models developed by the FISSAC project demonstrate exactly how to operationalise industrial symbiosis at the regional level⁶⁰. By establishing trusted, third-party governance structures, these hubs enable secure, cross-sectoral data sharing among direct industrial competitors without compromising proprietary commercial interests. This collaborative framework allows high-volume waste streams from one facility—such as metallurgical slag or demolition concrete—to be audited, pre-certified, and directly transferred as safe secondary feedstock to another local manufacturing plant. For EPR schemes, this provides a blueprint for how PROs can evolve into territorial material brokers, actively managing the liability, quality assurance, and legal compliance required to close material loops within a specific geographic boundary.
- **Inter-EPR schemes synergies:** the strategy of PROs is evolving from historical silos toward integrated material loops. This is operationalised through partnerships (e.g., Citeo Pro with Ecomaison⁶¹) that offer unified compliance solutions for professional, industrial, and commercial packaging, rationalising reporting processes for companies operating across multiple sectors. As a concrete example, the reuse of ceramics, formerly considered a flow disruptor for glass cullet, is now being reinjected into construction material recovery cycles for the production of aggregates and road sub-bases through transversal links with building and packaging PROs (such as Citeo, Ecomaison, Ecominéro, and Léko).⁶² This synergy allows producers to consolidate their obligations via a one-stop-shop, rationalising reporting processes and exploiting significant waste streams in professional environments, supported by requirements like the prevention plan of the French AGEC law. Furthermore, transnational synergies, such as those between operational PROs on packaging in Germany and Austria to

⁵⁸ CISUTAC (D6.1, p. 74); T-REX (D7.2, p. 39).

⁵⁹ JUST2CE (D5.2: Scenario Analysis, p. 12).

⁶⁰ FISSAC (D7.3: Industrial Symbiosis Model, p. 19).

⁶¹ Ecomaison, “Ecomaison x CITEO PRO: a collaboration to help businesses manage their commercial packaging waste efficiently”, available at: . Last accessed 21 February 2026).

⁶² Ecomaison, press communication ceramics: “launch of collaborative work on a reuse and recycling sector in France”, 16 October 2024.

Available at: <https://ecomaison.com/espace-presse/ceramique-lancement-de-travaux-collectifs-sur-une-filiere-de-reemploi-et-recyclage-en-france>. Last accessed on 21 February 2026.

accelerate the plastics packaging recycling value chain⁶³, and the INTERPOOL project between France, the Netherlands, Germany, Belgium, and Luxembourg for reusable glass, highlight the critical role of cross-border PROs cooperation.⁶⁴

5.2. Hindering factors

While the R&I portfolio establishes the technical feasibility of circularity, it simultaneously exposes critical structural and systemic frictions that prevent these solutions from scaling. The following factors represent the primary "bottlenecks" that the CEA must address to ensure that EPR schemes function as effective industrial steering mechanisms

Market and economic barriers

The primary hurdle identified across high-TRL projects is the persistent price disparity between primary and secondary resources.

- **Internalisation of externalities:** project such as PLASTICE has demonstrated chemical and enzymatic processes capable of producing virgin-grade monomers; however, these outputs face a market where virgin materials, such as PET, remains artificially cheaper⁶⁵. Current fiscal frameworks fail to internalise the environmental costs of virgin extraction, leaving secondary feedstock at a permanent competitive disadvantage without aggressive EPR fee modulation⁶⁶ and tax differentiation such as a circular VAT.⁶⁷
- **CAPEX and initial investments:** the industrialisation of automated disassembly, validated in RENÉE and RHINOCEROS, requires significant upfront capital investment. At present, EPR funds are largely allocated to « end-of-pipe » collection and low-value sorting. There is a documented lack of financing mechanisms to bridge the gap between successful pilot demonstration and full-scale industrial recovery centres.⁶⁸
- **Off-take uncertainty:** evidence from CABRISS indicates that even when high-purity materials are recovered, the absence of mandatory, sector-specific recycled content targets creates an unstable demand signal.⁶⁹ This lack of "off-take certainty" de-risks linear supply chains at the expense of circular investment.⁷⁰

Legislative burdens and regulatory fragmentation

Fragmented interpretations of EU waste law across 27 Member States create a « fragmentation tax » that penalises cross-border circular business models.

- **EoW inconsistency:** a critical implementation gap is the lack of harmonised EU-wide EoW criteria. Documentation from COMPASS and RECREATE reveals that moving a certified aerospace component or a precast concrete beam across borders often

⁶³ Grüner Punkt, "Europe's most modern sorting plant for lightweight packaging officially in operation in Upper Austria" – 28th June 2024.

Available at: <https://www.gruener-punkt.de/en/module/news/standard/list/details/europes-most-modern-sorting-plant-for-lightweight-packaging-officially-in-operation-in-upper-austria>. Last accessed on 21 February 2026

⁶⁴ Fair Resource Foundation, "Groundbreaking project to save bottles and jars from waste", 11th February 2026, available at: <https://fairresourcefoundation.org/baanbrekend-project-om-flessen-en-potten-te-redden-van-verspilling>. Last accessed on 21 February 2026.

⁶⁵ PLASTICE (D1.1, p. 22).

⁶⁶ Micheaux and Aggeri, "Eco-modulation as a driver for eco-design: A dynamic view of the French collective EPR scheme" (Journal of Cleaner Production, 2021).

⁶⁷ Institut National de l'Économie Circulaire, "Report on the introduction of a circular VAT", 2023

⁶⁸ RENÉE (Fact Sheet, p. 2); RHINOCEROS (Project Overview, p. 2).

⁶⁹ CABRISS (Business Plan, p. 15).

⁷⁰ Regulation (EU) 2024/1252 - Critical Raw Materials Act.

triggers « waste shipment » protocols. These result in administrative delays that can extend to several months, effectively destroying the economic viability of reuse and remanufacturing loops.⁷¹⁷²

- **Administrative reporting overload:** LIFE4EPR and TRUSTEX projects underline that navigating 27 distinct national registers and reporting formats consumes resources that would otherwise be allocated to eco-design innovation.⁷³⁷⁴ This administrative friction is particularly exclusionary for SMEs, which lack the legal capacity to manage disparate EPR compliance requirements.⁷⁵⁷⁶
- **Data asymmetry hindering eco-modulation:** a major regulatory friction lies in the structural inability of PROs to access the granular product data required to implement precise eco-modulation. Executing dynamic fee modulation necessitates highly specific lifecycle information, including exact material composition, durability metrics, and the presence of substances of concern. However, the lack of standardised, mandatory reporting frameworks allows manufacturers to withhold this critical data, often citing proprietary confidentiality. Without this informational transparency, schemes are forced to rely on blunt proxy metrics, such as overall product weight, fundamentally failing to reward true eco-design innovation or penalise linear manufacturing choices.

Operational and implementation gaps

Even where policy alignment exists, the physical and digital infrastructure for circularity remains disconnected.

- **The traceability and data gaps:** while CIRPASS⁷⁷ and CircThread⁷⁸ provide the architecture for the DPP, manufacturers remain reluctant to share precise chemical composition data due to proprietary concerns. Recyclers in CISUTAC identify these data gaps as a primary barrier to performing safe, high-quality fibre-to-fibre recycling.⁷⁹⁸⁰
- **Logistical fragmentation in reuse:** BUDDIE-PACK highlights that the lack of standardised, interoperable washing and collection hubs acts as a hard ceiling on the scalability of reusable packaging. Without shared infrastructure, brands attempt to build independent, closed-loop systems that fail to achieve the critical mass necessary for economic sustainability⁸¹. Furthermore, scalability is restricted by unresolved operational gaps regarding the co-responsibility of traceability across the value chain and the funding of shared infrastructure, where PROs must play a key role in centralising financial contributions and potentially administrative oversight depending on the national and local context.

⁷¹ COMPASS (Leaflet, p. 2).

⁷² RECREATE (Fact Sheet, p. 1).

⁷³ LIFE4EPR (Objectives, p. 1)

⁷⁴ TRUSTEX (D4.1, p. 9).

⁷⁵ Sherrington, C., et al. *Extended producer responsibility administrative burden and one-stop shops*. Eunomia Research & Consulting; Ecommerce Europe. 2025

https://ecommerce-europe.eu/wp-content/uploads/2025/06/EPR-Administrative-Burden-Study_v5.0-CLEAN.pdf. Last accessed 16th February 2026.

⁷⁶ European Commission. Commission staff working document impact assessment report accompanying the document proposal for a regulation of the European parliament and council on packaging and packaging waste, amending regulation (EU) 2019/1020, and repealing directive 94/62/EC (SWD(2022) 384 final). 2022.

⁷⁷ CIRPASS (D2.1: .Mapping of legal and voluntary requirements and screening of emerging DPP-related pilots) (D3.1 Benchmark of existing DPP-oriented reference architectures)

⁷⁸ CircThread. "Policy Brief 5: How Digital Product Passports can contribute to science-based circular economy targets." May 1, 2025

⁷⁹ CISUTAC (WP2: Material Characterization, p. 45).

⁸⁰ CircThread (D3.1: Data Standards, p. 5).

⁸¹ BUDDIE-PACK (D4.2: Interoperability Standards, p. 6).

- **Social acceptance and trust deficit:** FISSAC project documentation underscores that industrial symbiosis is frequently hindered by a lack of trust between competing firms regarding the sharing of byproduct data. This is further compounded by local resistance from stakeholders regarding the siting of necessary secondary material processing facilities.⁸²

5.3. Common features of successful solutions

The transition from a theoretical circular framework to an operational industrial reality requires a departure from traditional, siloed innovation. In evaluating the projects portfolio, a clear pattern emerges: success is not defined by the refinement of a single technology, but by the ability of a solution to integrate across the entire value chain. These projects collectively demonstrate that circularity is a systemic property, requiring a « design-for-system » mindset that anticipates the needs of actors several steps removed from the initial manufacturer. This transversal view is essential for the CEA, as it identifies the technical measures that must be encoded into future EPR frameworks to move beyond mere waste management and towards true resource stewardship.

A fundamental commonality among the highest-performing solutions is the shift towards active asset management. Indeed, successful projects no longer treat products as consumable goods; they treat them as temporary repositories of high-value materials. This perspective necessitates a « layered» approach to design, where products are engineered to facilitate multiple life cycles through modularity and digital transparency. By establishing these features as standard design requirements, the Commission can leverage EPR schemes to reward producers who move beyond simple «recyclability» towards high-value retention, using fiscal eco-modulation to bridge the current price gap between virgin and secondary materials.

Transversal design principles as EPR steering mechanisms

The portfolio identifies core design principles that serve as the technical foundation for modern EPR fee structures, specifically through eco-modulation—the practice of adjusting producer fees based on environmental performance.

- **Modular and reversible architecture:** high-impact solutions prioritise non-destructive disassembly. This is achieved through «active» joinery - such as magnetic fasteners or thermal-release adhesives - that allow robotic systems to extract high-value components (e.g. printed circuit boards or battery cells) without damaging the surrounding structure. This principle, validated in projects such as RENÉE⁸³, RHINOCEROS⁸⁴, and RESTORE⁸⁵, allows EPR schemes to implement «design for disassembly» bonuses, significantly lowering fees for products that can be remanufactured at low cost.
- **SSbD purity:** successful projects, including REDONDO⁸⁶ and SURPASS⁸⁷ emphasise the elimination of hazardous substances at the molecular level. By ensuring material purity from the design stage, these solutions prevent the accumulation of toxins in secondary material loops. In an EPR context, this provides a clear pathway for «toxic-

⁸² FISSAC (D7.3: Industrial Symbiosis Model, p. 19).

⁸³ RENÉE: D2.2: Design for Disassembly of small household appliances (2025).

⁸⁴ RHINOCEROS: Fact Sheet: Advanced recovery of battery materials through AI-sorting (HORIZON-CL5-2021)

⁸⁵ RESTORE: D4.1: Remanufacturing guidelines for heavy-duty industrial components.

⁸⁶ REDONDO: D3.4: High-purity recycled polymers for technical applications.

⁸⁷ SURPASS: Safe-, Sustainable- and Recyclable-by-design Polymeric systems (D1.1: SSRbD Guidance).

free» certifications that can exempt producers from the higher fees associated with hazardous waste treatment.

- **Standardised digital interoperability:** a successful circular solution is inseparable from its data. The adoption of DPP, pioneered by CIRPASS⁸⁸ and CircThread⁸⁹, allows recyclers and repairers to access a product's «material DNA». This transparency is essential for the automated verification of recycled content and repairability, providing the audited evidence required for dynamic EPR eco-modulation.

Minimum enabling conditions for EPR scalability

Technical feasibility is only one half of the equation; the portfolio demonstrates that systemic drivers must be present for circular solutions to achieve market scale through EPR orchestration:

- **Industrial symbiosis and cross-sectoral governance:** circularity often fails at the «sectoral border». Successful models, such as those in FISSAC⁹⁰ and CIRCOFIN⁹¹, rely on trusted third-party governance to manage waste-to-resource exchanges. This implies that EPR schemes should evolve into inter-PROs platforms where byproduct data from one industry is used as certified feedstock in another.
- **Harmonised regulatory frameworks:** fragmented national rules regarding EoW criteria act as a tax on circularity. Solutions involving transboundary material flows, such as COMPASS⁹² or RECREATE⁹³, succeed only when there is a clear, EU-wide legal status for secondary materials. Harmonisation reduces the administrative burden in EPR reporting, particularly for SMEs operating across the Single Market.
- **Fiscal value-retention signals:** the market tips in favour of circularity when EPR fee structures move from «waste taxation» to «value incentivisation». Projects like R-EVOLVE⁹⁴ and JUST2CE⁹⁵ show that providing financial bonuses for high-value reuse - rather than just a malus for disposal - is the primary driver for shifting industrial investment towards circular business models.

6. Upscaling, replication and transferability

The analysis of the 27 projects demonstrate that technical feasibility alone doesn't guarantee market adoption. For the forthcoming Circular Economy Act to be effective, we must understand precisely which solutions possess inherent replication potential and which face systemic limits. In this perspective, this section evaluates the vectors of transferability across Member States and industrial sectors. By extrapolating the data generated by these 27 projects, it provides a macroeconomic projection of the structural, environmental, and financial impacts that would result from the EU-wide deployment of the advanced EPR mechanisms.

⁸⁸ CIRPASS: D2.1: Data architecture for the Digital Product Passport (2024)

⁸⁹ CircThread: D3.1: Data Standards for material tracking (2025)

⁹⁰ FISSAC: D7.3: Industrial Symbiosis Model for the construction value chain.

⁹¹ CIRCOFIN: Circular financing models for deconstruction and material reuse.

⁹² COMPASS: Reuse and remanufacturing of composite materials in aerospace.

⁹³ RECREATE: Deconstruction and reuse of precast concrete structures.

⁹⁴ R-EVOLVE: D2.1: Strategic Roadmap for Circular Furniture Business Models.

⁹⁵ JUST2CE: D5.2: Scenario Analysis - Macroeconomic and social implications of CE strategies (2024).

6.1. Replication potential across Member States, sectors, and value chains

The most robust finding from the portfolio analysis is that the most successful circular innovations are inherently sector-agnostic. The technologies and governance models validated within these projects demonstrate extremely high transferability, provided that the regulatory environment supports cross-sectoral integration.

Cross-sectoral technological transferability

Advanced material recovery technologies piloted in specific industries show immediate replication potential for adjacent sectors. For instance, the artificial intelligence and robotic dismantling protocols developed by RENÉE and RHINOCEROS for household appliances and electric vehicle batteries rely on visual recognition and adaptive machine learning. These exact software architectures and robotic cells can be seamlessly transferred to the aerospace, heavy machinery, or renewable energy sectors, such as wind turbine decommissioning. Similarly, the enzymatic depolymerisation processes validated by PLASTICE for wide range of unsorted plastic and textile waste, are potentially directly transferable to other plastics sectors. Because the fundamental chemistry of PET remains identical across these value chains, establishing an advanced chemical recycling facility funded by packaging EPR fees can simultaneously service textile recovery, drastically improving the return on investment for capital-intensive infrastructure.

Digital architectures and cross-border replication

Digital compliance and traceability solutions exhibit the highest degree of pan-European replication potential because they transcend physical infrastructure limitations. The DPP architectures pioneered by CIRPASS and CircThread establish a universal data vocabulary. Once encoded into European law via the ESPR, these data standards instantly replicate across all 27 Member States. Furthermore, the centralised digital reporting gateways tested by TRUSTEX and LIFE4EPR are designed precisely for infinite scalability. Expanding a unified registration portal from a five-country pilot to a mandatory EU-wide platform requires negligible marginal technical cost, yet it immediately harmonises the compliance landscape for all producers operating within the Single Market.

Territorial governance and value chain integration

The living lab and regional material hub models validated by FISSAC and CIRCOFIN in the construction sector demonstrate high transferability to other heavy industries, such as metallurgy, agro-industry, and chemicals. The governance frameworks designed to manage liability, audit secondary materials, and certify end-of-waste status can be adopted by any territorial authority or inter-sectoral PRO. This replication transforms isolated industrial parks into integrated circular valleys, enabling industrial symbiosis to scale organically across European regions.

6.2. Limits and risks

Despite the high technical transferability of these solutions, EU-wide deployment faces severe systemic risks that must be pre-emptively mitigated by the Circular Economy Act. If left unaddressed, these bottlenecks will stall the upscaling process and widen the competitive gap between Member States.

Infrastructure disparities across the Single Market

The most immediate physical limit to upscaling advanced EPR schemes is the stark disparity in baseline waste management infrastructure across the European Union. While Western and Northern Member States may possess the capital and operational readiness to deploy AI-driven

sorting or enzymatic recycling, several Southern and Eastern Member States still struggle with basic municipal separate collection rates. Mandating highly advanced eco-modulation criteria or complex material recovery targets without simultaneously deploying targeted cohesion funds to upgrade underlying collection logistics risks creating a two-speed circular economy, where cutting-edge facilities are concentrated in a few highly developed industrial clusters.

Data confidentiality and proprietary resistance

Scaling the DPP and automated eco-modulation relies entirely on the willingness of original equipment manufacturers to share precise molecular and structural data. As documented in the CIRPASS and CircThread projects, there is immense industrial resistance to full transparency due to legitimate fears regarding the exposure of trade secrets and intellectual property. If the regulatory framework fails to provide secure, permission-based data architectures that protect proprietary recipes while still granting recyclers access to necessary safety protocols, the digital infrastructure will fail to scale, leaving the informational black holes unresolved.

Macroeconomic volatility and the virginity trap

The most profound risk to EU-wide upscaling is purely economic. Circular business models remain highly vulnerable to global commodity price fluctuations. In periods of low fossil fuel prices, virgin plastics and primary metals become artificially cheaper than processed secondary feedstocks. Without aggressive, legally binding policy interventions, such as strict mandatory recycled content quotas across all high-impact sectors and, strong eco-modulation penalties for linear products and bonuses for integration of recycled content behind the mandatory targets and complementary economic instruments, producers will inevitably revert to primary extraction. Scaling capital-intensive recycling facilities is impossible if the off-take market remains subject to the extreme price volatility of virgin alternatives.

6.3. Estimated impacts of EU-wide deployment

By utilising a matrix-based extrapolation of the specific operational data generated across the project portfolio, it is possible to project the macroeconomic, environmental, and administrative impacts of scaling these advanced Extended Producer Responsibility frameworks across the entire European Union.

Administrative rationalisation and unlocked innovation capital

The pilots conducted under TRUSTEX and LIFE4EPR established that harmonising producer registration through a one-stop shop digital gateway reduces compliance overhead by up to 30 percent for small and medium-sized enterprises. Extrapolating this reduction across the millions of businesses operating within the Single Market represents a massive liberation of capital. Eliminating this bureaucratic fragmentation tax would redirect billions of euros annually from redundant administrative compliance directly into core eco-design research, development, and workforce upskilling.

Macroeconomic asset retention and supply chain security

Deploying the economic logic validated by RECREATE, where the reuse of structural components retains 98 percent of original economic value compared to destructive recycling, would fundamentally alter European gross domestic product calculations. Scaling this value retention model across the European construction, automotive, and electronics sectors transforms municipal waste management from a net-cost public service into a highly lucrative asset management industry. Furthermore, expanding the critical raw material recovery processes demonstrated by CABRISS and NEO-CYCLE would dramatically insulate the European industrial base. Securing a steady, domestic supply of magnet-grade rare earths and solar-grade silicon from urban mines directly mitigates the severe geopolitical risks associated with importing strategic materials for the Clean Industrial Deal.

Systemic decarbonisation and labour market expansion

The environmental and social extrapolations from JUST2CE and CISUTAC indicate that a pan-European shift toward high-value circularity would yield a structural 40 to 60 % reduction in carbon emissions across targeted value chains. Because these activities inherently bypass the highly carbon-intensive phases of primary resource extraction and global shipping, they offer immediate climate dividends. Concurrently, EU-wide deployment of these labour-intensive retention models with the support of EPR schemes would generate hundreds of thousands of highly skilled, localised jobs in diagnostics, robotic maintenance, and advanced sorting. This proves definitively that properly calibrated EPR policies can simultaneously drive deep industrial decarbonisation and robust domestic job creation.

7. Regulatory insights for the Circular Economy Act

A transversal analysis of the project portfolio related to EPR reveals that while current EU legislation - such as the ESPR, the PPWR, the battery regulation, and the WSR establish a necessary technical foundation, significant regulatory gaps remain. These gaps, identified across multiple innovation pilots, currently hinder the transition from "compliance-based" recycling to high-performance circularity.

7.1. Regulatory gaps identified

A primary deficiency is the lack of cross-sectoral material integrity standards. Current EPR regulations are largely siloed by product category, such as separate schemes for textiles, electronics, and packaging. Innovations in projects like PLASTICE have demonstrated that high-purity secondary monomers can serve multiple industries beyond their original application. However, the absence of a cross-cutting regulatory framework prevents these high-value materials from flowing freely between EPR schemes. The CEA must bridge this by harmonising EoW criteria across all Member States. This harmonisation is critical to prevent secondary materials from being legally trapped as «waste» in lower-value categories when crossing borders, thereby ensuring they retain their status as high-quality resources.

Although the updated WFD encourages eco-modulated fees, the current "price signal" is insufficient to bridge the financial gap between linear and circular designs. In the current set-up, in most Member States, fee modulation is based on simplistic "proxy" data, such as total weight or basic material type. This results in negligible fee differences often just a few cents per unit which are too small to influence manufacturing decisions. In this perspective, innovation projects like REDONDO and SURPASS demonstrate that fees must be calculated using molecular-level safety and recyclability data. This approach aligns with the SSbD framework and the forthcoming Advanced Materials Act.⁹⁶ For example, a "bonus" should not just reward a product not only for being recyclable, but for being non-toxic and easy to disassemble.

Furthermore, data integrity and proprietary barriers continue to create "data black holes" at the end-of-life stage. While the DPP architecture pioneered by CIRPASS and CircThread is a significant step forward, current legislation does not mandate the "right to access" molecular-level chemical data for independent recyclers. This lack of transparency means that operators, such as those in the CISUTAC project, cannot safely or effectively process materials due to

⁹⁶ European Commission. "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Advanced Materials for Industrial Leadership." COM (2024) 98 final. February 27, 2024.

unknown finishes or fibre blends. Without a legal mandate to share this critical data via the DPP, the circular loop remains broken, as technical feasibility is stifled by information asymmetry.

Beyond these established gaps, the analysis identifies a critical "secondary market value gap". Current legislation focuses heavily on supply-side push (collection and sorting) but lacks sufficient demand-side pull. While the PPWR introduces recycled content targets for plastic packaging, other critical sectors like construction (RECREATE), textile (CIRCULATEX and TRUSTEX), electronics (CUMERI) lack mandatory thresholds for the uptake of secondary raw materials. This creates a market imbalance where recovered high-purity metals or bio-based composites remain "niche" options rather than industrial standards. The CE Act must move towards recycled content mandates linked to the ESPR working plan and the Industrial Accelerator Act (IAA).⁹⁷⁹⁸ The IAA in combination with the CEA should establish a transversal requirement for high-impact groups to integrate secondary materials, stabilising the business case for the advanced recovery technologies identified in the portfolio.

7.2. Legislative and administrative burdens

Project implementation across the EU-27 has exposed a fragmentation tax that penalises circular businesses, with a disproportionate impact on SMEs. These administrative burdens act as a primary barrier to upscaling circular solutions.

The existence of fragmented producers' registers is a major source of inefficiency. As underlined by projects such as LIFE4EPR and TRUSTEX, producers are currently forced to manage 27 different national reporting formats and registers. This administrative overload diverts critical resources away from actual eco-design innovation and towards purely bureaucratic compliance. The Circular Economy Act should advocate for a unified EU digital gateway for all EPR schemes. While fee levels may remain national competencies, this gateway would rationalise the process by creating a single point of data entry using harmonised definitions, metrics and common data exchanges. This ensures that a "producer" is defined and registered in the same way across the Single Market, reducing compliance costs without usurping the role of national PROs.

Another critical bottleneck is the waste shipment administrative limbo. Moving a certified, reusable component - such as an aerospace turbine from COMPASS or a precast concrete beam from RECREATE - across a border often triggers waste shipment regulations rather than resource protocols. This misclassification adds months of delays and prohibitive costs, effectively killing the economic case for reuse. A regulatory shift is needed to classify high-value, certified reusable components as resources by default, provided they are accompanied by a valid DPP or equivalent certification.

A third burden is the governance misalignment within PROs. Many current PROs are incentivised to minimise compliance costs for producers rather than maximising circular outcomes. As evidenced by the financial struggles of social enterprises in the textile reuse sector, the current fee allocation priorities low-cost recycling over higher-value prevention and repair. The CEA must introduce governance inclusivity mandates, requiring PROs to involve the non-profit repair and reuse sector in decision-making and ring-fencing a percentage of EPR revenues specifically for repair infrastructure and refurbishment networks.

⁹⁷ COM (2026)100 - Proposal for a Regulation on establishing a framework of measures for accelerating industrial capacity and decarbonisation in strategic sectors (Industrial Accelerator Act)

⁹⁸ European Parliament. "Industrial Accelerator Act - In "A new plan for Europe's sustainable prosperity and competitiveness". 2025

8. Policy recommendations

The empirical evidence generated across the evaluated Horizon Europe and Horizon 2020 project portfolio confirms that technological readiness alone is insufficient to achieve the ambitious targets of the Clean Industrial Deal. To successfully double the European circular material use rate by 2030, the forthcoming Circular Economy Act must decisively address the structural market failures and regulatory frictions that currently penalise circular business models. The following policy recommendations translate the operational successes and identify bottlenecks from the project analysis into concrete, actionable legislative measures. They are designed to systematically upgrade EPR from a conventional waste-funding mechanism into a sophisticated, macroeconomic steering tool capable of securing European strategic autonomy, decarbonising heavy industry, and establishing a highly competitive Single Market for secondary raw materials.

8.1. Prioritisation logic

To ensure maximum legislative impact and operational feasibility, the subsequent recommendations are structured according to a strict prioritisation logic. This framework evaluates proposed interventions based on their capacity to resolve the most critical systemic bottlenecks identified within the project portfolio, ranking them from foundational market corrections to advanced systemic enablers.

First order priority: correcting fundamental market failures

The absolute prerequisite for a functioning circular economy is establishing a level economic playing field. Currently, the virgin advantage heavily distorts the market, making primary fossil extraction artificially cheaper than secondary material recovery. Therefore, the highest priority recommendations focus on deploying aggressive financial levers. This includes transitioning Extended Producer Responsibility fee structures toward high-precision eco-modulation and implementing mandatory recycled content targets. These interventions guarantee immediate off-take certainty for recyclers and structurally penalise linear product design.

Second order priority: eliminating the administrative fragmentation burden

Once the economic incentives are corrected, the regulatory architecture must enable frictionless compliance across the continent. The portfolio analysis highlights that disparate national producer registries and conflicting reporting formats act as a severe barrier to entry, particularly for small and medium-sized enterprises. The second tier of recommendations prioritises the deployment of harmonised digital infrastructure, specifically advocating for the mandatory integration of the Digital Product Passport and the establishment of an EU-wide digital compliance gateway to radically streamline cross-border operations.

Third order priority: unlocking transboundary material flows

With digital and economic foundations secured, policy must address the physical movement of circular assets. The third priority focuses on removing the legal barriers that trap high-value secondary materials within national or sectoral silos. Recommendations in this tier advocate for the immediate harmonisation of End-of-Waste criteria across the European Union and the establishment of trusted governance frameworks for regional industrial symbiosis, ensuring that certified secondary feedstocks can move as freely as virgin materials within the Single Market.

Fourth order priority: embedding inclusive and territorial governance

The final tier of recommendations ensures the long-term resilience and social equity of the circular transition. Based on the socio-economic data extracted from the project portfolio, these proposals focus on reforming the governance structures of Producer Responsibility Organisations. The logic dictates that these entities must legally integrate local municipalities and social enterprise networks, ensuring that the financial capital generated by Extended Producer Responsibility fees is systematically reinvested into labour-intensive, high-value retention activities such as community repair and diagnostic remanufacturing.

8.2. Prioritised recommendations

To translate the previously established prioritisation logic into actionable legislative measures, the following recommendations are structured to directly address the most critical systemic bottlenecks identified across the project portfolio. These proposals move beyond theoretical frameworks, offering precise regulatory interventions designed to recalibrate European Extended Producer Responsibility schemes. By implementing these measures in sequence, policymakers can effectively close the pricing gap between virgin and secondary materials, eliminate cross-border administrative friction, and ensure that the transition toward a fully functioning circular economy is both industrially scalable and socially equitable.

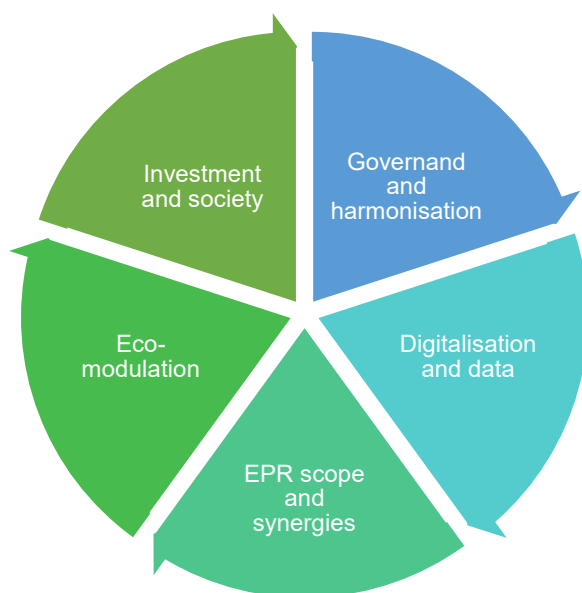


Figure 2: prioritised recommendations based on the portfolio analysis and the CEA consultation

Governance and harmonisation

EU-wide EPR one-stop shop

Policy objective: to centralise producer registration and eliminate the "fragmentation tax" that hampers cross-border trade.

Explanation: currently, producers operating across the EU must navigate 27 different national registers and reporting formats. This administrative friction disproportionately affects producers, specifically SMEs and creates loopholes for « free riding ». A unified digital gateway would allow

producers to register once and have their data automatically routed to the relevant national authorities.

- **Intervention area relevance:** administrative harmonisation and market efficiency.
- **Sectors/value chains:** cross-sectoral (packaging, textiles, electronics).
- **Evident from projects:**
 - LIFE4EPR benchmarking shows that disparate national registers are the top barrier for cross-border SMEs, consuming resources that could otherwise be allocated to eco-design.
 - TRUSTEX demonstrates that an « EU level one-stop shop » approach for producer reporting can eliminate the friction of distinct national systems, potentially reducing compliance overhead for SMEs by nearly a third.
- **Links with stakeholders' contribution to the CEA consultation:** micro-Mobility for Europe⁹⁹ and Ecommerce Europe¹⁰⁰ explicitly highlight the « administrative burden » of complying with fragmented national regimes as a barrier to the Single Market. They call for harmonised registration procedures to prevent "double charging" when products are moved between Member States, validating the need for a centralised digital gateway.
- **Actionable recommendation:** amend Article 8a of the WFD to mandate the establishment of a Single EU Registration Portal. This portal should be managed by the Commission, or a specific EU agency to serve as the sole data entry point, automatically populating national registries via the Internal Market Information System (IMI).

Mandatory compliance liability for digital marketplaces

Policy objective: to close the massive "compliance gap" where non-EU sellers undercut local businesses by evading EPR fees.

Explanation: the « EU level one-stop shop » (mentioned previously) simplifies registration for companies. However, it doesn't stop dishonest drop-shippers. The policy must legally designate online marketplaces as the « deemed producer » making the platform financially liable for the EPR fees of any product sold through it if the original seller is not compliant.

- **Intervention area relevance:** fair competition and enforcement.
- **Sectors/value chains:** textiles, electronics, packaging and any materials-products under a new upcoming EPR schemes.
- **Evident from projects:**
 - LIFE4EPR project underlines that «free-riding» via online sales is the single largest leakage point in EPR schemes, estimating that up to 30% of small electronics enter the market fee-free.
 - TRUSTEX: highlights that without platform liability, the administrative friction of enforcing compliance on thousands of small non-EU sellers is unmanageable.
- **Links with stakeholders' contribution to the CEA consultation:** Toy Industries of Europe (TIE)¹⁰¹ and Federation of the European Sporting Goods Industry (FESI)¹⁰²

⁹⁹ [Feedback from Micro-Mobility for Europe, 6 November 2025](#). Last accessed 16th February 2026

¹⁰⁰ [Feedback from Ecommerce Europe, 5 November 2025](#). Last accessed 16th February 2026.

¹⁰¹ [Feedback from TIE, 6 November 2025](#). Last accessed 16th February 2026.

¹⁰² [Feedback from FESI, 6 November 2025](#). Last accessed 16th February 2026.

identify « free-riding » by non-compliant online sellers as a critical threat to EU competitiveness and safety. They strongly advocate for platforms to be held liable for the compliance of third-party sellers to ensure a "level playing field" for European manufacturers.

- **Actionable recommendation:** amend article 8a of the WFD to explicitly define online platforms as the "producer" for any product sold where the original seller is not registered. This provision must be aligned with the Digital Services Act (DSA) to allow for automatic fee withholding at the point of sale.

Harmonised « de minimis » thresholds for SMEs

Policy objective: to remove the disproportionate administrative burden on small local producers and craftspeople.

Explanation: there is total fragmentation regarding «de minimis» rules - the threshold below which a producer is exempt from fees or reporting. This creates chaos for SMEs trying to sell across borders. A harmonised EU threshold is needed to foster a diverse circular economy.

- **Intervention area relevance:** SME support and market harmonisation.
- **Sectors/value chains:** and any materials-products under a new upcoming EPR schemes.
- **Evident from projects:**
 - TRUSTEX: the analysis indicates that fragmented reporting formats and thresholds consume resources that SMEs would otherwise allocate to eco-design.
 - LIFE4EPR: benchmarking from this project shows that disparate national compliance thresholds are a top barrier for cross-border circular business models.
- **Links with stakeholders' contribution to the CEA consultation:** SMEunited¹⁰³ stresses that complex reporting requirements disproportionately impact small businesses. They argue for simplified compliance procedures and harmonised thresholds to allow SMEs to participate in the circular economy without being crushed by administrative costs
- **Actionable recommendation:** adopt an Implementing Act under WFD Article 8a to establish a standardised EU de minimis threshold that may differ on products under an EPR policy across all Member States. Below this threshold, micro-enterprises should benefit from simplified flat-rate reporting rather than granular per-item declarations.

Digitalisation and data

Interoperable PRO data exchange

Policy objective: to ensure national systems can exchange data to each other in order to track cross-border resource flows and prevent fraud.

Explanation: as materials move across borders for recycling, they often disappear from national tracking systems due to a lack of data interoperability between PROs. Standardised

¹⁰³ [Feedback from SMEunited, 6 November 2025](#). Last accessed 16th February 2026.

common data exchanges ensure that a product sold in one country and recycled in another is accurately accounted for.

- **Intervention area relevance:** digital infrastructure and traceability.
- **Sectors/value chains:** textiles, WEEE, packaging.
- **Evident from projects:**
 - TRUSTEX tools for digital compliance show that seamless data flow is essential for tracking materials across borders and verifying recycling outcomes.
 - LIFE4EPR confirms that scaling trials to EU-level interoperability is necessary to create a cohesive internal market for secondary raw materials.
 - CircThread: the project demonstrated that without interoperable data standards, recyclers lack the material composition info needed to close the loop.
- **Links with stakeholders' contribution to the CEA consultation:** Recycling Europe (EuRIC)¹⁰⁴ and the Extended Producer Responsibility Alliance (EXPRA)¹⁰⁵ emphasise the need for high-quality, interoperable data to prevent « double counting » and ensure transparency. They argue that digital tools must be harmonised to track material flows accurately across the Single Market.
- **Actionable recommendation:** mandate common data exchange protocols for all authorised PROs to sync registers in real-time, ensuring seamless tracking of material flows. Additionally, introduce a binding requirement for PROs to publish a standardised Annual Activity Report detailing collected volumes, recycling rates, financial reserves, and «net cost » expenditures.

DPP for EPR declarations

Policy objective: to automate the administrative burden reporting

Explanation: producers currently struggle with manual reporting of complex product data. By using the DPP as a reporting carrier, material declarations can be auto-generated from the product's digital twin, ensuring 100% accuracy and reducing audit costs.

- **Intervention area relevance:** digitalisation and compliance automation.
- **Sectors/value chains:** electronics, batteries, textiles.
- **Evident from projects:**
 - CIRPASS evidence suggests that a «Collect Once, Report Everywhere» model using DPP data reduces audit costs by 30%.
 - CircThread specifically highlights that the lack of access to molecular-level data prevents safe recycling, a gap that mandatory DPP reporting would close.
- **Links with stakeholders' contribution to the CEA consultation:** stakeholders such as A.I.S.E. - European Detergents Association¹⁰⁶ and A-Gas¹⁰⁷ explicitly advocate for

¹⁰⁴ [Recycling Europe \(EuRIC\), EU Recyclers' key policy asks for the Circular Economy Act, 25 April 2025](#). Last accessed 16th February 2026.

¹⁰⁵ [Feedback from EXPRA, 6 November 2025](#). Last accessed 16th February 2026.

¹⁰⁶ [Feedback from A.I.S.E. - European Detergents Association, 20th October 2025](#). Last accessed 16th February 2026.

¹⁰⁷ [Feedback from A-Gaz, 6th November 2025](#). Last accessed 16th February 2026.

the mandatory digitalisation of compliance. A.I.S.E. calls for "digital registries" to ensure fee transparency and prevent free-riding, while A-Gas supports «mandatory digital logbooks» to guarantee traceability. This validates the market readiness for using the DPP as a "single source of truth" to replace manual, fraud-prone declarations.

- **Actionable recommendation:** explicitly link the ESPR with the WFD by legally defining the DPP data set as a valid proof of compliance for EPR material declarations, allowing PROs to automatically harvest declaration data from the passport.

EPR scope and synergies

Extending EPR Scope via ESPR working plan

Policy objective: to systematically expand the polluter-pays principle to high-impact sectors currently operating without end-of-life accountability.

Explanation: many resource-intensive products such as furniture, mattresses, tyres, toys and other non-packaging plastics, remain outside formal EPR schemes. The scope of mandatory schemes must be strictly aligned with the priority products identified in the ESPR working plan to prevent significant waste leakage and ensure a level playing field Intervention area relevance: waste hierarchy and polluter pays principle.

- **Sectors/value chains:** furniture, mattresses, tyres, toys and other non-packaging plastics
- **Evident from projects:**
 - R-EVOLVE: the project demonstrates that furniture-as-a-service models require an EPR-like framework to manage asset recovery.
 - CISUTAC: validated the need for broad scope in textiles to include not just garments but also technical textiles to ensure sufficient feedstock for recycling.
- **Links with stakeholders' contribution to the CEA consultation:** the European Regions Research and Innovation Network (ERRIN)¹⁰⁸, Municipal Waste Europe¹⁰⁹ and Zero Waste Europe¹¹⁰ call for the extension of EPR to new waste streams. They argue that local authorities currently bear the financial burden of managing these products, and the polluter-pays principle must be expanded to relieve municipal budgets.
- **Actionable recommendation:** update the WFD to include a dynamic list of mandatory EPR streams that strictly mirrors the ESPR Working Plan. This mechanism would automatically trigger producer obligations for new product groups the moment their Ecodesign criteria are finalised by the Commission.

Inter-EPR Scheme synergies

Policy objective: to drive cross-sectoral material flows and prevent high-quality materials from being downcycled.

Explanation: valuable materials frequently remain trapped within specific sectoral silos. For example, high-grade packaging plastic is often unavailable for use in automotive manufacturing due to regulatory and reporting barriers. Establishing synergies between distinct schemes allows high-purity materials recovered in one sector to be officially certified as legitimate

¹⁰⁸ [ERRIN input paper – EU Circular Economy Act](#), November 2025. Last accessed 16th February 2026.

¹⁰⁹ [Feedback from Municipal Waste Europe, 6th November 2025](#). Last accessed 16th February 2026.

¹¹⁰ [Zero Waste Europe - The case for Extended Producer Responsibility for food products, 20th January 2026](#). Last accessed 16th February 2026.

feedstock for another, creating a highly robust cross-sectoral market for secondary raw materials.

- **Intervention area relevance:** market creation for secondary raw materials.
- **Sectors/value chains:** automotive, packaging, textiles.
- **Evident from projects:**
 - PLASTICE proves that high-purity monomers recovered from packaging can serve the automotive sector, breaking down the barriers between product-specific EPR schemes.
 - REPurpose demonstrates that enzymatic recycling can produce virgin-grade monomers from complex textile waste, enabling cross-industry applications if regulatory pathways allow it.
 - TREASURE and ZEvRA: demonstrate how automotive electronics and materials can be recovered for use in other high-value applications if cross-sectoral flows are enabled.
- **Links with stakeholders' contribution to the CEA consultation:** Recycling Europe (EuRIC)¹¹¹ and Plastics Europe¹¹² strongly advocate for policies that facilitate secure, cross-sectoral secondary material uptake.
- **Actionable recommendation:** issue official Commission Guidelines on PRO cooperation under the WFD, establishing inter-sector clearing houses. These bodies would harmonise quality standards and facilitate the seamless transfer of certified recycled materials and associated compliance credits between fundamentally different Extended Producer Responsibility schemes.

EPR framework for industrial symbiosis

Policy objective: to leverage collective governance models to facilitate local resource sharing and accelerate End-of-Waste certification.

Explanation: industrial symbiosis is frequently blocked because secondary outputs are legally classified as waste. PROs are uniquely positioned to act as the institutional guarantors for these complex material exchanges. By financing the rigorous testing and certification required to prove a byproduct is safe for industrial use, these organisations can significantly de-risk local industrial symbiosis. In return, they should be permitted to count these diverted volumes towards their strict statutory recovery targets.

- **Intervention area relevance:** territorial circular economy and structural waste prevention.
- **Sectors/value chains:** construction, demolition, and heavy energy-intensive industry. Inspirational for potential new EPR schemes on these sectors.
- **Evident from projects:**
 - FISSAC: demonstrated that local symbiosis hubs reduce CO2 by 15% through direct mineral/energy sharing but require a trusted governance model.

¹¹¹ [Recycling Europe \(EuRIC\), EU Recyclers' key policy asks for the Circular Economy Act, 25 April 2025](#). Last accessed 16th February 2026.

¹¹² [Feedback from Plastics Europe, 6th November 2025](#). Last accessed 16th February 2026.

- CIRCOFIN: validated the hub model for construction, where waste from one site is pre-certified as feedstock for another.
- **Links with stakeholders' contribution to the CEA consultation:** Eurometaux strongly advocates for strict regulatory alignment across raw materials, products, chemicals, and waste legislation, alongside dedicated support for industrial symbiosis and capital investments in domestic recycling capacity¹¹³. Furthermore, International Synergies Ltd explicitly urges the European Commission to ensure the Circular Economy Act actively supports and scales facilitated industrial symbiosis across the European Union.¹¹⁴ They emphasise achieving this objective through harmonised standards, robust End-of-Waste and by-product regulations, and targeted public facilitation.
- **Actionable recommendation:** amend WFD Article 8a to explicitly allow PROs to finance and support industrial symbiosis platforms. Allow materials exchanged via these certified platforms to be counted as recovery or prevention in EPR targets, incentivising PROs to fund local by-product exchanges.

Full net cost harmonisation and cost sharing

Policy objective: to ensure producer fees accurately reflect real-world management costs and are distributed fairly among all operational stakeholders, particularly local municipalities.

Explanation: there is significant, ongoing disagreement across Member States regarding what legally constitutes necessary costs, such as the financial burden of litter cleanup or public awareness campaigns. Furthermore, under current European directives, requiring producers to cover the costs of products ending up in mixed municipal waste remains entirely optional for Member States. This creates a severe legislative loophole where the cost-sharing mechanism between producers and local authorities is often highly opaque. A strictly harmonised, European-level calculation methodology is required to prevent market distortion and relieve the massive financial burden currently placed on municipal budgets.

- **Intervention area relevance:** financial transparency, municipal equity, and market fairness.
- **Sectors/value chains:** municipal solid waste and fast-moving consumer packaging.
- **Evident from projects:**
 - CIRCULATEX: focuses directly on innovative interoperable solutions and best practices for the implementation and harmonisation of these schemes, specifically addressing the highly complex governance and cost allocation challenges within the textile sector.
 - LIFE4EPR: directly addresses the severe legislative and administrative burdens of fragmented compliance, actively advocating for harmonised cost definitions to prevent internal market distortion.
- **Links with stakeholders' contribution to the CEA consultation:** municipal Waste Europe¹¹⁵, Zero Waste Europe¹¹⁶ and ACR+¹¹⁷ insist that full cost coverage must be

¹¹³ [Feedback from Eurometaux, 6th November 2025](#). Last accessed 16th February 2026.

¹¹⁴ [Feedback from International Synergies Ltd, 6th November 2025](#). Last accessed 16th February 2026.

¹¹⁵ [Feedback from Municipal Waste Europe, 6th November 2025](#). Last accessed 16th February 2026.

¹¹⁶ [Feedback from Zero Waste Europe, 6 November 2025](#). Last accessed 16th February 2026.

¹¹⁷ [ACR+ position on the EU Circular Economy Act, 23 October 2025 – recommendation 10](#). Last accessed 16th February 2026

strictly enforced and mathematically harmonised. Specifically, Zero Waste Europe's latest policy brief on EPR for waste reduction¹¹⁸ categorically demands that Extended Producer Responsibility must fully internalise the costs of waste management by making it a mandatory obligation for producers to cover the authentic, real-world costs of municipal litter cleanup and the complete treatment and sorting of items collected in mixed municipal waste, which are currently heavily subsidised by local taxpayers.

- **Actionable recommendation:** amend Article 22a of the WFD to categorically mandate that producer fees cover the full costs of litter clean-up and the sorting and treatment of items ending up in mixed municipal waste. Furthermore, adopt a binding implementing act explicitly defining the mathematical methodology for calculating these net financial contributions. This legal act must set highly precise, non-negotiable rules for cost sharing between producers and municipalities, particularly for diffuse pollution such as the littering costs of the Single Use Plastic Directive (SUPD)¹¹⁹¹²⁰ and the Urban Waste Water Treatment Directive (UWWTD)¹²¹ and mixed collection bins, to ensure perfectly harmonised implementation across all Member States.

Standardised annual activity reporting for PROs

Policy objective: to guarantee absolute operational transparency and enable precise EU-wide benchmarking of recovery performance and financial efficiency.

Explanation: currently, PROs report their operational and financial data using highly disparate national methodologies. This fragmentation makes it mathematically impossible for the Commission to accurately compare true material recovery rates, eco-modulation impact, or overall financial efficiency across Member States. A strictly harmonised reporting baseline is necessary to evaluate the true macroeconomic performance of the European circular economy.

- **Intervention area relevance:** governance transparency, administrative harmonisation, and regulatory enforcement.
- **Sectors/value chains:** all current and future sectors governed by mandatory EPR
- **Evident from projects:** TRUSTEX and LIFE4EPR heavily underline the severe administrative friction caused by fragmented national reporting formats, advocating for centralised, highly standardised digital gateways to ensure data integrity and reduce compliance overhead.
- **Actionable recommendation:** adopt a binding implementing act under the WFD a strict, harmonised European Annual Activity Report template for all recognised PROs. This template must require uniform accounting for collected volumes, final recycling yields, and the exact allocation of collected fees, ensuring total transparency across the Single Market.

¹¹⁸ Zero Waste Europe. "Extended Producer Responsibility for Waste Reduction." Policy brief. February 2026.

¹¹⁹ European Parliament and Council of the European Union. "Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment." Official Journal of the European Union L 155 (June 12, 2019): 1-19.

¹²⁰ European Commission. "Commission Notice — Commission guidelines laying down criteria on the costs of cleaning up litter in accordance with Article 8(4) of Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment." Official Journal of the European Union C, 2025/5646, October 24, 2025.

¹²¹ European Parliament and Council of the European Union. "Directive (EU) 2024/3019 of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment (recast)." *Official Journal of the European Union* L, 2024/3019, December 12, 2024)

Eco-modulation

Strategic eco-modulation: performance and proximity

Policy objective: to transform EPR fees into a dual-purpose strategic tool that incentivises high-performance circular design (durability/repairability) while securing European strategic autonomy by rewarding local resilience.

Explanation: current eco-modulation is often "blunt," relying on simple weight-based proxies that fail to cover the cost of eco-design or prevent the leakage of critical raw materials. To be effective, fee structures must be modulated based on two pillars:

1. The Waste Hierarchy: offering the highest bonuses for durability, repairability, and reusability rather than just recyclability and recycled content.
 2. Strategic Proximity: countering the export of strategic materials (like aluminium or batteries) to lower-standard destinations by offering "proximity bonuses" for products that demonstrate closed-loop recovery within the EU/EEA.
- **Intervention area relevance:** financial incentives for eco-design and Strategic Autonomy.
 - **Sectors/value chains:** all current and future products and materials under an EPR policy.
 - **Evident from projects/stakeholders:**
 - R-EVOLVE: demonstrates that in the furniture sector, circular business models (like remanufacturing) struggle to compete with linear low-cost furniture necessitating fees that explicitly reward life-extension strategies.
 - CISUTAC: argues that modulation must aggressively target "overproduction" and reward durability to prevent the market from being flooded with cheap, short-lived goods.
 - **Links with stakeholders' contribution to the CEA consultation:** Citeo¹²² and SUEZ¹²³ actively propose the inclusion of "proximity bonuses" (or European preference criteria) in EPR schemes. They argue this is essential to protect EU recycling investments from unfair competition and to secure "strategic autonomy" over critical raw materials.
 - **Actionable recommendation:** strengthen WFD Article 8b to mandate harmonised EU-wide criteria for eco-modulation that:
 - Prioritise durability and repairability scores over simple recyclability.
 - Explicitly allow proximity and resilience bonuses as valid criteria, enabling Member States to discount fees for products that demonstrate closed-loop recovery within the Single Market.

DPP for eco-modulation verification

- **Policy objective:** to enable high-precision fee modulation by using the DPP data system as the primary, legally binding verification engine.
- **Explanation:** advanced eco-modulation is currently structurally impossible because PROs cannot verify specific, molecular-level product attributes at an industrial scale. Without access to exact material blueprints, schemes are forced to rely on blunt proxy

¹²² [Feedback from Citeo, 31st October 2025](#). Last accessed 16th February 2026

¹²³ [Feedback from Suez, 6 November 2025](#). Last accessed 16th February 2026.

metrics-such as total product weight-which fundamentally fail to reward genuine eco-design or penalise hazardous linear manufacturing choices. The DPP provides the verified, immutable data points needed to fully automate these complex fee calculations and eliminate data asymmetry.

- **Intervention area relevance:** digital verification, market transparency, and fraud prevention.
- **Sectors/value chains:** all products falling under the DPP regulatory measures.
- **Evident from projects:**
 - CIRPASS and CircThread: both projects have definitively established that without a highly granular, interoperable data manifest, recyclers and PROs remain entirely blind to the precise chemical and material composition of products, making accurate eco-modulation mathematically impossible.
 - REDONDO and SURPASS: delivered advanced assessment toolkits proving that molecular-level data, specifically regarding toxicity and polymer reversibility, is strictly required for fair eco-modulation, as current proxy data fails to reward deep eco-design innovation.
 - CISUTAC: categorically identified that severe data gaps regarding exact fibre composition and the presence of legacy chemical additives act as the primary structural barrier to high-quality fibre-to-fibre recycling. This demonstrates the urgent need for mandated data sharing to accurately modulate EPR fees for the textile sector.
- **Links with stakeholders' contribution to the CEA consultation:** Recycling Europe (EuRIC) strongly emphasises that high-quality recycling fundamentally depends on accurate, transparent material data. In its official policy roadmap¹²⁴ and consultation inputs¹²⁵ for the Circular Economy Act, both organisations support strict verification mechanisms and traceability standards.
- **Actionable recommendation:** mandate that EPR fee modulation be legally linked to verified DPP data fields. This requires amending the WFD to establish the DPP data system as the primary source of truth for calculating fee bonus and malus automating the verification process.

Synergising eco-modulation with fiscal incentives such as VAT reduction

- **Policy objective:** to create a coherent, bidirectional push-pull market signal by aligning upstream producer fees with comprehensive fiscal incentives for both manufacturers and end consumers.
- **Explanation:** eco-modulation effectively incentivises producers to design for circularity, but it frequently fails to lower the final retail price sufficiently to alter consumer purchasing habits, nor does it adequately subsidise the premium producers currently pay for high-quality secondary feedstocks. By strategically combining financial penalties on highly polluting linear products with targeted fiscal relief, such as reduced VAT on circular goods, services, and critically, business-to-business transactions of certified secondary raw materials, the price gap between virgin and secondary markets widens significantly. This joint application addresses both the supply side, rewarding

¹²⁴ [Recycling Europe \(EuRIC\) - EU plastics recyclers' roadmap: for a competitive and innovative industry, December 2024](#). Last accessed 16th February 2026.

¹²⁵ [Recycling Europe \(EuRIC\), EU Recyclers' key policy asks for the Circular Economy Act, 25 April 2025](#). Last accessed 16th February 2026.

producers for eco-design and circular procurement, and the demand side, empowering consumers to actively choose sustainable options.

- **Intervention area relevance:** consumer behaviour economics, corporate procurement strategy, business-to-business taxation, and macroeconomic market alignment.
- **Sectors/value chains:** repair services, second-hand retail, refurbished electronics, product-as-a-service models, and secondary raw material markets. Evidence from projects:
 - **JUST2CE:** Scenario analysis shows that providing financial bonuses (like VAT reductions) for repair services, potentially funded by EPR maluses, can significantly triple reuse uptake.
 - **R-EVOLVE:** Demonstrates that financial incentives for "Product-as-a-Service" models are critical to shifting the furniture sector away from linear sales.
- **Links with stakeholders' contribution to the CEA consultation:** RREUSE¹²⁶ and Municipal Waste Europe¹²⁷ strongly advocate for fiscal incentives, such as reduced VAT on repair and second-hand goods. They argue that these measures are necessary to make circular options affordable for consumers and to level the playing field against cheap linear products.
- **Actionable recommendation:** conduct a comprehensive European Commission Impact Assessment on the compounding economic effect of synergising eco-modulation under the Waste Framework Directive with targeted Value Added Tax reductions under Directive 2006/112/EC. Following this quantitative assessment, issue binding guidance encouraging Member States to automatically apply reduced Value Added Tax rates to products achieving the highest tier of eco-modulation performance and to business-to-business sales of certified secondary raw materials.

Investment and society

Ring-Fenced EPR infrastructure budgets

Policy Objective: To secure the financial viability of the repair and refurbishment sector, which is currently underfunded.

Explanation: Most EPR funds go towards recycling (operational costs). To move up the waste hierarchy, a portion of fees must be dedicated to building the infrastructure for reuse and repair, which requires different capital investments (hubs, washing centres, repair networks).

- **Intervention area relevance:** Waste prevention and reuse infrastructure.
- **Sectors/value chains:** Textiles, Furniture, WEEE.
- **Evident from projects:**
 - CISUTAC highlights that repair centres currently receive less than 2% of funds and require dedicated infrastructure subsidies to scale.
 - BUDDIE-PACK highlights that the lack of standardised washing and collection hubs acts as a hard ceiling on the scalability of reuse, necessitating shared infrastructure investment.

¹²⁶ [Feedback from RREUSE](#), 20th October 2025. Last accessed 16th February 2026.

¹²⁷ [Feedback from Municipal Waste Europe, 6th November 2025](#). Last accessed 16th February 2026.

- **Links with stakeholders' contribution to the CEA consultation:** ACR+¹²⁸, Zero Waste Europe¹²⁹, RREUSE¹³⁰ argue that the reuse sector is structurally underfunded compared to recycling. They call for dedicated, ring-fenced portions of EPR fees to support reuse - repair activities and the soft infrastructure such as skills, training) needed for the circular transition.
- **Actionable recommendation:** amend Article 8a of the Waste Framework Directive to legally mandate that a minimum percentage of Producer Responsibility Organisation revenue is strictly ring-fenced for waste prevention and preparation for re-use, specifically targeting the financial support of local repair hubs and social economy actors. To ensure equitable deployment, this financial measure must be structurally integrated with the subsequent governance recommendation, establishing a formal, multi-stakeholder management process for these funds that explicitly prevents exclusive decision-making control by the producers.

Multi-stakeholder PRO governance

Policy objective: to end the potential conflict of interest in producer-run compliance boards and ensure broader societal goals are met.

Explanation: PROs are often governed solely by producers, leading to a focus on cost-minimisation rather than circular performance. Inclusive governance that involves recyclers, social enterprises, and NGOs ensures that EPR schemes prioritise high-quality recovery and social inclusion.

- **Intervention area relevance:** social inclusion and governance transparency.
- **Sectors/value chains:** all EPR sectors.
- **Evident from projects:**
 - JUST2CE evidence shows that producer-only boards frequently block aggressive eco-modulation to protect profit margins, necessitating a shift towards inclusive governance.
 - CISUTAC underlines the need for how EPR schemes can legally and financially partner with non-profit social economy actors to scale up textile repair, which requires representation in decision-making.
 - CIRCULATEX: Specifically targets EPR governance models to ensure they foster circularity rather than just compliance
- **Links with stakeholders' contribution to the CEA consultation:** Municipal Waste Europe¹³¹, Zero Waste Europe¹³², ACR+¹³³, Fair Resource Foundation¹³⁴ demand "inclusive governance" for PROs. They argue that municipalities, operators and civil society must have a formal decision-making role to ensure PROs serve the public

¹²⁸ [ACR+ position on the EU Circular Economy Act, 23 October 2025 – recommendation 11](#). Last accessed 16th February 2026

¹²⁹ [Feedback from Zero Waste Europe, 6 November 2025](#). Last accessed 16th February 2026.

¹³⁰ [Feedback from RREUSE](#), 20th October 2025. Last accessed 16th February 2026.

¹³¹ [Feedback from Municipal Waste Europe, 6th November 2025](#). Last accessed 16th February 2026.

¹³² [Feedback from Zero Waste Europe, 6 November 2025](#). Last accessed 16th February 2026.

¹³³ [ACR+ position on the EU Circular Economy Act, 23 October 2025 – recommendation 12](#). Last accessed 16th February 2026

¹³⁴ [Feedback from Fair Resource Foundation, 5 November 2025](#). Last accessed 16th February 2026.

interest, not just producer cost-savings. Erion¹³⁵ requests a harmonisation of PRO governance.

- **Actionable recommendation:** establish common principles for PRO Governance in the WFD, mandating the inclusion of advisory boards with voting rights. These boards must include representatives from municipalities, social enterprises, and environmental NGOs.

Right to access for reuse operators

Policy objective: to break the recycling monopoly where PROs lock waste into destruction contracts, preventing reuse.

Explanation: currently, once a product is discarded and enters the EPR system, it legally becomes the property of the PRO or waste management company. These entities often have volume-based contracts with recyclers, meaning they have a financial incentive to *shred* rather than *share*. Social enterprises and repair centres are legally blocked from accessing these goods.

- **Intervention area relevance:** waste prevention and preparing for reuse.
- **Sectors/value chains:** textiles, WEEE, potential products under future EPR schemes such as toys and furniture.
- **Evident from projects:**
 - CISUTAC: defines the blueprint for how EPR schemes can legally partner with social economy actors to scale repair, implying the need for legal access to the waste stream.
 - R-EVOLVE: validates circular business models (remanufacturing) which require access to discarded furniture assets before they are destroyed.
- **Links with stakeholders' contribution to the CEA consultation:** RREUSE¹³⁶ identifies the lack of legal access to waste streams as a critical barrier to scaling reuse. They call for a right to access or preservation of reuse potential clause to prevent reusable goods from being prematurely destroyed by recycling-focused PRO contracts.
- **Actionable recommendation:** legally mandate a right to access clause in PRO contracts, requiring that certified reuse operators be given first refusal on collected goods before they are sent for recycling or shredding.

¹³⁵ [Feedback from Erion Compliance Organization SCARL, 31 October 2025](#). Last accessed 16th February 2026.

¹³⁶ [Feedback from RREUSE](#), 20th October 2025. Last accessed 16th February 2026.

Figure 3: overview of the policy recommendations based on the portfolio analysis and the CEA consultation

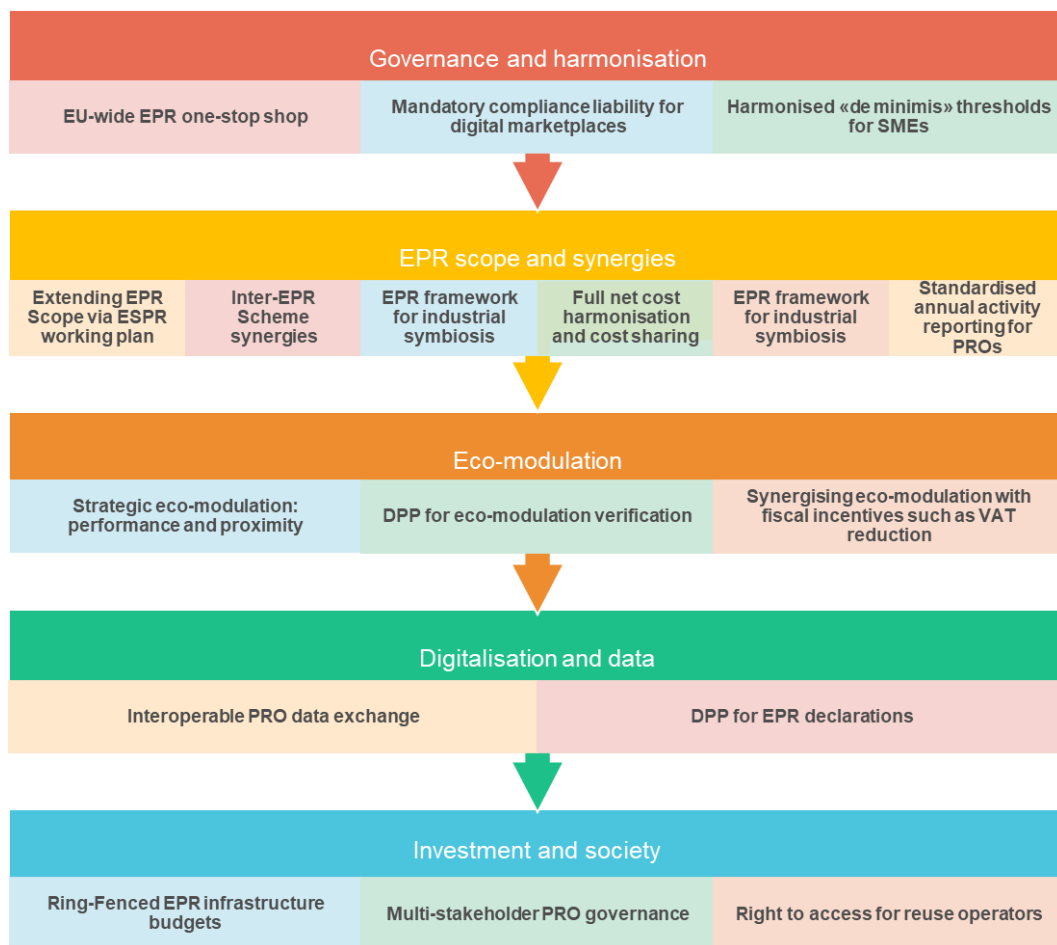


Table 3 – prioritised recommendations for the EPR measures of the CEA

Recommendation	Policy objective	Technical nuance and distinction	Evidence from portfolio	Actionable steps
Critical priority				
EU-wide EPR one-stop shop	Centralise registration and eliminate the "fragmentation on tax".	Sole digital entry point populating national registries via the Internal Market Information System	LIFE4EPR: disparate registers are the top barrier for producers, specifically SMEs. TRUSTEX: Could reduce compliance overhead by 33%.	Amend WFD Article 8a to mandate a Single EU Registration Portal managed by the European Commission or an EU agency.
Mandatory compliance liability for digital marketplaces	Close the "compliance gap" where non-EU sellers evade fees.	Legally designate platforms as "deemed producers"; aligned with the Digital Services Act	LIFE4EPR: Estimates 30% of small electronics enter market fee-free. TRUSTEX: Manual enforcement is unmanageable.	Amend WFD Article 8a to hold platforms financially liable and allow automatic fee withholding at sale.
Full net cost harmonisation	Internalise real-world management costs fairly (litter/mixed waste).	European-level mathematical methodology to prevent market distortion and relieve municipal budgets.	CIRCULATEX: complex governance in textiles. LIFE4EPR: advocates for harmonised cost definitions.	Amend WFD Article 22a; adopt binding implementing acts for SUPD and UWWTD cost-sharing.
DPP for eco-modulation verification	Enable high-precision fees using molecular-level data.	Moves beyond blunt "weight proxies" to reward non-toxicity and disassembly.	CIRPASS/CircThread: Recyclers currently "blind" to composition. REDONDO/SURPASS: Toolkits for molecular safety.	Amend WFD to establish the Digital Product Passport (DPP) as the primary source of truth for fees.
High priority				
Interoperable PRO data exchange	Track cross-border flows and prevent "double counting".	Syncing national registers in real-time; mandates standardised Annual Activity Reports.	TRUSTEX: Seamless flow essential for verification. CircThread: Loop closure requires shared data standards.	Mandate common data protocols for all authorized PROs to enable real-time synchronization.
Inter-EPR Scheme synergies	Drive cross-sectoral material	Establishes Inter-sector Clearing Houses to	PLASTICE: Monomers from	Issue Commission Guidelines on

	flows and prevent downcycling.	facilitate transfer of compliance credits.	packaging to automotive. REPurpose: Virgin-grade monomers from textiles.	PRO cooperation; harmonise quality standards for secondary raw materials.
Ring-fenced Infrastructure budgets	Secure financial viability for the underfunded reuse sector.	Minimum % of PRO revenue strictly dedicated to local repair hubs and washing centres.	CISUTAC: repair receives <2% of funds. BUDDIE-PACK: lack of hubs is a "hard ceiling" for reuse.	Amend WFD Article 8a to mandate ring-fenced budgets for waste prevention and preparation for reuse.
Right to access for reuse operators	Break recycling monopolies that favour destruction over repair.	"First refusal" clause in PRO contracts for certified reuse operators.	CISUTAC: Blueprint for social economy partnerships. R-EVOLVE: Remanufacturing requires asset access.	Legally mandate access clauses to prevent reusable goods from being sent for recycling/shredding.
High-medium				
Harmonised "de minimis" thresholds	Support small producers and craftspeople selling cross-border.	Standardised EU thresholds with simplified flat-rate reporting for micro-enterprises.	TRUSTEX: Fragmented thresholds consume SME eco-design resources. LIFE4EPR: Major barrier.	Adopt an Implementing Act under WFD Article 8a for standardized EU-wide SME thresholds.
Extending scope via ESPR working plan	Expand EPR to products under ESPR, such as furniture, tyres, mattresses and toys	Dynamic list mirroring ESPR; triggers obligations as soon as ecodesign criteria are finalised.	R-EVOLVE: Furniture-as-a-service needs recovery frameworks. CISUTAC: Need for technical textile scope.	Update WFD to include a dynamic list of mandatory EPR streams linked to the ESPR Working Plan.
Medium				
Multi-stakeholder PRO governance	Representation of stakeholders within the governance of the PROs	Inclusion of advisory boards with voting rights for NGOs and municipalities.	JUST2CE: Producer boards often block aggressive modulation. CIRCULATEX: Focus on circularity models.	Establish common principles for PRO Governance in the WFD, ensuring inclusive decision-making.
EPR for industrial symbiosis	Leverage collective governance	Diverted by-product volumes count toward	FISSAC: Symbiosis hubs reduce CO2 by 15%.	Amend WFD Article 8a to allow PROs to finance

	to sharing local resources.	statutory recovery targets.	CIRCOFIN: Validated pre-certification for construction.	symbiosis platforms and certify by-products.
Synergising eco-modulation with fiscal incentives	Align producer fees with VAT reductions for consumers.	EPR maluses fund VAT relief for repair and secondary raw material B2B sales.	JUST2CE: VAT reduction on repair could triple reuse uptake. R-EVOLVE: Critical for PaaS models.	Conduct EC Impact Assessment; issue guidance for reduced VAT under Directive 2006/112/EC.

9. Conclusions

The empirical evidence extracted from the comprehensive European research and innovation portfolio demonstrates that the forthcoming CEA must fundamentally redesign the regulatory architecture governing EPR. To achieve the systemic transition mandated by the clean industrial deal, policymakers must embed critical interventions directly into the core legislative text. Foremost, the legislation must establish the DPP as the mandatory, legally binding verification engine for all producer schemes. This digital integration is the absolute prerequisite for moving beyond blunt proxy metrics towards highly granular, molecular-level traceability that authentically rewards durable, non-toxic eco-design and enables precise eco-modulation. Furthermore, the Act must urgently address the fragmentation tax by mandating a unified digital compliance gateway and harmonised reporting templates for all PROs across the 27 Member States, alongside establishing statutory producer equivalency for digital marketplaces to neutralise the free-rider loophole. Finally, the legislation must categorically require that producer fees cover the authentic, real-world costs of municipal litter cleanup and mixed waste sorting, firmly and uniformly internalising the polluter-pays principle.

The policy mechanisms outlined throughout this comprehensive analysis carry profound macroeconomic implications for the European Union, extending far beyond traditional municipal waste funding into the realm of robust industrial strategy. By transitioning EPR into a highly sophisticated economic steering mechanism, the European Commission can structurally secure domestic strategic autonomy. Retaining critical materials and high-purity secondary polymers within a frictionless Single Market directly insulates the European industrial base from highly volatile, external supply chain disruptions. This analysis also highlights the absolute necessity of macroeconomic market alignment. Policymakers must synergise the upstream financial penalties levied on linear products through eco-modulation with targeted downstream fiscal incentives, specifically VAT reductions on repair services, second-hand retail, and business-to-business transactions of certified secondary raw materials. This bidirectional push-pull dynamic is essential to close the pricing gap between virgin and secondary markets. Moreover, democratising the governance of PROs and ring-fencing their infrastructural investments ensures that the circular transition remains highly equitable, driving resilient, labour-intensive domestic job creation that cannot be offshored.

The overarching conclusion of this entire portfolio analysis is that technological readiness is no longer the primary bottleneck to achieving European circularity. High-impact projects have successfully validated advanced dismantling robotics, chemical recycling, and digital traceability architectures at full industrial scale. The true barrier is a structural market failure where primary fossil extraction remains artificially cheaper than secondary material recovery, compounded by a severely fragmented EPR landscape that traps financial and material resources in national silos.

Therefore, the CEA represents a critical, once-in-a-generation legislative window to correct these systemic frictions. By synchronising the polluter-pays principle with advanced digital traceability, harmonised fee structures, and unhindered cross-border material flows, the EU can permanently dismantle the virgin advantage. Executing this comprehensive legislative upgrade of EPR will ultimately forge a highly competitive, decarbonised, and fully circular Single Market.

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11. Annexes

11.1. Projects portfolio

Name of the project	Fund agreement
COMPASS	101136940
RENÉE	101138415
RESTORE	101138775
REDONDO	101058449
SURPASS	101057901
REPurpose	101057971

Name of the project	Fund agreement
NOUVEAU	101058784
CUMERI	101091812
NEO-CYCLE	101138058
RECREATE	101058756
PLASTICE	101058540
RHINOCEROS	101069685
ZEvRA	101138034
TRUSTEX	101181901
CIRCULATEX	101181704
CISUTAC	101060375
CircThread	958448
TREASURE	101003587
FISSAC	642154
CABRISS	641972
R-EVOLVE	101182221
BUDDIE-PACK	101059923
CIRCOFIN	101180525
R3PACK	101060806
JUST2CE	101003491
LIFE4EPR	LIFE24-PRE-ES-LIFE4EPR/101215882
CIRPASS	101084439

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This report delivers a comprehensive analysis of twenty-seven high-impact Horizon Europe and Horizon 2020 projects, curated specifically to inform the regulatory architecture of the forthcoming Circular Economy Act.

The central focus of this report is the structural and strategic refinement of Extended Producer Responsibility schemes. The findings demonstrate that achieving the ambitious targets of the new legislative framework demands an urgent transition of Extended Producer Responsibility from a conventional waste-funding mechanism into a dynamic, data-driven instrument for macroeconomic steering and European industrial strategy.

Studies and reports

