

Research and Innovation projects supporting the Circular Economy Act

Focus Area: Transnational and regional initiatives



Independent Expert Report

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Focus area: transnational and regional initiatives

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Focus Area: Transnational and regional initiatives

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Executive Summary

This report analyses transnational and regional circular economy initiatives in Europe to identify regulatory, financial and governance barriers that limit their scaling across the EU. The findings are intended to inform the development of the Circular Economy Act (CEA).

The report draws on theory, practice and a portfolio of projects, complemented by expertise and experience in transnational and regional initiatives. The underlying premise of the analysis is that circular models are often more costly in financial terms, while the linear¹ models impose significantly higher costs in terms of resource use, environmental impact and human health. The analysis is informed by applicable theories such as: Problem Driven Iterative Adaptation² (Harvard Kennedy School – Building State Capability³), Facilitation in Complexity⁴, systemic design, Complex Adaptive Systems, Circular (Business) Models and Tactical Management in Complexity⁵, as well as Frameworks for adaptive management and governance, Ecosystems and Co-creation.

This analysis evaluates a purposive portfolio of 20 EU-funded R&I projects to provide an evidence-based foundation for the Circular Economy Act (CEA) 2026. Representing a cumulative investment of approximately €198 million and 1,780 full-time expert equivalents, the portfolio spans TRL 5 to TRL 8, addressing sectors as diverse as textiles, construction, bio-nutrients, and manufacturing. The analysis adopts a systems perspective to assess how circular solutions move from pilot to deployment.

Key findings show that technical feasibility is often not the main barrier to scaling. Instead, progress is constrained by **regulatory fragmentation, market conditions** and insufficient internalisation of environmental externalities. Across the portfolio, projects have developed **living labs, lighthouse references, and regional hubs, replication strategies and operational blueprints** that provide a basis for wider deployment and serve as societal prototypes for the **triple transition (social, green, and digital)**. These also point to **emerging roles** within circular ecosystems, including facilitation, coordination and replication functions (hereafter mentioned as Facilitators, Matchmakers, Orchestrators, or replicator fees).

A recurring finding is the need for a more integrated **Single Market for Secondary Materials**. This includes more consistent **End-of-Waste (EoW)** criteria and a unified **European Data Space for Circularity (solutions, platforms, infrastructures)** where Digital Twins hold the same legal validity as physical invoices.

The analysis also highlights the importance of a broader **pan-European perspective**. Cooperation with non-EU neighbouring countries (e.g. Western Balkans, Turkey, Ukraine, Switzerland and the UK) can help prevent 'waste sinks' and foster regional '**competitiveness**'.

¹ [The linear ridiculousness booklet.pdf](#) produced to convince on the paradigm shift

² Andrews, Matthew, Lant Pritchett, and Michael Woolcock. 2017. Building State Capability: Evidence, Analysis, Action. Oxford University Press.

³ <https://bsc.hks.harvard.edu/about/>

⁴ Facilitation in Complexity: From creation to co-creation, from dreaming to co-dreaming, from evolution to co-evolution, Renata Petrevska Nechkoska, Gjorgji Manceski, Geert Poels (Editors), Springer Nature, 2023, ISBN 978-3-031-11064-1, Series Title Contributions to Management Science, DOI <https://doi.org/10.1007/978-3-031-11065-8>

⁵ Tactical Management in Complexity - Managerial and Informational Aspects, Renata Petrevska Nechkoska (UGent), book, SPRINGER NATURE Switzerland, (2020) <https://doi.org/10.1007/978-3-030-22804-0> and <https://www.springer.com/gp/book/9783030228033>

Establishment of **circularity hubs**, and integrating a Balkans hub (Sofia, Skopje, Belgrade) **can transform the Balkans from a follower of EU policy into a critical supplier of the raw materials needed for the Green Deal**. Ultimately, this report suggests a mindset shift from abundance to scarcity, proposing that the CEA prioritises **rethink and recover** strategies to decouple economic growth from resource depletion and achieve climate neutrality by 2050. In fact, what is highly recommended is the **circularity by design** and **circularity by default** strategic principles.

From a systemic perspective, the portfolio identifies a set of enabling and limiting factors for scaling. Enablers include coordination across value chains, efficient **ecosystem orchestration** – facilitating collaboration and trust across sectors and regions – and **financial patchworks** that allow access to blended finance (e.g. R&D grants with private green bonds). Barriers include **regulatory uncertainty** (particularly around waste classification), which traps processed secondary materials in legal limbo, and **slow standardisation processes**, where the 2-to-5-year delay for CE marking outlasts the financial runway of circular startups.

Approximately **75% of the analysed projects demonstrate potential for upscaling and sector transferability**, although often under specific territorial or market conditions. Replication models range from regional and territorial/ecosystem-based approached, to more technical or sector specific (e.g. industrial, digital) solutions.

The **regulatory insights** and policy recommendations conclude the analysis of the roles and purposes of actors and systems under Circular Economy Act 2026, with the potential to contribute Europe's current circularity rate (12%) towards a more regenerative, climate-neutral economy.

The **actionable policy recommendations** are organised according to the following perspectives and roles of ecosystem, citizen, household, local community, ecosystem governance, network infrastructure as well as the introduction or redefinition of existing or emerging roles. The analysis also highlights the importance of a **Pan-European approach to the CEA**, including, where appropriate, cooperation with non-EU European neighbouring countries.

The report concludes that **achieving scale will require a combination of EU-level framework conditions and context-specific implementation at national and regional level**. Strategic elements such as DPP, End-of-Waste criteria and data frameworks may benefit from EU-wide alignment, while other measures require adaptation to local conditions (e.g. country-level or regional regulation, industry-specific, or even ecosystem-specific legal sandboxes) to provide the patchwork for **modularity and adaptation**. The shift envisaged under the CEA can be illustrated through analogies from natural systems, such as the functioning of a bee colony – the bee, its nature, behaviour, living, ecosystem. Just as honeycomb's hexagonal cells form efficient, resilient and interconnected systems, Europe's circular economy will require policy frameworks that are coherent, efficient, and regenerative. To operate within planetary boundaries, the EU needs to **transition towards a regenerative, resource-efficient, and resilient economic system**. Natural systems offer useful reference points in this regard. In a bee colony⁶, materials, roles, and processes are interlinked, contributing both to internal resilience and to positive externalities in its whole ecosystem. Similarly, circular economy

⁶ Short document for using the biomimicry of bee ecosystems with the CEA [BEe Circular.pdf](#)

systems aim to minimise waste, optimise resource use and generate broader environmental and societal benefits.

In practical terms, this implies designing systems where products last longer, materials circulate, and value regenerates. Governance structures need to be adaptive, and coordinated across levels, while data flows should support **transparency and accountability across supply chains**. As in natural systems, the objective is not only efficiency within the system, but also regeneration of the wider environment and society.



Figure 1. Conceptual illustration inspired by: [Facilitation in Complexity: From Creation to Co-creation, from Dreaming to Co-dreaming, from Evolution to Co-evolution](#)

1. Scope and policy relevance

1.1. Role of the 5 CEA intervention areas – why a focus on transnational and regional initiatives

Analysing **transnational and regional initiatives** is important for the Circular Economy Act (CEA) as it provides practical insights into how circular solutions operate and how a systemic regeneration approach works beyond incremental recycling. These initiatives address challenges that cannot be resolved at a single governance level, including regulatory fragmentation; cross-border logistics; differences in procurement, standards and certification; data sharing, traceability and IP governance; and financing, capacity and stakeholder coordination.

Across the analysed portfolio, a consistent set of barriers emerges: misalignment in Extended Producer Responsibility (EPR) schemes, complexities in waste shipment rules, fragmented

procurement frameworks, lack of interoperability in data systems, and challenges in financing and coordination. These barriers directly affect the functioning of secondary raw material markets.

A key issue is **regulatory fragmentation**, particularly regarding End-of-Waste criteria. Diverging national definitions limit the free movement of secondary materials and create uncertainty for market actors. Insights from regional initiatives support the case for more harmonised approaches at EU level, while recognising the need for flexibility in implementation.

The portfolio also demonstrates the importance of **testing scalability and transferability**. **Many projects function as pilot environments or societal prototypes for new circular solutions**, including Living Labs, regional hubs and replication models. These provide practical evidence on what works under specific territorial conditions.

Transnational initiatives also contribute to the development of **shared digital and technical solutions**, including traceability systems and early-stage Digital Product Passport approaches, but also: Unified Data Spaces, or a more unified (or single) European Data Space for Circularity, ensuring a material's 'Digital Twin' is as legally valid as a physical invoice. While promising, many of these are still under development and should be considered as emerging practices rather than fully validated solutions.

Another important dimension is the **relationship with neighbouring non-EU countries** (incl. Western Balkans, Turkey, Ukraine, UK) **through a Pan-European Circular Economy Act**. For some of these countries (e.g. Western Balkans) this becomes critical for preventing these regions from becoming 'waste sinks', and in enabling neighbourhood integration and resource supply rather than waste disposal. Funding alignment can be achieved through mandatory consortia and requirements in the Instrument for Pre-accession Assistance (IPA), European university alliances and Erasmus+ projects, all of which must adhere to CEA standards, making circularity a prerequisite for infrastructure funding in these regions.

The analysis also confirms that **policy and regulatory conditions are often more decisive for scaling than technology itself**. Projects consistently highlight the importance of addressing price signals, regulatory barriers and market conditions. At the same time, circular economy implementation requires engagement of multiple actors, including citizens, households, local communities, industries and public authorities, reflecting the systemic nature of the transition.

1.2. Link to CEA objectives and related EU legislation

Circularity economy implementation is inherently cross-sectoral, transnational, interdisciplinary and systemic. It relies on regional material flows, local industrial symbiosis, and cross-border value chains that cannot be optimised at EU or national levels alone.

The Circular Economy Act (CEA) 2026 is expected to translate strategic objectives into operational regulatory frameworks, contributing to the EU's broader goals under the European Green Deal and climate neutrality by 2050. **Effective implementation will require coordination and alignment between EU-level rules, national transposition and regional execution.**

Resource extraction and processing account for a significant share of greenhouse gas emissions (50%), reinforcing the role of circularity as a decarbonisation strategy and no longer an 'optional' waste management option. The transition is closely linked to digital tools (e.g.

traceability systems / DPP, data platforms, digital waste shipments), and increasingly also to social dimensions, including skills and behavioural change.

Relevant policy frameworks include the **Single market act** and the **Circular Economy Action Plan** (CEAP 2020), which aims to accelerate the transition to a sustainable economy. CEAP 2020 focuses on high-impact sectors (e.g. textiles, construction, and electronics) and sets an ambitious target to double the EU's circular material use rate by 2030. Key elements such as: the European Dataspace for Smart Circular Applications⁵ and strengthened cooperation with national authorities on enforcement of sustainability requirements for products in the EU market – through concerted inspections and market surveillance - will be addressed in this analysis. Complementary regulations, such as the Clean industrial deal, which aims to convert the decarbonisation into a driver of growth for European industries, help navigate uncovering redundancies in processes, new technologies across project portfolios and optimise operations towards sustainability. In terms of skills and quality jobs, initiatives like Erasmus+ can serve as multipliers with tangible impact both within the EU and beyond.

The **Critical Raw Materials Act** provides a foundation for enhancing long-term competitiveness, without simply increasing demand for critical raw materials (e.g. lithium, cobalt and nickel) in the next years 5-7 times which would risk perpetuating scarcity issues by substituting one non-renewable input with another. This Act must be complemented by regional and transnational circular strategies, including urban mining hubs, cross-border secondary raw material markets, and regionally specialised recovery infrastructures. Given that rare earth elements are inherently scarce and non-renewable, for the emphasis should be on circular substitution rather than demand expansion.

The **Packaging waste regulation** encourages re-use, refill, deposit, and return systems, alongside incentives for producers to manage their own packaging. Beyond products, this analysis will also address circular processes, business models, ecosystems and roles/responsibilities. Aligning granular supply in CE with granular demand is crucial, otherwise transportation and intermediaries increase costs, environmental impacts and reduce incentives for agro-producers.

Evidence from the project portfolio confirms that multi-country initiatives face recurring regulatory and operational challenges, including:

Challenge	Why it matters for multi-country consortia	Concrete examples from analysed project portfolio
Regulatory divergence and EPR misalignment	Different national rules on Extended Producer Responsibility (EPR), waste classification, chemical limits and product standards block harmonised collection, recycling targets and market access. This raises compliance costs and slows roll-out of common business models.	Textile projects explicitly target harmonised EPR because national schemes differ and prevent scale-up; TRUSTEX and Circula-TEX focus on aligning EPR and policy instruments across partners.

Cross-border logistics, waste shipment and permitting	Moving waste, by-products or feedstock across borders triggers complex permitting (Basel/Shipment rules), transport costs, and delays that undermine circular value chains and demo timelines.	Urban and CDW projects (CityLoops, URBANREC, WaysTUP!) reported that moving bulky or contaminated streams between regions complicates pilot replication and supply continuity.
Fragmented procurement and public policy instruments	Public procurement rules and local procurement priorities differ, making it hard to replicate procurement-led circular solutions or to scale municipal pilots across countries.	CityLoops highlighted procurement as a core lever and a recurring barrier when transferring solutions between cities with different procurement frameworks.
Data interoperability, traceability and IP governance	Cross-border pilots need shared data models, traceability for secondary materials, and clear IP/data rules; lack of interoperability stalls digital platforms and monitoring.	Projects combining digital tools and regional pilots (AD REDGIO, BIOMODEL4REGIONS, digital components of bio/circular projects) face delays when partners cannot exchange standardised datasets or agree on data ownership.
Market fragmentation and trade barriers for secondary materials	Different quality standards, labelling and acceptance of recycled feedstocks across countries reduce demand and create multiple small markets rather than a single EU market.	Bio-based and textile feedstock projects struggle to create pan-EU supply chains because recycled inputs are not equally accepted or certified across member states. This is a known international trade challenge for circular value chains.
Financing, cost allocation and state aid constraints	Cross-border financing of infrastructure or shared facilities raises questions about who pays, how revenues are shared, and whether national support triggers state-aid rules.	Regional bioeconomy and pilot infrastructure projects (MAINSTREAM-BIO, BIOMODEL4REGIONS, DECISO) must design financing that works across national funding rules and avoids state-aid pitfalls.
Capacity, skills and cultural/language differences	Varying technical capacity, administrative practices and languages slow coordination, increase transaction costs and reduce speed of replication.	Multi-city and multi-region pilots (CityLoops, PRIMED) reported extra time for stakeholder engagement and training when partners had different baseline capacities.

The learnings from transnational initiatives shape the following advice for policymakers:

- **Create EU minimum regulatory pathways for key waste streams:** Establish EU-wide minimum end-of-waste and by-product criteria, accompanied by a fast mutual-recognition mechanism for secondary materials (e.g. textiles, CDW, ash, digestate). This reduces legal uncertainty when materials move across borders and

creates a single market for recycled inputs. Evidence from city-level and project pilots shows end-of-waste divergence is a key barrier to scaling.

- **Introduce a policy alignment obligation for funded transnational pilots:** Require Horizon-funded/Act-supported transnational pilots to include a Policy Alignment Work Package (legal gap analysis, procurement templates, state-aid compliance check) as a condition for funding. This institutionalises the mitigation steps projects consistently identified. Deliverables could include letters of intent or pre-approvals from national/regional authorities.
- **Standardise traceability and data interoperability at EU level:** Define mandatory minimal traceability data for priority streams (e.g. textiles, bio-waste, CDW) and require open APIs and common data schemas for EU-funded platforms. This enables aggregation of impact metrics and reduces IP/data disputes across partners, and supports replication. City-level pilots emphasise data interoperability as essential for replication.
- **Deploy a transnational green public procurement accelerator:** Launch an EU facility that provides ready-to-use GPP templates, standard legal clauses and joint procurement frameworks for groups of cities/regions purchasing circular products and services across borders. Joint procurement reduces market fragmentation and stimulates demand for secondary materials. Evidence from recent transnational procurement initiatives shows that templates can accelerate uptake.
- **Create EU-level fast-track certification and testing hubs:** Fund a network of sectoral testing hubs (textiles, construction materials, bio-based fertilisers) to provide harmonised testing, certification roadmaps and mutual recognition letters. This addresses the market acceptance barrier for recycled inputs. Stakeholder submissions to the Circular Economy Act highlight the importance of harmonised certification frameworks.
- **Provide dedicated de-risking finance for cross-border infrastructure:** Establish an EU blended-finance instrument to co-fund cross-border or multi-region infrastructure, including coverage of legal/state-aid advisory costs. A standardised state-aid screening service should be included to accelerate approvals. Project experience indicates that financing uncertainty is a major barrier to scaling regional bioeconomy and treatment facilities.
- **Mandate capacity building and peer learning for networks:** Require funded consortia to allocate budget for regional DIHs, training, translation and stakeholder brokering, and create a European-level peer-learning platform linking mature pilots with regions seeking replication. Projects report high transaction costs due to capacity gaps; structured peer learning reduces these barriers.

Strategic Perspective: Policymakers should adopt a mindset shift from abundance to scarcity, recognising that decoupling economic growth from resource use and its environmental impacts is essential. Current EU circular economy policy frameworks do not yet fully capture the territorial and transnational dimensions of circular value creation, particularly the role of regions, cross-border ecosystems, and place-based governance mechanisms. Strengthening these dimensions is critical both for existing value chains and for emerging circular economy systems.

2. Methodology and analytical framework

2.1. Analytical logic

The methodology combined both qualitative and quantitative steps, including:

1. Defining initial requirements for portfolio analysis based on DG RTD's instruction and CEA public consultation inputs.
2. Conducting a broader portfolio analysis and selecting a purposive sample according to thematic areas.
3. Expert evaluation using CORDIS data, project websites, and SYGMA.
4. Alignment and consultation with experts to validate findings.
5. Structuring the analysis matrix and documents for systematic assessment.
6. Exploration using AI tools (Gemini and Copilot) to cross-check project acronyms and data.
7. Comparative analysis and consolidation of findings across projects.
8. Iterative drafting, consultation with other European Commission's Directorates, and working group alignment leading to the final version.

Additional inputs were provided through collaboration with **Ghent University**, particularly with professor Dr. Geert Poels⁷, reflecting approaches for a fully functional ecosystem for CE as well as Manufacturing-as-a-Service models. Additionally, the affiliation to Ghent university and the focused work of the EU team (Sylvia Gildemyn, PhD, UGent EU Account Manager – Bioeconomy & Environment) facilitated consultations and insights on key Horizon projects, including:

- WOODSTOCK: Empowering climate-smart, circular, and zero-waste use of underutilized wood from the forest and building stock in the construction sector to support the New European Bauhaus (Pillar 2, Cluster 6),
- PROSPER: Promoting innovation for sustainable sorting and recycling of dedicated bio-based plastics (Pillar 2, Cluster 6, CBE JU),
- ELECTRO: Electrified conversion of plastic waste into olefins & downstream integration (Pillar 2, Cluster 4),
- CliMaFlux: Circular design and manufacturing techniques for next-generation highly-efficient integrated axial flux motor drives for electric vehicles (Pillar 2, Cluster 5), and
- SCARPA: Sustainable and Circular Footwear Training Program (Pillar 1, MSCA-DN).

The UGent consultations also included reflections to the Green Hub, which implements numerous hands-on activities in relevant domains. While not always explicitly labeled as 'circular economy', these activities are directly connected and provide practical policy-relevant insights, particularly regarding tender procurement (coordinator: Riet Van De Velde).

2.2. Sources and evidence

Primary sources for the analysis included:

- Project portfolio (CORDIS and SYGMA links: [Transnational and regional initiatives, Analysis matrix individual projects v2.1 Renata.xlsx](#))

⁷ <https://www.flandersmake.be/nl>

- Foundational publications informing the expert approach:
 - Facilitation in Complexity: from Creation to Co-Creation, from Dreaming to Co-dreaming, from Evolution to Co-evolution⁸,
 - Problem Driven Iterative Adaptation as strategy in complexity⁹,
 - Tactical Management in Complexity: Managerial and Informational Aspects¹⁰
 - Complexity theories¹¹.

Analytical perspective:

Traditional policy focuses on creation (the government creates a rule) and execution, command and control. In complex systems, this cannot be enforced easily because the government cannot predict how millions of agents will react.

Complex Adaptive Systems (CAS) are composed of interrelated sociotechnical agents – citizens, technology, households, regions, states – that dynamically align around individual and collective purposes. Applying facilitation theory suggests three key shifts:

1. **From creation to co-creation:** Policy makers should **facilitate platforms** where industry, academia, and citizens co-create value, rather than delivering ready-made solutions. This includes populating prosumer roles and encouraging active participation.
2. **From dreaming to co-dreaming:** Establish a shared European purpose –e.g. healthy and happy lives, supported by clean waters, soil and air. Regional clusters can also co-dream their specific circular futures alongside a collective European 2050 vision.
3. **From evolution to co-evolution:** Technological advances (e.g. chemical recycling) require simultaneous evolution of legal frameworks, market incentives, and consumer habits. This co-evolution must include both EU and non-EU European countries to achieve genuine circularity across Europe.

The CEA should act as a **facilitator**, not only as a regulator, providing the "legal scaffolding" for regional ecosystems to self-organise.

Problem-Driven Iterative Adaptation (PDIA) in practice:

PDIA offers a strategy suited to contexts of uncertainty, where best practices do not exist:

- **Problem-driven:** Stop starting with the solution (e.g., "We need more recycling bins"). Start with a specific, locally-defined problem (e.g., "Why is 40% of our textile waste ending up in illegal landfills in the Balkans?").
- **Iterative adaptation:** Instead of a 5-year rigid plan, use shorter sprints, interventions, measurements, learning from the failures, and adaptation.
- **Authorising environments:** Provide local project managers with safe spaces to deviate from the original plan if new insights indicate better paths. The lump sum grant

⁸ Facilitation in Complexity: From creation to co-creation, from dreaming to co-dreaming, from evolution to co-evolution, Renata Petrevska Nechkoska, Gjorgji Manceski, Geert Poels (Editors), Springer Nature, 2023, ISBN 978-3-031-11064-1, Series Title Contributions to Management Science, DOI <https://doi.org/10.1007/978-3-031-11065-8>

⁹ Andrews, Matthew, Lant Pritchett, and Michael Woolcock. 2017. Building State Capability: Evidence, Analysis, Action. Oxford University Press.

¹⁰ Tactical Management in Complexity - Managerial and Informational Aspects, Renata Petrevska Nechkoska (UGent), book, SPRINGER NATURE Switzerland, (2020) <https://doi.org/10.1007/978-3-030-22804-0> and <https://www.springer.com/gp/book/9783030228033>

¹¹ <https://www.santafe.edu/>

approach is an example, which underlines the achieved objectives, emphasizing objectives achieved over rigid budget planning.

Tactical Management for Circular Systems:

Finally, the strategy set by EU and its operationalisation, happen through tactics.

- **Managerial aspect:** The Tactical Manager acts as the "Ecosystem Orchestrator", steering the **Complex Adaptive System (CAS)** toward its purpose using real-time adjustments.
- **Informational aspect:** Tactical decisions require **Tactical Management Information Systems (TMIS)**. The **Digital Product Passport (DPP)** is the most important policy tool now. It provides the 'runtime data' (the informational aspect) that allows managers to make tactical decisions (the managerial aspect) about material flows.

Circularity is an **emergent property**, not something that can be mandated. By creating appropriate conditions – simple rules and moderately dense connections – circular outcomes can emerge non-linearly.

- **Tactical Recommendations:** Adaptive milestones can replace fixed deliverables, especially in legal sandboxes, giving project coordinators flexibility to pivot technical strategies based on early operational data.

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 "transnational and regional" focus area, the portfolio underwent a rigorous expert validation and filtering process.

3. R&I Project Portfolio scope & overview

3.1. Portfolio overview

This chapter provides an overview of the analysed R&I project portfolio. A **summarised table of projects** is included below, while the **full portfolio matrix** is provided in the Annex. A consolidated and aggregated analysis across thematic areas has been carried out. Detailed individual project insights, as well as supporting analytical sheets corresponding to the headings of this document and additional dimensions, are available in a separated, working document.

3.2. Portfolio characterisation

Transnational and regional initiatives portfolio

The portfolio demonstrates a **high degree of diversity** across technologies, sectors, governance approaches, and levels of maturity. It can be characterised along several dimensions, including **TRL distribution, sectoral coverage, material focus, and types of solutions** (technological, governance, business, and social innovation).

Overall scale and resources

According to the budget and person-months, the **analysed portfolio covers around 200 million EUR budget and 17.800 person months, which denote approximately 1.500 FTE experts** and knowledge invested and in need to be utilised by the European Union for the CEA and beyond.

Summary of analysed projects

#	Project Acronym	Total Budget (€M)	EU Contribution (€M)	Person-Months	Category	TRL
1	AD REDGIO 5.0	19.8	17.2	1,850	AI / High-Tech	8-9
2	AshCycle	11.2	10.1	980	Mineral Recovery	7-8
3	SYMSITES	9.4	8.5	820	Urban/Ind. Nexus	6-7
4	REDOL	12.6	11.4	1,150	Symbiosis	6-7
5	MOBICCON-PRO	13.1	11.8	1,200	Infrastructure	8-9
6	tExtended	9.8	8.9	890	Textile Systems	7-8
7	P2Green	8.5	8.4	760	Bio-Nutrient	
8	SYMBIO	7.4	7.4	680	Bio-Chemical	6-7
9	PRIMED	6.2	5.9	550	Bio-Economy	5-6
10	MAINSTREAM-BIO	3	3	510	Agri-Research	5-6

11	FRONTSH1P	18.9	16.1	1,650	Regional Lighthouse	7-8
12	BIOMODEL4REGIONS	2.8	2.5	420	Governance	5-6
13	DECISO	4.5	4.2	390	Financial De-risking	6-7
14	URBANREC	10.1	8.9	910	Bulky Waste	8-9
16	WaysTUP!	10.5	9.2	940	Urban Bio-Waste	7-8
17	CityLoops	11.8	9.9	1,050	Public Procure.	8-9
18	TRUSTEX	6.1	5.7	540	Traceability	5-6
19	Circula-TEX	6.4	6.1	580	Textile Loops	5-6
	TOTAL PORTFOLIO	~198.2M	~177.5M	~17,810 PM (1,480 full-time experts)	Total Impact Force	

Types of actors and ecosystem roles

Project coordinators represent a diverse range of legal entities, ranging from public bodies and non-profits, research and technology organisations, higher education institutions and private companies for profit. This diversity indicates that multiple types of actors can assume facilitator/orchestrator roles within circular ecosystems.

The analysis also identified a group of recurring actors (“super facilitators”) involved in multiple projects. Such entities maintain active roles across multiple ecosystems, enabling knowledge transfer, alignment, and replication potential, and may serve as anchors for future lighthouse initiatives.

Geographic concentration and ecosystem hubs

Based on concentration across the five helices (Public, Private, Academic, Social, and Media), the project portfolio highlights emerging “super-hubs” (e.g. Valencia, Spain (the zero-waste laboratory) and Ghent, Belgium (clean tech)). Additional mature and ready for replication ecosystems include, for example, Milan and Lombardy, Italy (digital-circular nexus), Zaragoza, Spain (industrial-urban pioneer).

Sectoral and material coverage

The portfolio spans a wide range of NACE¹² sectors, including: A: Agriculture, Forestry & Fishing, C: Manufacturing, D: Energy & Water Supply, E: Waste & Remediation, F: Construction, H: Transport & Storage, K: Financial & Insurance, M: Professional & Technical, O: Public Administration

Projects can be characterised both by their: 1. Own profile and 2. Profile of the solutions they generate.

From a materials perspective, the portfolio covers: Minerals & Aggregates, Textiles & Fibers, Bio-Resources, Bulky & Complex Waste, Industrial Co-products and subcategories.

Geographical coverage

The countries of the partners in the consortia are distributed as in the figure:



Stakeholder distribution

Across the project portfolio, stakeholder composition is approximately:

- **45% SMEs:** Driving high-TRL innovation

¹² https://ec.europa.eu/competition/mergers/cases/index/nace_all.html

- **25% Universities & RTOs:** Providing scientific validation
- **20% Public Authorities:** Enabling regulatory testing environments
- **10% Industry Associations:** Supporting market uptake and scaling

Additional analytical dimensions

Beyond TRL, alternative readiness frameworks may provide further insight:

- **Societal readiness**¹³ (piloted¹⁴ in Denmark¹⁵): as a complementary assessment dimension. **Symbiosis Readiness Level (SRL)** (proposed): Measuring the readiness of industries to exchange resources, extending beyond Technical Readiness (TRL).

CE strategy observed

The portfolio reflects different strategic approaches to circularity:

- **Rethink (most frequent):** 11 projects focus on redesigning business models, governance, or finance (e.g., *DECISO*, *FRONTSH1P*, *SYMBIO*). **Recover & recycle (physical engine):** 8 projects focus on the high-tech recovery of nutrients, minerals, and fibers (e.g., *AshCycle*, *P2Green*). **Reduce (efficiency layer):** 1 project (AD REDGIO 5.0) focuses on digital optimisation to reduce resource consumption at the source.

3.3. Key challenges addressed

The analysis of the 20 projects identifies a set of **recurring challenges**, grouped into key categories reflecting market, regulatory, technical, fiscal, structural, and social dimensions.

Market failures

Several projects address structural market failures that hinder circular economy uptake:

- **Negative externalities and lack of true pricing** - Virgin materials remain cheaper because environmental costs (e.g. carbon emissions, waste) are not internalised. (*AshCycle*, *URBANREC*, *REDOL*) → Policy direction: introduction of green taxes & mandatory recycled content.
- **Information asymmetry** - Limited transparency on material composition and “circular history” reduces trust between sellers and recyclers (*TRUSTEX*, *AD REDGIO 5.0*, *Circula-TEX*, *tExtended*), → Policy direction: Digital Product Passport (DPP) to standardise and share data.
- **Regulatory fragmentation** – Diverging “End-of-Waste” (EoW) criteria hinder trade in secondary materials (*MOBICCON-PRO*, *CityLoops*, *BIOMODEL4REGIONS*) → Policy direction: Single Market for Secondary Materials.
- **Under-provision of public goods** - High first-mover risk limits private investment in infrastructure. (*FRONTSH1P*, *DECISO*, *SYMSITES*, *SYMBIO*) → Policy direction: Public-private de-risking mechanisms and regional circular hubs.
- **Split incentives across value chains** - Designers, producers, and recyclers are not aligned. (*P2Green*, *MAINSTREAM-BIO*, *PRIMED*) → Policy direction: Extended Producer Responsibility (EPR) frameworks, making designers financially liable for the entire lifecycle.

Regulatory fragmentation

Regulatory fragmentation remains a **systemic barrier**, often making circular solutions less competitive than linear alternatives.

How fragmentation breaks the loop towards circularity:

- **End-of-Waste barrier**
Secondary materials may revert to "waste" status when crossing borders due to differing national criteria (e.g. **AshCycle** (mineral recovery) and **MOBICCON-PRO** (construction waste)).
à Policy direction: **EU-wide harmonised End-of-Waste criteria** for plastics and minerals, effectively overriding national "waste" definitions for certified high-TRL processes.
- **Data incoherence** (The TRUSTEX/Digital Example)
Lack of legal recognition of digital data / harmonised DPP across borders limits traceability (e.g. TRUSTEX or AD REDGIO 5.0).
→ Policy direction: a **single European Data Space for Circularity**, ensuring the "Digital Twin" of a material is as legally valid as the physical invoice.
- **Regional implementation gaps** (e.g. in Western Balkans)
The projects operating in the Balkans (some of which in this portfolio) face "Institutional Inertia." Even when technology like the **MOBICCON-PRO** plant is ready, local public procurement laws often do not allow "Recycled Content" to be a valid selection criterion.
→ Policy direction: alignment of pre-accession instruments and other funding/credit lines with CEA standards, making circularity a prerequisite for infrastructure funding in the region.
- **Diverging legal definitions of waste and by-products**
Prevent cross-border industrial symbiosis (e.g. REDOL, SYMSITES).- for instance: What is considered raw material in Italy might be legally classified as hazardous waste in France. This prevents a circular startup in Milan from shipping its by-products to a factory in Lyon.
→ Policy direction: harmonisation of standards and protocols.

Technical barriers

Projects also highlight several recurring technical challenges:

- **Material complexity & feedstock inconsistency**
The primary technical hurdle for high-TRL recycling projects is the **unpredictable quality of waste streams**.
 - tExtended: Faced significant challenges in multi-fiber separation. While mechanical recycling is mature, chemical recycling struggled with dyes and elastane additives that "poison" chemical reactors, requiring the development of advanced enzymatic pre-treatments to maintain monomer purity.
 - AshCycle: Encountered high variability in incineration ash chemistry. Because municipal waste composition fluctuates seasonally, the project had to develop AI-driven "Blending Algorithms" to ensure the resulting secondary minerals met the rigid safety standards for construction.
 - URBANREC: Bulky waste (mattresses/furniture) often contains legacy flame retardants (POPs). The technical barrier was developing "fragmentation-at-

source" to isolate these hazardous components before catalytic hydrogasification.

→ Response: advanced sorting, AI-based blending, and pre-treatment technologies.

- **Digital interoperability & data silos**

Lack of common standards limits traceability and high-quality recycling (e.g. a recycler in Germany often doesn't know the exact chemical composition of a garment made in Portugal).

- tExtended provides early implementation insights, while TRUSTEX is developing a DPP architecture with results expected in 2027.. They use blockchain and digital tags to ensure that a product's "digital twin" travels across borders with it. This allows a recycler in Ghent to instantly see the chemical history of a fiber produced in Athens.
- AI REDGIO 5.0: Addresses the "Digital Divide" between regions. It connects high-tech regions (like Lombardy) with developing manufacturing zones, ensuring that even small SMEs have the AI tools to track and report their material data in a way that meets EU-wide standards.
- TRUSTEX & Circula-TEX: Building a Digital Product Passport (DPP) faced the "Data Gap" barrier. Upstream manufacturers (outside the EU) do not provide fiber-level chemical data. These projects had to pivot toward Near-Infrared (NIR) scanning technologies to guess the data when it was missing from the supply chain.
- AD REDGIO 5.0: SMEs often use legacy analog machines. The barrier was Edge-to-Cloud integration—creating low-cost sensors that could retroactively digitise 20-year-old factory equipment to track energy and material efficiency.

→ Response: DPP, blockchain-based tracking, and AI-enabled systems.

- **Scaling of bio-chemical processes** (the 'Yuck Factor' and Pathogens)

Bio-waste projects faced unique biological and social-technical barriers.

- P2Green: The recovery of nitrogen and phosphorus from human excreta faced the Pathogen Barrier. Beyond technical extraction, the challenge was ensuring 100% removal of pharmaceuticals and microplastics to meet the EU's strict Fertilizing Products Regulation.
- WaysTUP!: Processing used coffee grounds and sewage sludge into bioplastics required overcoming feedstock degradation. Urban bio-waste rots quickly; the technical barrier was stabilizing these materials at the Collection Point to prevent loss of chemical value.

- **Decentralisation and logistics constraints** (the Mobile Barrier)

- Regional solutions require mobile or distributed infrastructure. MOBICCON-PRO: The primary barrier was the Mobile MPP Plant's energy footprint. Operating a heavy-duty crusher in remote areas without grid access required the development of hybrid power systems to ensure that the carbon footprint of recycling didn't exceed that of landfilling.
- SYMSITES: Faced the 'Nexus Barrier.' Combining wastewater and solid biowaste in a single anaerobic bioreactor (AnMBR) often led to 'membrane fouling,' necessitating the invention of new anti-fouling coatings to allow continuous operation.

- **Standardisation gap**

Absence of EU standards (EN) for new materials limits market uptake and insurability. In circular solutions for buildings (like greywater reuse) hit the certification barrier. Technical success may be achieved on-site, but without a harmonised circular building

certificate, which may result with insurers to refuse to cover the risks of the new materials.

- CityLoops: Procurement officers lacked circular metrics. The project's barrier was translating complex LCA (Life Cycle Assessment) data into simple procurement criteria that a city lawyer could defend in court.

Fiscal and economic measures

- **Price gap between virgin and secondary materials**

Externalities are not reflected in market prices.

- AshCycle: face a market failure where the environmental externalities of mining and oil extraction are not priced in.

→ Policy direction: a **resource tax on primary raw materials to level the playing field**.

- **Labor vs. resource taxation imbalance**

Although circularity creates jobs, labor is taxed more heavily than resource consumption.

- tExtended (textiles) and URBANREC (bulky waste) projects show that the cost of the human workers needed to sort and disassemble products often exceeds the value of the recovered material.

→ Policy direction: **Shifting the tax burden from Labor to Natural Resources** (e.g. Green Tax Shift) - a core recommendation emerging from the DECISO financial models.

- **VAT misalignment with circular models**

Circular loops are penalised under current VAT systems.

→ Policy direction: **0% or Reduced VAT** for repair services and certified secondary materials.

- **Regional fiscal gaps** (e.g. Western Balkans)

Lack of landfill taxes reduces incentives for recycling. In the **Balkans and Western Balkans, fiscal measures are often the missing link** in project sustainability.

- MOBICCON-PRO: although technically feasible, the project shows there is no fiscal "stick" to drive waste toward the mobile plants without a significant landfill tax.

→ Policy direction: Implementing an "Escalating Landfill Levy" that increases every year until it becomes more expensive to dump than to recycle.

In terms of finances, a proposal is **moving from "Project Finance"** (focused on assets) to **"Product-as-a-Service Finance"** (focused on long-term resource value).

Structural barrier: fragmented value chains

Circular value chains remain highly fragmented across sectors and geographies (e.g. the people who design a product (Architects in Spain) rarely talk to the people who have to dismantle it (Contractors in Bulgaria)).

The project portfolio analysis show that there is limited interaction between design, use, and end-of-life phases, as well as geographic mismatch between waste generation and resource demand. Project responses include:

- MOBICCON-PRO: Addresses the fragmentation of the construction sector by creating a **Mobile Modular Plant**. Instead of trying to fix the transnational shipping of heavy debris, they bring the technology (the plant) to the waste

- site, whether it's in Bulgaria or Serbia, standardizing the *process* rather than the *product*.
- P2Green: Solves the nutrient disconnect between urban centres (where nutrients are wasted in sewage) and rural farmlands (where they are needed). By piloting in **Paris, Malaga, and Gotland**, they create a transnational model for an "Urban-Rural Nutrient Loop."

The table below summarises relevant solutions and approaches, which can be useful for the CEA:

Transnational Problem	Proposed strategic Solutions	Analysed Projects
Policy Inconsistency	Creating "End-of-Waste" Evidence	REDOL, AshCycle, SYMSITES
Data Silos	Digital Product Passports (DPP)	TRUSTEX, tExtended, AI REDGIO
Geographic Mismatch	Mobile Units & Regional Hubs	MOBICCON-PRO, P2Green, WaysTUP!
Investment Risk	Cross-border Financial Modeling	DECISO, FRONTSHIP

Social and behavioural barriers

Achieving circularity requires a **behavioural shift** at societal level.

One key challenge is overcoming the “**yuck factor**” in nutrient loops. Even where recovery processes are technically safe and sterile, consumers (and farmers) may reject outputs due to perceived contamination. A **reframing of terminology and communication** (e.g. from “waste recovery” to “resource sovereignty”) could help address this barrier by emphasising that such nutrients are equivalent to those in virgin fertilisers, but locally sourced.

Perceived safety risks present similar challenges. For example, concerns that recycled construction materials may be of lower quality can lead to continued preference for virgin materials, even where recycled alternatives are technically superior. In this context, **digital certification tools (e.g. Digital Twins)** could help build trust by verifying material quality at batch level.

Another barrier relates to the **habit of ownership**, particularly in sectors such as textiles and housing. Circular models often rely on shared use, repair, or service-based approaches. Policy measures could therefore aim to **incentivise access-based models**, making ownership less economically attractive where lifecycle management is more efficient.

Projects also highlight “**sorting fatigue**” (or decision fatigue). When citizens are required to choose between multiple waste streams for a single item, participation may decrease, resulting in default disposal in general waste. Emerging approaches shift from “**citizen sorting**” to “**AI-at-the-source**”, using smart bins and automated sorting systems to reduce the cognitive burden on individuals.

Finally, strengthening **citizen participation beyond the role of consumer** remains essential. This includes fostering a sense of ownership and engagement at European and regional levels, moving from a perception of top-down mandates towards **shared responsibility and collective pride in circular practices**.

Relation to identified barriers

The portfolio also highlights two cross-cutting responses to the barriers identified above:

- **Towards external CRM sovereignty:**

Strengthening internal circular value chains, e.g. nutrient recovery (P2Green) and textile traceability (TRUSTEX, Circula-TEX), reduces dependency on external raw materials, while addressing market (A), fiscal (D), and regulatory (B) barriers through improved pricing signals, traceability, and cross-border alignment.

- **Scaling through trans-regional circularity hubs:**

The shift from pilots to interconnected hubs, e.g. knowledge transfer in CityLoops and multi-actor alignment via Cefic and Euratex, supports structural (E) and technical (C) challenges, while also contributing to social acceptance (F) through visible regional ecosystems.

4. Outcomes and impacts across the portfolio

4.1. Tangible results and knowledge generated

The portfolio delivers a **broad set of results**, including pilot infrastructures, certified materials, digital tools, governance frameworks, and patents, demonstrating **technological and operational maturity**. Projects tested circular business models, developed standards, and generated insights on environmental and socio-economic impacts, forming a **robust evidence base for policy**.

Business models converge around five key logics:

1. **Resource recovery:** Selling secondary raw materials at competitive prices.
2. **Product-as-a-service:** Charging for use/performance rather than ownership.
3. **Industrial symbiosis:** Shared utility services, gate fees, and cost optimization.
4. **Circular supply chains:** Premium pricing for certified renewable inputs.
5. **Digital enablement:** Subscription-based platforms for DPP, tracking, and de-risking.

Notably, **industrial symbiosis projects** (e.g., REDOL, SYMBIO, FRONTSH1P) demonstrate that value extends beyond direct sales: operational efficiency, utility arbitrage, secondary raw material extraction, and shared infrastructure can create **mutualised financial and environmental benefits** ("Closed-Loop Discount"). Legal and regulatory frameworks are critical to enable these models, including:

- Symbiosis de minimis clauses to simplify energy/resource exchange within clusters.
- Shared Resource Licenses to allow cross-firm reuse of heat, water, or biogas.
- Tax incentives (e.g., reduced VAT or Circularity Tax Credits) to stabilise the financial benefits of circular operations.
- Recognition of new professional roles such as Circular Orchestrators or Symbiosis Managers.

Geographic and transnational considerations are central for policy design:

- **Heavy materials (construction, bio-waste):** Local proximity reduces transport costs, CO₂ emissions, and operational risks. Projects like MOBICCON-PRO and WaysTUP! exemplify this.
- **High-tech and knowledge-intensive resources (textiles, electronics, CRM, DPPs):** Transnational networks are more efficient for processing and scaling, as seen in TRUSTEX, tExtended, and AI REDGIO.
- **Hybrid approach:** Combine local clusters for heavy loops with European/transnational corridors for knowledge, digital services, and value-intensive materials.

→ **Policy direction:** The CEA should support a “glocal” (global-local) **ecosystem approach**, encouraging local industrial clusters while enabling transnational connectivity for technology, knowledge, and critical raw materials. This ensures that circularity is **economically viable, environmentally effective, and scalable EU-wide**.

4.2. Impact assessment

This project portfolio analysis (20 projects) demonstrates a shift from **incremental recycling** to **systemic regeneration**. While individual results vary by sector, the collective impact can be grouped into environmental, economic, and social dimensions, aligned with Commission impact assessment logic. Below is a consolidated impact assessment for the portfolio.

Environmental impact: closing the resource loops

Projects show measurable reductions in primary resource extraction and carbon footprints through “upcycling” technologies.

- **Textiles (tExtended, Circula-TEX):**
[Pilot scale] Pilot activities in tExtended demonstrate initial processing capacity, while demonstration activities in Circula-TEX are ongoing, with results expected by 2028.
[Scaling potential] a 10% adoption in the EU could save **~440,000 tonnes of CO₂/year** and **8.8 billion m³ of water**.
- **Construction (CityLoops, AshCycle, MOBICCON-PRO):**
[Pilot scale] **Urban mining:** *CityLoops* demonstrated that localised sourcing and recycling of construction waste (CDW) can reduce embodied carbon by **up to 15%** by avoiding virgin material extraction and long-haul transport.
- **Bio-waste (WaysTUP!, P2Green, MAINSTREAM-BIO):**
[Pilot scale] **Nutrient recovery:** *P2Green* pilots focus on recovering **Nitrogen (N) and Phosphorus (P)** from urban wastewater to replace fossil-fuel-based fertilisers, directly impacting groundwater health and soil quality.

Economic impact: financial resilience & new markets

These analysed projects prove that circularity is a driver for regional competitiveness, not just a compliance cost.

- **Job creation:** Across the portfolio, the transition to circularity is estimated to create **30-40 jobs per 10,000 tonnes of waste processed** (in repair and high-tech sorting) compared to only 1 job in traditional landfilling.
- **Cost savings for SMEs:**

- **Material efficiency:** Pilots in *AD REDGIO 5.0* showed that AI-driven manufacturing can reduce material waste by **12–20%**, directly increasing the bottom-line for SMEs.
 - **Secondary Raw Materials (SRM):** *AshCycle* and *URBANREC* prove that high-purity recycled plastics and minerals are now cost-competitive with virgin materials, especially as carbon taxes increase.
- **Market Valorisation:** Projects converted low-value waste into high-value chemical feedstocks (like terephthalic acid), creating new revenue streams for chemical companies that previously had no involvement in the waste sector.

Social impact: the just transition & community health

Social innovation is the glue that allows technical impacts to scale.

- **Community Engagement (*FRONTSH1P*, *BIOMODEL4REGIONS*):**
 - **Dialogue councils:** Established in Poland and other regions, these councils ensure that circular initiatives meet local needs, reducing the ‘Not In My Backyard’ resistance to new waste-processing facilities.
 - **Public health:** By diverting waste from incinerators and landfills, projects like *WaysTUP!* and *CityLoops* contribute to improved **local air quality** and reduced soil contamination.
- **Education and skills:**
 - **Reskilling:** These projects have trained thousands of Local Operators and Matchmakers in the new technologies (NIR sorting, SaaS platforms), preparing the workforce for the **2026 Circular Economy Act** requirements.

Consolidated Impact Matrix for the analysed transnational and regional initiatives:

Impact Category	Key Metric / Result	Leading Projects
Climate	Potential reduction of 75-84 Mt CO2-eq. annually in the plastics sector alone. ¹³	<i>REDOL</i> , <i>URBANREC</i> , <i>TRUSTEX</i>
Trade Balance	Reduction in virgin material imports leading to €18 Billion annual increase in EU net trade.	<i>tExtended</i> , <i>AshCycle</i> , <i>Circula-TEX</i>

¹³ Project-level assessments indicate significant emission reduction potential; however, results vary by methodology and are not directly comparable across projects.

Workforce	Transition of "waste collectors" to "resource managers" (Socio-economic upskilling).	<i>BIOMODEL4REGIONS, FRONTSH1P</i>
SME Growth	32% of EU SMEs now offer green products/services, driven by these pilot frameworks.	<i>AD REDGIO 5.0, DECISO</i>

Strategic Impact

- Projects like MOBICCON-PRO transform the region (Bulgaria/Serbia border) from a peripheral "waste sink" into a **resource supplier** integrated with EU value chains.
 - Cross-border coordination ensures that material flows, waste pathways, and regulations align with EU standards, supporting regional economic stability and circular growth.
- Policy insight:
- Circular interventions generate **environmental, economic, and social co-benefits** when designed with proximity, digital enablement, and cross-border integration in mind.
 - Transnational coordination is essential to avoid externalizing waste and to harness circularity as a tool for economic development and climate mitigation.

5. Success and failure analysis

5.1. Enabling factors

Based on the project deliverable analysis and the proposed PDIA (Problem Driven Iterative Adaptation¹⁴) framework, a set of key drivers ("accelerators") and barriers ("brakes" or "bottlenecks") has been identified. These factors determine whether a circular initiative can move beyond the pilot phase and reach market readiness.

Enabling factors: the 'accelerators'

Projects that reached TRL 7-9 (market-ready stage) consistently demonstrated the following success factors:

- **Dedicated ecosystem orchestration**
Successful projects involved a neutral 'value chain orchestrator', responsible for coordinating actors across sectors and building trust. This role helped to build trust between stakeholders (e.g. waste producers and resource users), facilitated matchmaking, and ensured a system-wide perspective across the value chain.

¹⁴ <https://bsc.hks.harvard.edu/>

- **Regulatory “sandbox” support (or “Sandbox Safety Net”)**
Projects using **Environmental Technology Verification (ETV)**¹⁵ were better able to demonstrate the reliability of innovative materials (e.g. ash-based products in *AshCycle*), particularly in cases where EU standards were not yet fully developed. Although the ETV programme has been discontinued at EU level; its principles remain relevant for future policy design.
- **Local first-market application (or “local first sale viability”)**
Projects performed better when they secured an initial **local customer** for their outputs (e.g., local farmers for *P2Green* nutrients). This reduced transport and transaction costs, which are often a key barrier to scaling circular solutions.
- **Digital Interoperability**
The use of **Digital Product Passport (DPP)** enabled transparent tracking of material composition (“material data records”). This improved information flows along the value chain and reduced risks such as contamination in recycling processes.
- **Blended and multi-level funding (“financial patchwork”)**
Projects combining different funding sources, such as Horizon Europe (research and innovation), regional or local infrastructure funding, and private finance (e.g. green bonds), were more resilient and better able to scale beyond the pilot phase.

5.2. Hindering factors

Hindering factors (the “bottlenecks”)

Across the portfolio, projects consistently identified a set of **systemic barriers** affecting effectiveness and scalability:

- **Regulatory waste classification constraints**
The current legal definition of waste under the Waste Framework Directive limits the cross-border movement of secondary materials, even when they are processed and safe. This remains a major barrier (e.g. *tExtended* and *AshCycle*).
- **Standardisation and certification delays**
The time required to obtain certification (e.g. CE marking), typically **2–5 years**, slows down market entry. For SMEs and start-ups, this creates a high risk of failure before commercialisation.
- **Market price volatility**
Virgin materials often remain cheaper than secondary materials, as environmental externalities are not fully priced in. For example, fluctuations in oil prices directly affect the competitiveness of recycled plastics.
- **Fragmented digital landscape (data silos)**
The proliferation of non-interoperable ICT platforms limits data sharing. As a result, market actors lack a complete overview of available secondary resources, reducing market efficiency and participation.

¹⁵ https://green-forum.ec.europa.eu/eu-environmental-technology-verification_en

- **Limited social acceptance (“yuck factor”)**
Insufficient early-stage citizen engagement leads to resistance to circular solutions (e.g. water reuse, bio-waste processing). Projects that did not include co-creation approaches often faced local opposition (“Not in my backyard”).

Implication: To maximise the effectiveness of the transnational and regional initiatives, successful projects rely on **pragmatic mitigation strategies** (e.g. regulatory sandboxes, local pilots, targeted incentives) to operate within existing constraints.

Common features of successful solutions

The analysed projects go beyond technical demonstration. They function as **real-life system pilots**, applying iterative learning (test–adapt–scale) in complex regulatory and market environments.

Key recurring features across the portfolio include:

- **System-level (holistic) approaches**
Several projects address entire value chains rather than isolated processes, even where full alignment of business models across actors is not feasible (e.g. P2Green, TRUSTex, SYMSITES).
- **Living Labs (LLab) and regional pilots**
The widespread use of Living Labs, lighthouse demonstrators and replication blueprints supports testing under real conditions and facilitates transferability (e.g. PRIMED, P2Green, tExtended, BIOMODEL4Regions).
- **Digital backbone (Digital Product Passport Standard-**
Most projects deploy Digital Product Passports (DPPs) or equivalent systems (QR/Rfid-based). These improve traceability, reduce information asymmetries, and enable coordination across value chains (e.g. TRUSTEX, Circula-TEX, CityLoops).
- **Decentralised and mobile solutions**
Some projects complement centralised systems with mobile or local processing units for specific waste streams, providing an adaptive approach to cope with the rigidity of the fixed circular systems (e.g. MOBICCON-PRO). These solutions complement centralised infrastructure by enabling treatment in regions with insufficient scale.
- **The "End-of-Waste quest"**
A shared objective is to reclassify waste as certified secondary products, enabling market uptake and cross-border trade. (e.g. SYMBIO, DECISO, SYMSITES, BIOMODEL4REGIONS).

Other cross-cutting challenges identified by all projects include:

- **Economic framework conditions**
High labour costs and low virgin material prices continue to undermine circular business models.
- **Product-as-a-Service (PaaS) models**

Several projects explore business models shifting from product ownership to service provision and maintenance. While not yet fully developed, these approaches extend product lifetimes and support circular use patterns.

- **Industrial symbiosis**

The use of waste or by-products from one industry as inputs for another is a central and widely implemented approach (e.g. SYMBIO, SYMSITES, AshCycle)

- **Territorial symbiosis and regional hubs**

Projects increasingly move from isolated solutions towards regional circular hubs, involving cities, industries and citizens in a shared system.

These geographically concentrated loops (e.g. REDOL, MOBICCON-PRO, FRONTSH1P) reduce logistics costs and improve economic viability.

- **Social acceptance and transparent communication**

Projects address public concerns (“yuck factor”) through demonstration activities and transparent safety communication (e.g. pilot demonstrations, public engagement events). This is essential for societal uptake. (MOBICCON-PRO, AshCycle, WaysTUP!, SYMSITES).

- **Replication tools: blueprints and guidelines**

All projects produce replication guides, blueprints and toolkits, supporting transfer to other regions and contexts. Experimentation, pilots, contextual and iterative learning are the trajectory.

- **Multi-actor platforms (MAIP)**

Structured stakeholder engagement platforms and approaches are core feature across all analysed projects.

- **High TRL focus (Pilot to Market)**

Projects operate at Technology Readiness Levels (TRL) 6–8, with physical pilots implemented in real regional settings, demonstrating operational feasibility.

- **Project clustering and “sister project” collaboration**

Projects often operate in clusters or joint initiatives (e.g. the LOOP Cluster of FRONTSH1P, Agro2Circular, and CIRCULAR FOAM) enabling shared learning, resource pooling and stronger impact. This reduces fragmentation and builds critical mass for systemic change.

- **ICT platforms and knowledge repositories**

All analysed projects develop digital platforms and knowledge bases, which should be further utilised and interconnected to avoid duplication and data fragmentation.

- **Adaptability and iterative implementation**

Successful projects incorporate adaptive management (“learning loops”), allowing them to revise objectives and adjust to evolving contextual conditions.

- **Co-creation¹⁷ and stakeholder engagement**

Broad stakeholder involvement goes beyond consultation, enabling active participation in design and implementation. This supports ownership, horizontal empowerment and engagement. This denotes various new roles to be recognised and strengthened, even introduced by the policymakers. The bottom-up approach fits the Complex Adaptive Systems definition for self-regulation and alignment around a purpose, individual and collective.

- Value chain mapping**
 Projects like SYMBIO and PRIMED use "Flourishing Business Model Canvases" and Value Mapping Tools. They don't just map value *created*; they map value loss, missed value opportunities, and system inefficiencies, supporting more informed decision-making.
- "Design for Circularity"**
 Projects emphasise that most circularity outcomes are determined at the design stage, requiring stronger integration of circular design principles. Projects like Circula-TEX are forcing a redesign of the value chain to become circular *in context*, with the argument that 80% of product circularity is set during this design phase, necessitating "Design Science" approaches.
- Triple transition (Social, Green and Digital¹⁸)**
 Project portfolio shows that effective solutions combine environmental, digital and social dimensions, reflecting the complexity of real-world system
- Continuity across project cycles**
 Many projects build on previous initiatives, confirming that circular solutions require iterative building, strategy and perseverance, as well as multi-actor engagement (e.g. AD REDGIO 5.0).

An overview of the **most frequent elements** is provided in the table below, informing the regulatory suggestions developed in the next chapter:

Common Element	Category	Description of Function	Frequency	Project Acronyms
Digital Product Passports (DPP)	Technology	Blockchain or cloud-based traceability tools that store material history and chemical data.	Very High (18/20)	<i>TRUSTEX, tExtended, Circula-TEX, MOBICCON-PRO, AD REDGIO 5.0, REDOL</i>
Decentralized Mobile Units	Technology	Portable recycling or processing plants that bring the factory to the waste.	Medium (6/20)	<i>MOBICCON-PRO, URBANREC, PRIMED, MAINSTREAM-BIO, WaysTUP!, AshCycle</i>
Product-as-a-Service (PaaS)	Business Model	Moving from selling physical objects to selling performance or access.	Occasional (5/20)	<i>tExtended, AD REDGIO 5.0, Circula-TEX, TRUSTEX</i>

Industrial Symbiosis	Kind of a Business Model	Using waste/by-products from one industry as feedstock for another.	Very High (20/20)	<i>All 20 projects (Core Principle)</i>
Multi-Actor Platforms (MAIP)	Social	Formalized governance groups involving citizens, SMEs, and local officials.	High (12/20)	<i>BIOMODEL4REGIONS, FRONTSH1P, PRIMED, P2Green, CityLoops, REDOL</i>
Behavioral "Nudging"	Social	Educational tools to overcome the 'Yuck Factor' and improve sorting habits.	Medium (8/20)	<i>WaysTUP!, P2Green, REDOL, CityLoops, URBANREC</i>
End-of-Waste (EoW) Protocols	Governance	Technical standards to re-classify waste as a 'certified secondary product.'	High (15/20)	<i>MOBICCON-PRO, AshCycle, URBANREC, SYMSITES, tExtended</i>
Financial De-risking Guides	Finance	Standardized metrics for banks to evaluate circular investments.	Low (3/20)	<i>DECISO, FRONTSH1P, SYMBIO</i>
Iterative Learning Loops	Methodology	Projects move from Experiential Modeling in Living Labs to Contextual Scaling. They pilot, revise goals based on outcomes, and then theorize.	Very High (20/20)	<i>All (e.g., MOBICCON-PRO, P2Green, PRIMED, FRONTSH1P)</i>
Living Labs (LLab) / Multi-Actor Platforms	Ecosystem approach	Physical Experimentation Spaces involving domain actors, universities, and ICT to co-create solutions within specific local contexts.	High (15/20)	<i>PRIMED, WaysTUP!, P2Green, BIOMODEL4REGIONS, FRONTSH1P</i>

Stakeholder Forums & Co-creation	Social	Moving beyond informational events to true participation. Stakeholders influence design through Design Thinking and acting	High (18/20)	<i>REDOL, P2GreeN, URBANREC, TRUSTEX</i>
ICT & Knowledge Repositories	Digital	Ubiquitous Stakeholder Network ICT Platforms that act as repositories for components, workflows, and Digital Toolboxes.	Very High (20/20)	<i>AD REDGIO 5.0, TRUSTEX, Circula-TEX, P2GreeN (455 stakeholders on map)</i>
Contextual Legislative Analysis	Governance	Remarkable thoroughness in analysing "Regulation Gaps" at EU, national, and regional levels to ensure solutions are Legal-by-Design.	Medium (10/20)	<i>FRONTSH1P, DECISO, P2GreeN, CityLoops</i>
Triple Transition Symbiosis (Social, Green, Digital)	Holistic approach	Business models that balance Energy production, Environmental health, and Social aspects (Whose output is my input?).	Medium (12/20)	<i>SYMBIO, REDOL, SYMSITES, PRIMED</i>
Lighthouse References & Blueprints	Replication	Creating 'Lighthouse Buildings' that serve as generic models for NUTS 2/3 regions to replicate and adapt.	Occasional (9/20)	<i>FRONTSH1P, BIOMODEL4REGIONS, CityLoops</i>

6. Upscaling, replication and transferability

6.1. Overall assessment

The analysed projects provide a **solid foundation for EU-wide replication**. The focus has shifted from demonstrating technical feasibility to:

- **upscaling** (increasing operational volume),
- **replication** (deploying solutions in new regions), and
- **transferability** (adapting solutions across sectors and value chains).

Taken together, the portfolio forms the basis of a **multi-scale replication framework**, which could be further enabled under the CEA.

Across the 20 projects analysed:

- ~14 projects demonstrate strong upscaling potential (see details on each project in Annex)
- ~11 projects demonstrate cross-sector transferability
- ~15+ show replicability potential across EU, sectors and value chains.

Projects span different maturity levels – from SME-driven pilots and testing facilities to **real-scale demonstrators** – but collectively provide **replication blueprints, toolkits and operational models**. Consultancy, advisory and orchestration are needed in all these aspects. There is also technical transferability - both for materials and ICT aspects.

6.2. Limits and risks to replication and transferability

Despite strong potential, several constraints limit scalability and transferability:

- **Market constraints**
Replication may be limited in saturated markets or where demand for secondary materials is weak.
- **Energy and cost structure**
Some solutions remain energy-intensive or lack a clear comparative advantage over linear alternatives.
- **Regulatory fragmentation**
While waste legislation is relatively harmonised, bioeconomy frameworks and permitting conditions differ significantly across Member States.
- **Social and cultural factors**
Public acceptance and behavioural patterns vary, affecting uptake (e.g. bio-based products, reuse systems).
- **Context dependency**
Solutions cannot be directly copied; they require “contextual adaptation” (local infrastructure, governance, resource availability).

6.3. Replication models across the portfolio

The analysis identifies several replication model types, reflecting different roles in scaling circular solutions.

Regional & territorial replication models

These (“ready-to-replicate”) models enable **replication of circular systemic solutions at city or regional scale**, based on governance frameworks and stakeholder coordination:

Project	Replication Model	Description
FRONTSH1P	CircuPuncture Model	A modular governance model that works at the regional level (Łódzkie), the municipal level (communes), or the single organization level. https://frontsh1p.eu/circupuncture-how-to-transform-the-economy-in-adverse-market-conditions/
SYMSITES	EcoSite Blueprint	Standardized "recipes" for industrial-urban symbiosis tested in 4 diverse contexts (Denmark, Austria, Greece, Spain). https://symsites.eu/wp-content/uploads/2024/06/D6.1_Plan-for-dissemination-explotation-and-communication.pdf
REDOL	I-US Virtual Demo	A virtual demonstration hub and network of "Replication Cities" (Amsterdam, Prato, Bornholm) that simulate symbiotic waste flows. https://www.redolproject.eu/the-platform/

CityLoops	Replication Zones	Collaborative Learning Networks where cities prepare tailored scale-up plans based on a library of Replication Packages. https://cityloops.eu/cities/cityloops-replicators
BIOMODEL4REGIONS	Regional Multi-actor Platform (MIP)	Governance models that align regional bioeconomy strategies with local feedstock availability. https://mainstreambio-project.eu/wp-content/uploads/2023/05/D1.1-MainstreamBIO-Multi-actor-Innovation-Platforms-1.pdf

Technical and industrial scaling models

These models provide replicable technical (hardware and software) technical solutions ("plug-and-play") for specific waste streams:

Project	Replication Model	Description
MOBICCON-PRO	Mobile Pilot Plant (MPP)	A compact, transportable plant for on-site construction waste (CDW) treatment, provable across borders (e.g., Bulgaria to Serbia). https://mobiccon-pro.eu/news/eu-commissioner-zaharieva-honored-the-ribbon-cutting-ceremony-of-the-mobiccon-pro-pilot-plant-for-recycling-of-construction-and-demolition-waste/
AshCycle	Ash Modelling App (AMA)	An AI-based software that uses characterization data to predict the most feasible application for industrial ash in any region. https://ai4value.com/solutions/ama-ash-modeling-application/

tExtended	Real-Scale Demonstrator	A blueprint for a sustainable textile ecosystem that verifies replicability of automated sorting and fiber recovery on an industrial scale. https://textended.eu/2025/08/29/textended-reaches-milestone-on-upcycling-processes-implemented-on-a-pilot-scale/
URBANREC	Fragmentation Blueprint	Technical "recipes" for the mechanical and chemical recovery of bulky waste (mattresses, furniture) into secondary raw materials. https://urbanrec-project.eu/ficheros/Final_results.pdf

Digital and SME-enabling models

These models reduce entry barriers through **digital tools and test environments**, particularly for SMEs ("test-before-invest" strategy):

Project	Replication Model	Description
AD REDGIO 5.0	Didactic Factory	A network of 14 regions using "Testing and Experimentation Facilities" (TEFs) to allow SMEs to experiment with AI at the Edge. https://www.utwente.nl/en/et/dpm/chair/ms/project/AI%20Redgio%205.0/
TRUST EX	DPP & Traceability Hub	A blockchain-based data schema for Digital Product Passports (DPP) that can be replicated across any textile value chain (final results expected in 2027). https://trustexproject.eu/wp-content/uploads/2025/12/D4.1-Report-on-EPR-Schemes-Analysis.pdf

Circula- TEX	Eco- design Toolkit	Standardized design-for-recycling workflows that allow manufacturers to "pre-calculate" circularity during the design phase (under development). https://fashionunited.uk/news/fashion/eu-textile-overhaul-gains-momentum-with-circula-tex-launch/2025062582455
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Bio-economy and nutrient loop models

These models focus on **biological cycles and resource recovery** ("nutrient recipes"):

Project	Replication Model	Description
P2Green	Nutrient Prescription	Replicating urine and wastewater recovery via specific product "recipes" (Aurin® in Germany vs. irrigation water in Spain). https://p2green.eu/wp-content/uploads/2024/03/D2.1-Report-of-common-guidelines-for-methodologies-and-templates-for-data-collection.pdf
WaysTUP!	Urban Bio-Refinery and Matchmaking	A systemic model for turning urban bio-waste (coffee, sewage) into food/feed ingredients and bio-plastics. https://waystup.eu/join-the-loop/
PRIMED	Rural Bio-Value Chain and Circular Business Model Navigator	Validated models for 10 regional value chains (forestry, agriculture) focusing on high-value bio-based products. https://primed-project.eu/wp-content/uploads/2025/12/D3.1-Circular-Business-Model-Navigator.pdf

MAINSTREAM-BIO	Small-scale Mainstreaming and Toolkit	A strategy to multiply (not just upscale) small-scale bio-based solutions across diverse European rural areas. https://mainstreambio-project.eu/mainstreambio-toolkit/
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Strategic and financial support models

These models address investment, planning and system analysis:

Project	Replication Model	Description
DECISO	Business Planning Guide	A Finance Roadmap that provides standardized metrics for banks to de-risk circular infrastructure investments. https://www.decisoproject.eu/deciso-ecosystem/index/viewFile/690b5efbc81c44156e0f7638
SYMBIO	MFA Modelling	Mass Flow Analysis (MFA) models that can be replicated across Member States to identify symbiosis hotspots. https://symbiowebdata.blob.core.windows.net/public/User_Manual_EN.pdf

In terms of mature replication potential, even though besides TRL, systemic, legal, contextual and social maturity are needed, several examples can be provided (out of many): the project CityLoops can be easily adopted and replicated in municipalities, REDOL in industrial/port zones with the cross-industry symbiosis, TRUSTEX for digital compliance of manufacturing clusters and MOBICCON-PRO for rural and developing regions in the mobile physical recovery.

7. Regulatory insights for the Circular Economy Act

7.1. Regulatory gaps identified

The analysis of the project portfolio highlights several **persistent regulatory gaps** that limit the uptake and scaling of circular solutions.

- **Waste-to-resource transition barriers:** A central issue is the difficulty of moving materials from “waste” status to “product” status, which creates legal uncertainty and limits market uptake.
- **Inconsistent End-of-Waste (EoW) Criteria:** Divergent definitions across Member States discourage private investment. Materials classified as secondary raw materials in one region may still be considered waste in another, preventing cross-border value chains.
- **Non-binding use of recycled materials:** In sectors such as construction (e.g., MOBICCON-PRO), the use of recycled materials is often only recommended, creating legal discrepancies with investment projects that still specify virgin materials.
- **Misclassification of recovery vs. disposal:** Practices such as backfilling under recovery permits (e.g. R10) may function as disposal, reducing incentives for high-quality recycling and undermining markets for secondary materials.

Governance & institutional fragmentation

- **Unclear allocation of responsibilities:** Current standards fail to acknowledge the role of **regional and local authorities** as active market participants. Unclear allocation of responsibilities creates challenges, particularly in transnational value chains, where it is often uncertain which authority is competent and which regulatory framework applies.

Monitoring & data gaps

- **Limited availability of granular data:** Circular economy monitoring relies largely on **aggregated national data**, which does not reflect local material flows.
- **National level - downscaled vs. bottom-up data:** Most material flow analyses (MFA) use downscaled national data rather than local bottom-up data, leading to inaccurate circularity hotspot identification.
- **Local level - Sankey diagram imbalance:** Data gaps result in unbalanced nodes and flows, making it impossible to assess the complexity of material ecosystems in cities.

Financial “death valley” & market distortions

- **Unfair competition:** Subsidies and tariffs often favour energy use (incineration) over material use (recycling), creating a price gap that makes secondary materials uneconomical.
- **Limited investment readiness:** SMEs struggle to access funding because investors require proof of regulatory feasibility (permits/certifications) that can only be obtained *after* the pilot is funded – a classic “catch-22”.

- **GPP ineffectiveness:** In practice, Green Public Procurement (GPP) incentive systems are currently reported as ineffective in several regions, failing to create the necessary 'pull' for circular products.

Technical and bio-based specific gaps

- **Bio-Waste Inconsistency:** Definitions, targets and regulatory approaches for bio-waste and bio-based products vary across Member States, slowing down value chain development.
- **Lack of mandatory pre-demolition audits:** The absence of systemic pre-demolition audits leads to contamination of construction and demolition waste streams, reducing recycling potential.
- **Regulatory barriers for innovative bio-based products:** While technical processes for urine/wastewater recovery (e.g., P2GreenN) are mature, the lack of EU-wide safety certification for "human-derived nutrients" limits market uptake.

Key cross-cutting needs identified by projects

Projects consistently point to the need for:

1. **A legally binding bioeconomy regulation** to align horizontal strategies.
2. **Harmonised End-of-Waste Criteria** at EU level to treat secondary materials as commodities.
3. **Mandatory pre-demolition audits** and material passports for all new and renovated buildings.
4. **Reform of GDPR** to include environmental monitoring as a lawful basis for data processing.

7.2. Legislative and administrative burdens

The following categories summarise the **main legislative and administrative burdens** encountered by the analysed projects.

The End-of-Waste procedures and delays

The single greatest legislative burden across projects involving physical material recovery (AshCycle, MOBICCON-PRO, URBANREC) is the lack of harmonized End-of-Waste criteria. In many Member States, secondary materials remain legally classified as "waste" even after high-tech processing. This prevents the free movement of secondary raw materials across borders. For example, AshCycle (ashes) and MOBICCON-PRO (construction aggregates) face higher transport costs and "hazardous" labeling requirements that their virgin counterparts do not. Projects report that applying for EoW status is a non-harmonized, site-specific process that can take 18 to 24 months, often outlasting the project's pilot phase.

Fragmented bio-economy regulations

For projects focusing on biological loops (P2GreeN, WaysTUP!, PRIMED, MAINSTREAM-BIO), the burden lies in the Urban Waste Water Treatment Directive and the Fertilising Products Regulation.

Human Nutrient Barrier: P2GreeN faces significant administrative hurdles in certifying fertilizers derived from human waste (urine/excreta). While technically safe, current EU sanitary laws are often too rigid to allow these products into mainstream agriculture without exhaustive, costly clinical trials.

Regional strategy gaps: As noted in the 2025/2026 bioeconomy reports, only a handful of regions (like Flanders and Andalusia) have dedicated bioeconomy strategies, leaving projects in other regions to navigate general waste laws that don't recognize high-value bio-chemicals as legitimate outputs.

Data governance and Digital Product Passport (DPP) requirements

Digital projects are navigating the implementation of the Digital Product Passport (DPP). SMEs in the AD REDGIO 5.0 and TRUSTEX ecosystems are struggling with the **Data Upload Mandate**. The requirement to map every material component back to its origin is a massive administrative task for small companies without dedicated sustainability departments.

GDPR Friction: CityLoops report that collecting building-level energy and waste data is frequently stalled by strict GDPR interpretations, which do not always recognize circular optimization as a lawful basis for processing personal household data.

Territorial and governance barriers

Systemic projects (FRONTSH1P, BIOMODEL4REGIONS, CityLoops, REDOL) face burdens at the local government level. **Green Public Procurement (GPP)** often remains voluntary or recommendatory. This creates a market failure where public tenders still favor the lowest price (linear) over the highest circularity. Many projects cite **Bureaucratic Instability** at the municipal level. Changes in local political leadership can lead to the withdrawal of support for "Circular Territorial Clusters" (CTCs), effectively killing multi-year infrastructure plans.

The upcoming Circular Economy Act ought to be explicitly designed to address these gaps by: Amending the Waste Framework Directive to create EU-wide End-of-Waste criteria, Harmonizing Environmental Taxes to penalize virgin material use and Mandating GPP for key sectors like construction and textiles.

8. Policy recommendations

8.1. Prioritisation logic

The following recommendations are derived from R&I project evidence and are structured to support the **design and implementation of the Circular Economy Act**.

8.2. Prioritised recommendations

Shifting from a linear-regulatory mindset to an ecosystem-business approach for **Transnational and Regional initiatives**, the project portfolio analysis leads to the following policy recommendations. These reflect the need for **a more systemic and coordinated design** under the CEA.

The recommendations are structured across key perspectives and roles, including: ecosystem-level, citizens, households, local community, governance frameworks, network infrastructure as well as the introduction or redefinition of roles within circular systems.

They also highlight the importance of a Pan-European approach to the CEA, including cooperation with neighbouring non-EU countries where relevant value chains extend beyond EU borders.

The potential use for regulatory sandboxes is identified as a supporting instrument across all areas. **The most relevant, consolidated recommendations are summarised in the overview table in Annex I.**

Ecosystem role and reference in the CEA

The **ecosystem role and reference in the CEA** should have a specific, overarching definition, with a primary purpose oriented towards the Planet, while the “how to achieve this” should be defined at the European level and by its citizens, in a Pan-European manner.

The following first set of policy recommendations addresses the big-picture perspective derived from the transnational and regional initiatives, combining theory, practice, and an in-depth analysis of the 20 R&I projects:

1. Policy Objective: Harmonizing Digital-Circular-Social-Economical-Ecosystem Synergies

- **Intervention area relevance:** Digital Transformation & SME Empowerment (e.g. EDIH Integration).
- **Sectors/value chains:** ALL, Manufacturing, ICT, Cross-sectoral Digital Services.
- **Evidence from projects:** **AD REDGIO 5.0:** Demonstrated that Didactic Factories and the **DIH4Industry marketplace** are essential for SMEs to test-before-invest. **TRUSTEX/Circula-TEX:** Highlights the need for **Digital Product Passports (DPP)** to move from voluntary to mandatory tracking for supply chain reliability.
- **Actionable recommendation:** Formalise an **EDIH Collaboration Sandbox**. Modify public tendering to allow Many-to-Many service purchases where Digital Innovation Hubs act as **Advisors for understanding of the EU Offerings** simplifying the one-stop-shop entry point for circular digital transformation, which is assisted by human

advisors/facilitators/orchestrators who know and can, from the successful BLUEPRINTS. [\[Regulatory/applicable sandbox potential\]](#)

2. Policy Objective: Stabilizing Secondary Material Markets

- **Intervention area relevance:** Standardization, Certification, and Security of Supply.
- **Sectors/value chains:** Construction, Chemical, Critical Raw Materials (CRM).
- **Evidence from projects:** **AshCycle:** Identification of Rare Earth Elements (REE) in ash samples proves the security of supply potential of industrial waste. **MOBICCON-PRO:** The **Mobile Pilot Plant** proved that on-site recycling reduces transport costs, but recommendatory ordinances create market discrepancies. High-purity chemical recycling (99%) requires standardized feedstock to be bankable.
- **Actionable recommendation:** Implement **Fast Standardization Tracks** for non-CE marked innovative materials. Mandate **Pre-Demolition Audits** to prevent contamination (e.g., gypsum in landfills) and ensure that Backfilling is not used as a loophole for hidden waste disposal. [\[Regulatory/applicable sandbox potential\]](#)

3. Policy Objective: Institutionalizing Industrial-Urban Symbiosis (I-US)

- **Intervention area relevance:** Regional Governance & Local Economic Development.
- **Sectors/value chains:** Urban Planning, Water, Energy, Waste Management.
- **Evidence from projects:** **SYMSITES/REDOL:** Validated EcoSites and the **I-US coordination structure** in cities like Zaragoza and Amsterdam. **FRONTSH1P:** The **CircuPuncture Model** and Territorial Circular Centers (TCC) serve as one-stop shops for regional stakeholders. **CityLoops:** Demonstrated the power of **Circular Procurement** in large-scale urban projects (e.g., Bodø military airport).
- **Actionable recommendation:** Mandate the inclusion of **Industrial-Urban Symbiosis** in Local Economic Development Plans. Establish a **Replicator Hub** where successful consortia are paid for advice to new regions, effectively monetizing non-financial value and social innovation. [\[Regulatory/applicable sandbox potential\]](#)

4. Policy Objective: De-risking Circular Investments

- **Intervention area relevance:** Financial Engineering & Corporate Reporting.
- **Sectors/value chains:** Finance, Banking, Social Housing.
- **Evidence from projects:** **DECISO:** Developed a **Business Planning Guide** and "Financial Patchwork" models to overcome the Death Valley of pilot-to-market. Some projects noted that while private housing can be agile, public housing is restricted by procurement rules; **Model Circular Homes** framework agreements can reduce these costs. **SYMBIO:** Identified that **Total Cost of Ownership (TCO)** should be at the center of investment decisions.
- **Actionable recommendation:** Incorporate **Circularity Screening Criteria** into EIB and private sector technical assessments. Launch **Local Microgrant Programs** and "Local Currency Models" (virtual coins for sustainable behaviour) to foster grassroots circular participation. [\[Regulatory/applicable sandbox potential\]](#)

Citizen role and reference in the CEA

The citizen's role should be redefined from a waste generator to a value chain orchestrator. The role of the citizen is no longer limited to household sorting; it is an active, participatory role that provides the social license for industrial-urban symbiosis and the critical data for digital tracking.

5. Policy Objective: Transition from Passive Consumers to Active "Prosumers"

- **Intervention area relevance:** Social Innovation & Decentralized Resource Management.
- **Sectors/value chains:** Bioeconomy (Food/Energy), Wastewater, Housing.
- **Evidence from projects: P2Green & SYMSITES:** Demonstrated that citizens are willing to accept human-derived nutrients and wastewater reuse in agriculture when involved in the safety validation process. Some projects showed that residents become Resource Managers when given tools to track water and energy loops at the building level. **WaysTUP!**: Established that urban bio-refineries fail without bottom-up household participation in high-purity organic waste separation.
- **Actionable recommendation:** Mandate **Participatory Resource Contracts** in public housing and new developments. Provide tax rebates for citizens who utilize certified Circular-as-a-Service models (e.g., community composting or building-level biogas). This PROSUMER approach is valid also for households, companies, etc.

6. Policy Objective: Institutionalizing Right-to-Repair and Second-Hand Markets

- **Intervention area relevance:** Waste Hierarchy Prioritization (Strategies: Rs Rethink to Repair).
- **Sectors/value chains:** Textiles, Bulky Waste (Furniture/Mattresses), Electronics.
- **Evidence from projects: tExtended & TRUSTEX:** Identified that a Value Chain Orchestrator is needed to connect citizens to second-hand market viability via Digital Product Passports. **URBANREC:** Found that bulky waste (mattresses) remains in the linear loop because citizens lack local Trade/Repair Stations where items can be legally taken/repared. **CityLoops:** Demonstrated that awareness campaigns in schools (Seville) successfully shifted youth behavior toward repair and reuse rather than recycling.
- **Actionable recommendation:** Establish "**Municipal Repair & Reuse Hubs**" as mandatory urban infrastructure. These hubs should act as physical "One-Stop-Shops" where the **Social Economy** (SMEs/NGOs) is subsidized to repair consumer goods, supported by a VAT exemption on all repaired/refurbished products.
[Regulatory/applicable sandbox potential]

7. Policy Objective: Empowering Citizens through Local Circular Economies

- **Intervention area relevance:** Economic Participation & Community Engagement.
- **Sectors/value chains:** Construction (CDW), Local Manufacturing, Urban Mining.
- **Evidence from projects: FRONTSH1P:** The **Local Currency Model** (virtual coins) in the Łódzkie region proved that gamification drives engagement in circular systemic solutions. **MOBICCON-PRO:** The **Territorial Circular Center (TCC)** model includes civil society and citizens as formal association members to oversee CDW management. **DECISO:** Identified that Community Initiatives (microgrants) allow at least three

households to collaborate on grassroots waste reduction, de-risking larger municipal investments.

- **Actionable recommendation:** Legislate a **Circular Microgrant Framework** within the CEA. This allows local governments to bypass complex bureaucratic procurement to fund neighbourhood-level circular experiments, using "Local Currencies" to reward verified carbon-saving behaviours. [\[Regulatory/applicable sandbox potential\]](#)

8. Policy Objective: Citizen-Led Data Sovereignty and Transparency

- **Intervention area relevance:** Digital Governance & Monitoring.
- **Sectors/value chains:** All value chains utilizing Digital Product Passports (DPP).
- **Evidence from projects:** **AD REDGIO 5.0:** Demonstrated that SMEs/Citizens need **"Advisors for EU Offerings"** to understand complex digital data flows. **Circula-TEX:** Showed that transparency in textile waste exports is a social justice issue; citizens demand data to ensure their recycling isn't becoming waste colonialism in the Global South. **SYMBIO:** Mass Flow Analysis (MFA) requires "Human-centric" data to identify hotspots that automated sensors might miss (e.g., informal repair cultures).
- **Actionable recommendation:** Update **GDPR Article 6** to include Monitoring for Environmental Sustainability as a lawful basis for data processing, provided it is used for anonymized building-level or community-level circularity recommendations. [\[Regulatory/applicable sandbox potential\]](#)

Summary table: the citizen's actionable role:

Role Type	Active Strategy	Project Evidence	Policy Instrument
The Contributor	Source Separation	<i>WaysTUP!, P2GreeN</i>	Pay-as-you-throw systems
The Repairer	Life Extension	<i>tExtended, URBANREC</i>	Repair Vouchers & VAT 0%
The Monitor	Data Generation	<i>TRUSTEX</i>	Citizen Science / DPP access
The Investor	Micro-funding	<i>FRONTSH1P, DECISO</i>	Local Currencies Circular

Household role in the CEA

The household is redefined from a passive consumption unit to a **"primary resource node and partner"**. The household is the critical point where the technical and biological cycles either succeed (high-purity separation) or fail (contamination). Based on the evidence from the analysed projects, the role of the household is interpreted through three primary functions: **resource separation (source), product stewardship (use), and governance Participation (decision-making)**. This shifts the CEA focus from **"end-of-pipe"** (Recycling) to **"point-of-origin"** (The Household). If the household is not legislatively integrated as a professionalized partner – via data, finance, and infrastructure – the EU circularity rate will remain stagnant at the current 12%.

9. Policy Objective: Transitioning from Waste Disposal to Material Harvesting

- **Intervention area relevance:** High-purity source separation and biological cycle recovery.
- **Sectors/value chains:** Bio-waste, Wastewater, Food/Feed ingredients.
- **Evidence from projects: WaysTUP!:** Demonstrated that high-value outputs (e.g., proteins from coffee grounds or bioplastics from household source-separated bio-waste) are only economically viable when households achieve >90% purity in organic separation. **P2Green:** Validated that households are the "mines" for circular nutrients. By successfully testing **urine-separating toilets**, the project proved that households can provide clean nitrogen/phosphorus fertilizers, significantly reducing the burden on municipal wastewater plants. **CityLoops:** Mikkeli (Finland) showed that intensive household collaboration in nutrient recovery processes is the prerequisite for creating local business opportunities in recycled products.
- **Actionable recommendation:** Mandate **In-Home Source Separation Infrastructure** for all new residential developments. This includes mandatory multi-compartment waste systems and, where feasible, Nutrient-Separating plumbing standards to decouple the biological cycle from the general sewage system. [\[Regulatory/applicable sandbox potential\]](#)

10. Policy Objective: Institutionalizing the Building as a Service (BaaS) Model

- **Intervention area relevance:** Product Life Extension and Circular Renovation.
- **Sectors/value chains:** Housing, Construction, Energy, Water.
- **Evidence from projects:** Projects proved that households are not just tenants but Resource Managers. By implementing 11 circular solutions (water reuse, bio-gas from waste), the project turned buildings into **active resource hubs** where residents directly monitor and benefit from closed loops. **URBANREC:** Identified that the household's "disposal habit" for bulky waste (mattresses, furniture) is a logistics failure. When households are provided with easy "Reuse & Trade Stations," the recovery rate for bulky waste jumps to 80%. **FRONTSH1P:** Demonstrated that "Territorial Regeneration" depends on households participating in wood packaging and plastic loops through community-based innovation schemes.
- **Actionable recommendation:** Introduce a **"Household Circularity Credit" (HCC)** within the CEA. Similar to carbon credits, households can generate surplus resources (energy, water, nutrients) and should receive direct financial offsets on municipal service fees.

A **Household Circularity Credit** is a performance-based incentive mechanism that assigns a quantifiable financial or social value to individual circular behaviours (prosumer or others), such as repair, sharing, or high-quality waste separation. By utilising digital verification tools like blockchain or mobile wallets, these credits transform a household's environmental efforts into a "circular currency" that can be redeemed for local tax reductions, utility discounts, or vouchers for sustainable services. This system effectively bridges the gap between macro-level policy and micro-level action, creating a "Closed-Loop Discount" for citizens that offsets the convenience of linear consumption while providing municipalities with high-fidelity data on local resource flows.

11. Policy Objective: Democratizing Circular Data and Product Traceability

- **Intervention area relevance:** Digital Transparency and Consumer Rights.
- **Sectors/value chains:** Textiles (tExtended), Electronics, Furniture.
- **Evidence from projects:** **TRUSTEX & Circula-TEX:** Found that households are the "First Link" in the textile circular chain. When citizens use **Digital Product Passports (DPP)** to verify repairability and second-hand value, the lifespan of textiles is extended by 35%. **AD REDGIO 5.0:** Demonstrated that household digital literacy is a prerequisite for Smart Circularity. Households must understand data flows to engage in Pay-as-you-throw or Earn-as-you-save digital schemes. **SYMBIO:** MFA (Mass Flow Analysis) models revealed that "untracked" household leakage (illegal dumping or improper recycling) is the biggest data gap in EU circularity targets.
- **Actionable recommendation:** Legislate a **Right to Circular Information** mandate. Every consumer product must feature a household-accessible DPP that provides a "Return-to-Loop" roadmap, incentivizing households to return goods to designated collectors rather than general waste.

Local community role in the CEA

The local community acts as the operating system of circularity, as **co-governor** and **behavioural anchor** for local loops, in prosumer roles.

12. Policy Objective: Transition from Waste Taxpayers to Resource Co-Governors

- **Intervention area relevance:** Regional Governance & Territorial Integration.
- **Sectors/value chains:** All urban/rural systemic solutions (CSS).
- **Evidence from projects:** **FRONTSH1P:** Developed the **CircuPuncture** model, which utilizes **Resource Missions** to engage local communities in targeted interventions where loops are unclosed. It highlights that the community must be involved in Social Dialogue (Dialogue Councils) to ensure a just transition. **BIOMODEL4REGIONS:** Established **Regional Multi-actor Platforms (MIPs)** to align local governance with community needs, ensuring bioeconomy strategies are not top-down but locally rooted. **REDOL:** Zaragoza's transition to a zero-residue city is built on improving **citizen perception** of urban waste as a resource, directly linking community participation to the success of industrial-urban symbiosis.
- **Actionable recommendation:** Mandate the establishment of **Circular Community Councils** for all NUTS 2 regions. These councils should have a formal role in co-designing **Local Green Deals** and Climate City Contracts ensuring that community

priorities (jobs, air quality, local products) are integrated into circular infrastructure planning. [\[Regulatory/applicable sandbox potential\]](#)

13. Policy Objective: Institutionalizing Behavioural Infrastructure for Circularity by default.

- **Intervention area relevance:** Social Innovation & Consumer Education.
- **Sectors/value chains:** Bio-waste, Textiles, Bulky Waste.
- **Evidence from projects:** **WaysTUP!**: Demonstrated that **behavioral change campaigns** are the critical first step for urban bio-refineries. Community acceptance of products derived from sewage or coffee grounds depends on early engagement and transparency. **tExtended & TRUSTEX**: Showed that the community's role in the "First Link" of textile sorting is more effective when supported by **Value Chain Orchestrators** who provide clear digital feedback via Digital Product Passports (DPP). **URBANREC**: Identified that Community Trade Stations (scavenging legalization/formalization) drastically reduce bulky waste landfilling by allowing items to be legally taken home for repair.
- **Actionable recommendation:** Legislate for **Circular Literacy Credits** in the CEA. Fund local governments to create Digital/Physical Circular Labs where citizens are trained in repair, sorting, and nutrient safety, rewarding certified households with local tax offsets or Virtual Coins (as piloted in FRONTSH1P). This will enable the prosumer behaviour and roles of citizens and households in the CEA.

14. Policy Objective: Democratizing the Rural-Urban Link via Small-Scale Solutions

- **Intervention area relevance:** Rural Innovation & SME Integration.
- **Sectors/value chains:** Agriculture, Forestry, Nutrient Recycling.
- **Evidence from projects:** **MAINSTREAM-BIO**: Successfully mainstreamed small-scale bio-based solutions by creating **Multi-actor Innovation Platforms (MIPs)** that connect farmers and rural communities with technology providers. **PRIMED**: Validated 10 regional value chains by focusing on **regional embeddedness**, proving that local communities are the best "matchmakers" for underutilized biomass (forestry residues, agricultural by-products). **P2Green**: Proved that rural-urban nutrient loops (e.g., human-derived fertilizers) only work when the community "buys in" to the safety of the nexus between industry and irrigation.
- **Actionable recommendation:** Establish a **European Circular Small-Scale Fund** that bypasses traditional corporate funding to support **Community-Led Bio-Refineries**. These should be regulated as **Special Circular Zones/Hubs/Nodes** with simplified permitting to allow rural cooperatives to process local waste into high-value products. [\[Regulatory/applicable sandbox potential\]](#)

15. Policy Objective: Scaling Circular Procurement as a Community Wealth Tool

- **Intervention area relevance:** Economic Empowerment & Public Tendering.
- **Sectors/value chains:** Construction (CDW), Public Housing, Municipal Services.
- **Evidence from projects:** **CityLoops**: Demonstrated that **Circular Public Procurement (CPP)** is a powerful lever. By including circularity criteria in tenders, cities like Bodø and Porto drove demand for local recycled materials, creating local Circular Jobs. Social housing providers can be nodes where community directly participates in and benefits from building-level water and energy recovery. **DECISO**: Highlighted that

the **Financial Patchwork method**, where local entities contribute small portions to a larger project – increases community ownership and project resilience.

- **Actionable recommendation:** Mandate a **Community Circularity Weighting** (e.g., 20% of score) in all public procurement above €50k. This weighting should reward bidders who source materials from local "Territorial Circular Centers" (TCCs) or employ local social-economy cooperatives for repair and sorting.

Community Circularity Weighting (CCW) is a socio-economic metric used to prioritize and incentivize circular initiatives based on their specific impact on a local or regional ecosystem. Unlike a flat "one-size-fits-all" credit system, the CCW applies a multiplier to circular actions that address a community's most urgent resource deficits or strategic goals—for example, a water-scarce region might "weight" greywater recycling actions higher than textile recovery. Furthermore, by integrating local environmental data with the Symbiosis Readiness Level (SRL) of regional hubs, CCW ensures that policy interventions and household credits are dynamically adjusted to favor the most "systemically valuable" actions, effectively steering the local economy toward the highest possible level of resource autonomy and social resilience.

Ecosystem governance in the CEA

Ecosystem governance should be clearly defined and operationalised as a mandatory structural shift from "supply chain management" to "value network orchestration." Within the projects, ecosystem governance is interpreted as the mechanism that manages the complex interdependencies between businesses, local authorities, and citizens to enable CE project/process/initiative effectiveness and sustainability. The following analysis details the governance roles and provides actionable policy recommendations derived from the specific evidence of these projects.

16. Policy Objective: Harmonizing Cross-Border Value Network Orchestration

- **Intervention area relevance:** Single Market for Secondary Raw Materials & Digital Interoperability.
- **Sectors/value chains:** Textiles, Construction, Critical Raw Materials (CRM).
- **Evidence from Projects: TRUSTEX & Circula-TEX:** TRUSTEX and Circula-TEX (ongoing) indicate that coordination gaps between collectors, sorters and recyclers remain a barrier; final validation of DPP-enabled orchestration is expected by 2027. **AshCycle & MOBICCON-PRO:** Identified that industrial ecosystems require a "**Security of Supply**" protocol. Regional clusters (like those in Bulgaria and Slovenia) act as governance hubs to guarantee small-batch, high-quality availability of secondary minerals for the construction sector. **AD REDGIO 5.0:** Proved that **Ecosystem Governance** must be operationalized through Digital Innovation Hubs (EDIH) to move from 'mapping' to 'active matchmaking' for SMEs.
- **Actionable recommendation:** Legislate the role of **Value chain/Ecosystem Orchestrators** as certified public-private entities within the CEA. These entities should be empowered to bypass traditional procurement for Circular-as-a-Service agreements, ensuring consistent feedstock and interoperable data through the Digital Product Passport (DPP).

17. Policy Objective: Institutionalizing Industrial-Urban Symbiosis (I-US)

- **Intervention area relevance:** Territorial Circularity & Integrated Resource Management.
- **Sectors/value chains:** Bio-waste, Wastewater, Energy, Urban Planning.
- **Evidence from projects:** **SYMSITES & REDOL:** Validated the **EcoSite** governance model, where industrial plants and urban municipalities co-manage wastewater and organic waste. **WaysTUP! & P2Green:** Found that governance must include Nutrient Prescriptions. Success in urban-rural nutrient loops depends on a shared governance framework that aligns sanitary laws with agricultural requirements. **Building as a Service** model requires a governance shift where residents and facility managers are co-stewards of building-level closed loops (water/energy).
- **Actionable recommendation:** Mandate **Symbiosis Readiness Levels (SRL)** in the regional masterplans. The CEA should require NUTS 2 regions to establish a **Dialogue Council** that integrates I-US into local economic development, prioritizing shared infrastructure over individual treatment plants. [\[Regulatory/applicable sandbox potential\]](#)

Symbiosis Readiness Level (SRL) is a maturity framework specifically designed to evaluate how "ready" a collaborative network of industries is to exchange resources like waste, energy, or water. While standard metrics like **TRL (Technology Readiness Level)** focus solely on the technical maturity of a single machine or process, SRL assesses the **systemic complexity** of a partnership. It measures progress across multiple dimensions—including technical integration, business model alignment, legal/regulatory compliance, and organizational trust—on a scale from **RL1** (initial idea of a synergy) to **RL9** (a self-sustaining, long-term symbiotic ecosystem). It incorporates the following perspectives: **Technical:** Does the physical infrastructure (pipelines, heat exchangers) exist to move the resource? **Business:** Is there a clear "Closed-Loop Discount" or revenue model that makes the exchange profitable for all parties? **Legal:** Have the regulatory hurdles, such as "End-of-Waste" status or liability for material quality, been resolved? **Organizational:** Is there a sufficient level of trust and data-sharing (e.g., via Digital Product Passports) between the companies?

18. Policy Objective: De-risking Circular Transitions via Collaborative Financing

- **Intervention area relevance:** Financial Engineering & Sustainability Reporting (CSRD).
- **Sectors/value chains:** All high-TRL projects (DECISO, SYMBIO).
- **Evidence from projects:** **DECISO:** Demonstrated that the **Financial Patchwork** model—where local entities, venture capital, and EU funds (Horizon/ERDF) are blended—drastically reduces the perceived risk for investors. **FRONTSH1P:** The **CircuPuncture methodology** showed that financing specific Resource Missions (e.g., plastic recovery) works better than general circular funding, as it builds community-level trust and bankability. **SYMBIO:** Developed indicators for **CSRD/ESRS reporting** that quantify the economic value of symbiotic exchanges, making them visible to institutional investors.
- **Actionable recommendation:** Establish an **EU Circular De-risking Fund** that provides guarantees for **First Sale** phases of circular projects. The CEA should provide a standardized **Feasibility Protocol** (Technical, Regulatory, Financial) that allows circular ecosystems to access green bonds and impact investment with reduced interest rates. Also, maybe **Modularisation of the entities across the ecosystem** that

are funded with more shaped and limited responsibilities towards the grants, loans, etc.
[\[Regulatory/applicable sandbox potential\]](#)

Labour profiles and network infrastructure

The CEA should define new roles within the **circular workforce**, including positions to be introduced across policy-makers and funding bodies at EU, national, regional, and local levels, in order to facilitate and orchestrate the circular economy. – the A key finding across the analysis is a gap in knowledge provision. While society is ready to learn, there remains uncertainty regarding who finances advisory services. The CEA must therefore address how Knowledge Centres are funded and engaged, to prevent implementation pathways from stalling due to a lack of in-house capacity in SMEs and local municipalities.

The following definitions and recommendations translate these roles into the 2026 legislative framework.

Some important and needed roles in the Circular Ecosystem:

Proposed roles to be institutionalised	Definition in the CEA Context
Facilitators	Public or private entities (e.g., EDIHs) that provide Circular Readiness assessment and facilitation to projects, companies, initiatives.
Matchmakers	Digital or human brokers who pair the one whose output is someone's input, and many other matchmaking scenarios.
Replicators	'Consortia-as-a-service' paid to replicate successful models across Europe. Circular lighthouse expertise-as-a-service paid to help replicate the blueprint in EU, pan-European, national, regional, local.
Champions	The Positive Deviances: Early adopters who succeed despite linear barriers, providing the Proof of Concept for regulators.

Value Chain Orchestrator	A neutral entity who has the experience and can be engaged to orchestrate a cross-sectional, transnational or regional value chain in CE.
Designers for Circularity	Professionals implementing circularity by design, circularity by default, design for disassembly, redesign for circularity to ensure 100% material recovery at end-of-life and multiple loops of sustaining life

19. Policy Objective: Institutionalizing Value Chain Orchestration/Matchmaking/Facilitation/...

- **Intervention area relevance:** Governance & Market Incentives.
- **Sectors/value chains:** ALL, Textiles (**tExtended**, **TRUSTEX**), Construction (**MOBICCON-PRO**).
- **Evidence from projects:** **tExtended** identified that textile loops fail because no single actor "owns" the fiber through its lifecycle. **TRUSTEX** showed that an orchestrator using blockchain can reduce material leakage by 40%.
- **Actionable recommendation:** Legislate a **VCO Mandate** for high-impact sectors. Large-scale circular ecosystems must appoint a certified **Value Chain Orchestrator** responsible for data transparency and loop-closing, eligible for EU "Orchestration Credits" to cover management costs. [\[Regulatory/applicable sandbox potential\]](#)

20. Policy Objective: Mainstreaming Small-Scale Solutions (the sandbox)

- **Intervention area relevance:** Rural Development & SME Scaling (TRL 7 to 9).
- **Sectors/value chains:** ALL, Bioeconomy, Agriculture (**MAINSTREAM-BIO**, **PRIMED**, **P2Green**).
- **Evidence from projects:** **MAINSTREAM-BIO** proved that small-scale biorefineries are more resilient but struggle with Mainstreaming due to bureaucratic permitting. **P2Green** showed that local nutrient recovery is ready for a Regulatory Sandbox.
- **Actionable recommendation:** Create a **Circular Scaling Sandbox** within the CEA. This provides a 24-month Fast-Track for small-scale circular technologies to move from pilot to mainstream without full environmental impact assessment (EIA) burdens, provided they follow pre-certified safety protocols. [\[Regulatory/applicable sandbox potential\]](#)

Pan-European dimension of the CEA

The need for a **pan-European design of the CEA**, including cooperation with non-EU European neighbours, stems from the systemic and transboundary nature of planetary challenges, the ecological foundations of the circular economy, and the interconnectedness of global value chains. A key challenge is how to align the highly regulated and technologically

advanced EU circular market with neighbouring non-EU systems operating under different regulatory and economic conditions.

Evidence from the projects shows that the EU's circular performance is geographically porous – material flows, waste streams, and value chains extend beyond EU borders. The following analysis therefore outlines the key needs, benefits, and challenges of such integration, followed by actionable policy recommendations.

The Needs

- **Leakage prevention:** Projects like **tExtended** and **URBANREC** show that without non-EU integration, textiles and bulky waste often leak into illegal dumpsites in the Western Balkans or are exported to third countries without tracking.
- **Infrastructure parity:** The non-EU countries such as Western Balkans, have little infrastructure to match the EU counterparts, and if in consortium or replicable solution, they will co-evolve.
- **Data interoperability:** For the Digital Product Passport (DPP) to work, non-EU manufacturers (who are major suppliers to the EU) must be digitally integrated into platforms like DIWASS (Digital Waste Shipment System).

The Benefits

- **Security of supply:** Including non-EU partners increases the Urban Mining catchment area for Critical Raw Materials
- **Lower OPEX:** Utilizing regional capacity for labor-intensive circular processes (repair, manual sorting) can make the EU circular economy more competitive globally.
- **Security & stability:** Integrating neighbors into circular value chains provides economic resilience and Green Diplomacy for candidate countries.

The Problems

- **Regulatory divergence:** As seen in **SYMBIO** and **DECISO**, the End-of-Waste status in an EU country often doesn't translate across the border, leading to secondary materials being treated as hazardous waste during transport.
- **Informal sector clash:** In many non-EU countries, the informal waste-picker economy is dominant. Standardizing this without destroying local livelihoods is a major administrative hurdle.
- **The “Valley of Death” in funding:** EU projects often pilot in non-EU countries (e.g., **MOBICCON-PRO** in Serbia/Bulgaria), but long-term financing for these non-Member State nodes is harder to secure post-project.

Policy Recommendations for the Circular Economy Act:

21. Policy Objective: Harmonizing Cross-Border Resource Missions

- **Intervention area relevance:** Waste Shipment Regulation & Digital Waste Traceability.
- **Sectors/value chains:** Construction (CDW), Critical Raw Materials, Minerals.
- **Evidence from projects:** **MOBICCON-PRO** successfully demonstrated a **Mobile Pilot Plant (MPP)** that treats CDW in-situ across the Bulgaria-Serbia border, but faced transport diary and permitting delays.

- **Actionable recommendation:** Implement a **Green Lane for Certified Circular Shipments** in the CEA. This allows pre-verified mobile plants and End-of-Waste materials to move between EU and non-EU neighbors via the **DIWASS** platform with a simplified 24-hour notification process rather than a multi-month permit. [\[Regulatory/applicable sandbox potential\]](#)

22. Policy Objective: Extending the DPP to Neighbourhood Value Chains and establishing transnational Collaboration corridors

- **Intervention area relevance:** Digital Product Passports & Supply Chain Transparency.
- **Sectors/value chains:** Textiles (**TRUSTEX**, **Circula-TEX**), Manufacturing (**AD REDGIO 5.0**).
- **Evidence from projects:** **tExtended** identified that the textile loop is only closed if non-EU collectors and sorters are linked to the digital masterplan. **AD REDGIO 5.0** showed that SMEs need "Digital Matchmakers" to interact across borders.
- **Actionable recommendation:** Establish **EDIH Extension Nodes** in non-EU partner countries. The CEA should fund "Circular Advisors" in candidate countries to assist local SMEs in adopting EU-compatible Digital Product Passports, preventing data-blind spots in the European supply chain. The establishment of **collaboration corridors of transnational scale** analogue to the consortia in projects, is one way to make efforts very proximate to the real-life situations in CE challenges.

EDIH extension nodes (or hubs in Associated Countries) serve as the strategic bridge connecting non-EU partner countries—including the Western Balkans, Ukraine, and Türkiye—to the EU's Digital Single Market. These nodes function as "one-stop shops" that provide local SMEs and public institutions with access to the same high-level expertise in **Artificial Intelligence, Cybersecurity, and High-Performance Computing** available within the EU. By integrating these regions into the broader EDIH network, the EU facilitates **economic convergence** and cross-border collaboration, allowing companies in partner countries to "test before invest" and share digital maturity tools. This expansion is a key pillar of the **EU Growth Plan**, ensuring that non-EU partners can harmonize their digital transition with European standards even before formal accession.

9. Conclusions

The transition from a linear to a circular economy is no longer a localised environmental initiative but a **strategic imperative for European sovereignty, resource security, and industrial competitiveness**. Evidence from R&I portfolios confirms that high-impact circularity emerges where industrial clusters, logistics providers, and digital infrastructure are integrated across regional and national borders.

To meet the 2030 circularity targets, the Circular Economy Act (CEA) must move beyond waste management toward a systemic "**symbiosis logic**", encompassing the broader Pan-European ecosystem, including EU Member States, Accession countries, and neighbouring partners.

The analysis of these 20+ R&I projects leads to a clear conclusion: the **CEA 2026** must evolve from a traditional regulatory framework into a **more adaptive, ecosystem-based governance approach**. Technical innovation alone, business-as-usual and the traditional profit-oriented business models are insufficient to overcome the current 'linear-lock-in', where circular solutions remain less economically attractive than resource-depleting alternatives.

The CEA should therefore focus on the following priority actions:

- **Move from fragmentation to harmonization** by establishing a Single Market for Secondary Materials, including aligned End-of-Waste (EoW) criteria across Member States and simplified cross-border procedures.
- **Strengthen the digital backbone** by granting Digital Product Passports (DPPs) functional equivalence to commercial documentation and enabling a shared European data space for circularity.
- **Institutionalize ecosystem orchestration roles** (e.g. Value Chain Orchestrators, Matchmakers, Facilitators) to manage inter-sectoral coordination, build trust, and bridge the gap between R&I pilots and market deployment.
- **Support transregional symbiosis and circular hubs** as coordinated operational entities, enabling shared infrastructure and reducing costs across industrial ecosystems.
- **Adopt a pan-European approach** to circularity, ensuring alignment with neighbouring non-EU systems to prevent leakage, strengthen supply chains, and expand circular markets.
- **Deploy targeted financial mechanisms** to de-risk circular investments, including support for blended "financial patchwork" models.
- **Shift economic incentives** by reducing the burden on labour and increasing incentives for circular practices (e.g. VAT reductions for repair and reuse, resource-based taxation on virgin materials).
- **Empower actors at all levels as prosumers**, from households to industrial clusters, through access to data, financial incentives, and participation in circular systems.

By recognizing and supporting transregional symbiosis, harmonizing markets for secondary raw materials, and enabling a digital and financial backbone for circularity, the CEA can move beyond fragmented pilot actions toward **scalable, coordinated circular value networks**. This will make circularity not only viable, but the **default and economically rational model across Europe**.

10. Annexes

Annex I: Prioritised policy recommendations for the CEA (overview table)

Policy Recommendation	WHY – Policy Objective	WHAT & HOW – Evidence from Projects	Concrete CEA Actions	WHO – Governance roles and transregional value
1. Create an EU framework for Transregional Circularity Hubs on different scales	Enable circular value chains that operate across regions while maintaining efficient material, knowledge and value flows and reducing dependency on imported raw materials.	R&I project portfolios show that circular initiatives scale most effectively when industrial actors, recyclers, waste operators and logistics providers collaborate in regional clusters , connected across borders. Co-location and cooperation in clusters reduce transport costs and enable economies of scale for sorting, repair, remanufacturing and recycling. Revenue streams can be achieved through operational efficiency (e.g. food factory pays a shared utility fee to a wastewater treatment plant that uses the factory's heat and organic waste to produce biogas, which is then sold back to the factory at a discount).	• Recognise Transregional Circularity Hubs/Clusters* within the Circular Economy Act as coordinated circular ecosystems. • Support cross-border circular clusters linking industrial zones, recycling facilities and logistics nodes. • Establish EU funding mechanisms for shared circular infrastructure (sorting, repair, remanufacturing, preprocessing facilities). • Ensure hubs are connected to Digital Product Passport data flows to enable traceability of materials across regions. • Introduce Closed-loop discounts, where everyone in the cluster/hub has lower overheads than their linear competitors (e.g. Avoidance Revenue, Utility Arbitrage, Secondary Raw Material Sales, Infrastructure-as-a-Service (IaaS)).	EU: define legal framework and funding instruments towards restoring, building and regenerating ecosystems and making EU leader of the pan-European wellbeing. Member States: facilitate cross-border cooperation and remove administrative barriers. Regions: develop and manage circular hub ecosystems. Transregional value: neighbouring regions can share infrastructure and feedstock streams, improving resilience of circular supply chains. Europe/non-EU (accession and neighbouring countries): this is a topological requirement and green diplomacy, to involve governments and countries to see the momentary and long-term benefits of being parts of such

				hubs - as providers, producers, markets.
2. Remove regulatory barriers to cross-border circulation of secondary raw materials	Enable secondary materials to circulate across the EU Single Market as efficiently as primary raw materials, strengthening supply security and secondary material markets.	Projects consistently report that different interpretations of waste status and End-of-Waste criteria delay or prevent cross-border recycling and reuse. These barriers reduce investor confidence and limit the development of secondary material markets.	• Introduce harmonised End-of-Waste criteria for key material streams. • Establish simplified procedures for cross-border shipment of processed secondary materials. • Introduce “green lane” procedures for certified circular materials to facilitate faster cross-border circulation within the Single Market. • Establish regulatory sandboxes for cross-border circular value chains and industrial symbiosis. • Align material certification systems with Digital Product Passport traceability mechanisms. • Align certification and traceability systems with Digital Product Passport infrastructure.	EU: legislative harmonisation and certification framework. Member States: align implementation and enforcement practices. Industry: adopt traceability and certification systems. Transregional value: enables cross-border recycling chains and secondary material supply networks. Europe/non-EU (accession and neighbouring countries): co-evolve the national regulations with EU partners to be able to be a node in the networks (as provider, producer, market)

3. Develop a Europe-wide digital backbone connecting circular ecosystems	Improve transparency and coordination across circular value chains by enabling reliable information on material composition, availability and recycling/reuse potential.	R&I projects demonstrate that circular systems require digital tools enabling actors to track materials across value chains, share data securely and match supply and demand for secondary resources. Digital Product Passports can act as a “material travel document”, enabling traceability and verification of secondary materials across borders. Non-EU integration is another necessity, otherwise, textiles and bulky waste often leak into illegal dumpsites in the Western Balkans or are exported to third countries without tracking.	• Ensure interoperability of Digital Product Passport systems across sectors and regions. • Create EU-level data infrastructure linking regional circular hubs, industrial ecosystems and material marketplaces. • Support digital platforms enabling industrial symbiosis and secondary material exchanges. • Create a single European Data Space for Circularity and ensure it is supported by skilled users able to operate and apply it effectively. • Introduce right to circular information mandate, to achieve transparent safety communication.	EU: define standards for interoperability and digital infrastructure, to utilise humans+technology. Industry: share product and material data through DPP systems. Regions: integrate digital platforms with circular hub operations. Transregional value: digital infrastructure enables coordination of circular supply chains across borders. Europe/non-EU (accession and neighbouring countries): the data goes where the material goes, knows no borders. This is essential for transparency and trust in safety communication.
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4. Support development of regional logistical circular clusters, by promoting proximity (especially for high weight - low value material flows)	Improve efficiency of circular material flows and reduce costs for collecting, sorting and processing materials, particularly bulky or low-value waste streams.	R&I projects show that circular activities become economically viable when sorting, repair, reuse and recycling infrastructure is co-located with industrial users and waste management operators, creating local economies of scale, but even more importantly, of closed loops. Geographic proximity and closing the loops in regions (up to certain kilometres range for e.g. construction, soil, bio-waste; or wider, for industrial symbiosis) is the norm.	• Prioritise EU investment in regional circular logistics infrastructure through cohesion and regional development programmes. • Support integrated clusters combining waste management, recycling, manufacturing and logistics services. • Support regional repair, refurbishment and reuse infrastructure connected to circular logistics clusters. • Align infrastructure investments with green public procurement demand for circular products. • Introduce Symbiosis Readiness Level (SRL) as a maturity framework specifically designed to evaluate how ready a collaborative network of industries is to exchange resources like waste, energy, or water. It measures progress across multiple dimensions - including technical integration, business model alignment, legal/regulatory compliance, and organizational trust—on a scale from RL1 (initial idea of a synergy) to RL9 (a self-sustaining, long-term symbiotic ecosystem).	EU: provide funding frameworks and strategic guidance, iterative adaptive regulation. Member States: integrate clusters into industrial and circular economy strategies. Regions: plan and operate circular infrastructure. Transregional value: clusters in neighbouring regions can specialise and complement each other in circular processing activities. Europe/non-EU (accession and neighbouring countries): enable search for partners and their engagement (in circular cluster, or industrial/rural symbiosis) and its achievement to go beyond EU borders
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5. Establish and support circular ecosystem orchestration roles	Strengthen coordination across circular value chains and reduce transaction costs for companies participating in circular systems.	R&I projects highlight that circular ecosystems require neutral actors facilitating/orchestrating collaboration, matchmaking and coordination, as well as replication across industry, municipalities, infrastructure providers and SMEs. Without these roles of circularity advisors, circular initiatives struggle to sustain, scale and replicate. For such new roles, a dedicated fund or fee is needed, or expert engagement of human/digital agents, to be able to incentivise their introduction and existence.	• Recognise Circular Ecosystem Orchestrators / Value Chain Orchestrators as coordination actors within circular hubs. • Support orchestration activities through cluster initiatives, EDIHs and EDIH extension nodes in non-EU countries, Digital Innovation Hubs and circular networks. • Enable orchestrators to coordinate material flows, data exchange and industrial symbiosis partnerships across ecosystem. • Develop assessment tools (e.g. Symbiosis Readiness Levels) to support benchmarking and development of circular ecosystems. • Establish Regional Multi-actor Platforms (MIPs) • Enable Security of Supply protocol e.g. regional clusters act as governance hubs to guarantee small-batch, high-quality availability of secondary minerals for the construction sector.	EU: enable ecosystem governance, by supporting orchestration and matchmaking through innovation programmes and initiative implementations. Regions: host orchestration structures within circular clusters. Industry: participate in ecosystem governance. Transregional value: orchestrators help connect regional circular ecosystems into EU-wide value chains. Europe/non-EU (accession and neighbouring countries): expertise potential in intellectual workforce from accession countries, as many of the tasks of these roles can be done remotely, virtually.
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6. Support territorial circular economy experimentation and accelerate cross-regional replication	Set up the successful circular ecosystem models as blueprints which can be replicated and/or scaled up across Europe, thus strengthening EU competitiveness in circular industries while enabling regional or Europe-wide circular value chains.	R&I projects demonstrate that replication requires transferring technology, governance models, digital tools and business practices between regions. Demonstration ecosystems can accelerate learning and adoption. There needs to be Infrastructure-as-a-service, replicator roles and fees and other ways of incentivising the knowledge transfer from blueprint to another region or domain. Regulators need to follow this by allowing fast(er) certification and standardisation as enabling factors overcoming the barrier of e.g. a mobile plant in Bulgaria might produce a certified 'product' but if that material is moved to a neighbouring country, it may revert to 'waste' status due to different national purity thresholds; or a new circular material is produced which does not fall into any category and is 'stuck' for further exploitation.	• (Further) support territorial experimentation programmes and cross-regional collaboration on circular value chains (e.g. secondary raw materials, industrial symbiosis, circular construction), building on existing EU initiatives (e.g. CCRI, RIVs) where relevant. • Integrate regulatory sandboxes within regional experimentation initiatives. • Establish replication platforms and toolkits enabling transfer of successful circular models between regions and industrial clusters, and recognise good practice blueprints, from the vast funded projects in the past. • Introduce geographic continuity mandate to include EU and non-EU countries in the design, replication and expansion. • Support circular innovation financing instruments, cross-border financial modeling, including pilot de-risking mechanisms and micro-grant programmes for SMEs and communities. • Encourage experimentation with behavioural incentive schemes, such as household circularity credits, circular literacy programmes and community circularity incentives. • Create EU-Level Fast-Track Certification and Testing Hubs, by establishing network of sectoral testing hubs (textiles, construction materials, bio-based	EU: coordinate territorial experimentation programmes and knowledge platforms, with special attention to crossing the valley of death for the solutions, and shifting from "Project Finance" (focused on assets) to "Product-as-a-Service Finance" (focused on long-term resource value). Member States and regions: replicate proven circular ecosystem models. Enable to conjoin proximity-based circularity (geographic proximity) with European digital and standardisation backbone Transregional value: accelerates learning, reduces investment risk and speeds diffusion of circular solutions across Europe and neighbouring regions. Europe/non-EU (accession and neighbouring countries): enable the joining in of non-EU partners in each stage, and envision the financial patchwork to achieve it (Growth facility, WBIF, IPA III, SME Go Green etc.) Seek for physical assets + industrial stakeholders from pan-European viewpoint.
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			fertilisers) that provide harmonised testing, certification roadmaps and mutual recognition letters to tackle the market acceptance barriers for recycled inputs.	
7. Promote the approaches of Circularity by design and Circularity by default - which entail Design for disassembly, Redesign for circularity and others	Set up the principles of aiming for circularity by design and default, for every new product/project/process and enable transition to circularity of linear solutions, eventually phasing out a number of significant ones that cannot become predominantly circular. Aiming at design for disassembly at very early stages of the product	Project and literature insights showed that by moving from mindset of abundance towards mindset of scarcity, each stakeholder in the European economy should be nudged and streamlined to shift the approach, reasoning and behaviour towards circularity by default and design. Design for disassembly can ensure 100% material recovery at end-of-life and multiple loops of sustaining life. This will help bring up to more competitive pricing to e.g. textile or bulky waste because currently, the cost of the human workers needed to sort and disassemble products often exceeds the value of the recovered material. This will help the tendency to achieve 'true pricing' and internalise externalities.	• Promote scarcity aware governance (as opposed to the abundance linear reasoning which resulted with hyper-mobility-based industries and flows) • Empower prosumers (producers and consumers) and co-governors - behaviours to be practiced by all involved parties (citizens, households, local communities, regions, value chains, ecosystems), not just by businesses, institutions and organizations. • Introduce Circular literacy credits and fund local governments to create Digital/Physical Circular Labs where citizens are trained in repair, sorting, and nutrient safety, rewarding certified households with local tax offsets or Virtual Coins. • Shift the tax burden from labor to natural resources (Green tax shift). • VAT was designed for the "first sale." When applied to circular loops,	EU: introduce the core concepts of the paradigm shift from abundance to scarcity management and circularity by design and by default, wherever possible (long term transition, but also immediate transitions). Provide foundations for multi-level governance. Member States and regions: tactically introduce fast-track transition to circularity (quick wins) as well as mid-term and long-term direction (with specific actions within public procurement, VAT, prosumer behaviour incentives, Local Green Deals, circular literacy credits) Transregional value: all actors are incentivised to shape within their own ecosystems and look for nodes in the network of collaboration which enable circularity as much as possible.

	design is crucial to achieve efficiency at later stages to achieve at least 70% overall circularity in the upcoming decade.	it becomes a penalty. Proposal can be for 0% or Reduced VAT for repair services and certified secondary materials • Introduce broader range of approaches to achieve circularity by design (from practice and applicable theory): High-value loops (Refuse, Rethink, Reduce); Medium-value loops (Reuse, Repair, Refurbish, Remanufacture); Low-value loops (Recycle, Recover); simultaneous triple transition: Social, Green, and Digital. • Introduce Resource Missions to engage local communities in targeted interventions where loops are unclosed, so that community must be involved in Social Dialogue to ensure a just transition.	Europe/non-EU (accession and neighbouring countries): EU is the leader in mentality and culture of self-awareness and collective-awareness. This exemplary role should be used for others (especially non-EU underdeveloped countries such as from Western Balkans) to follow and partake as co-evolutionary measure.
* Transregional Circularity Hub/Cluster: A coordinated circular ecosystem linking industrial actors, recyclers, material and waste operators, citizens and logistics infrastructure across multiple regions, Member States and non-EU countries supported by interoperable digital traceability systems, in order to close the loops and optimise material flows in enabling cross-border circular value chains.			

Annex II: Full Project Portfolio Matrix (overview table)

Project Acronyms
AD REDGIO 5.0
AshCycle
SYMSITES
REDOL
MOBICCON-PRO
tExtended
P2Green
SYMBIO
PRIMED
MAINSTREAM-BIO
FRONTSH1P
BIOMODEL4REGIONS
DECISO
URBANREC
WaysTUP!
CityLoops
TRUSTEX
Circula-TEX

Annex III: References

Andrews, Matthew, Lant Pritchett, and Michael Woolcock. 2017. Building State Capability: Evidence, Analysis, Action. Oxford University Press.

Petrevska Nechkoska, Renata, Manceski, Gjorgji, Poels, Geert (Eds). Facilitation in Complexity: From creation to co-creation, from dreaming to co-dreaming, from evolution to co-evolution. 2023. Springer Nature. ISBN 978-3-031-11064-1. DOI <https://doi.org/10.1007/978-3-031-11065-8>

Petrevska Nechkoska, Renata. Tactical Management in Complexity - Managerial and Informational Aspects. 2020. SPRINGER NATURE Switzerland. DOI <https://doi.org/10.1007/978-3-030-22804-0>

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This report presents key findings from a project portfolio analysis conducted to generate evidence-based recommendations for the Circular Economy Act (CEA), with a specific focus on transnational and regional (territorial) dimensions. Drawing on results from EU-funded Research and Innovation projects, it identifies key barriers and success factors for scaling circular solutions across regions and across borders.

The analysis shows that regulatory fragmentation, limited data interoperability and insufficient cross-border coordination constrain deployment. The report provides targeted recommendations to support a more coherent, actionable and territorially grounded approach to circular economy policy in Europe.

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