Cleaner Environmental Systems 21 (2026) 100445

Contents lists available at ScienceDirect

Cleaner Environmental Systems

journal homepage: www.journals.elsevier.com/cleaner-environmental-systems

Closing or curving the loop? An evaluation of EU circular economy policy instruments through R9, ReSOLVE, and socio-technical transition frameworks

Alexandre Coussa

University of Fribourg, Center for Competitiveness, Bd. de Pérolles 90, Fribourg, 1700, Switzerland

A B S T R A C T

Since 2015, the European Union (EU) has advanced ambitious circular economy (CE) objectives through successive policy initiatives, yet the extent to which policy instruments enable transformative changes remains underexplored. Drawing on policy instrument theory and socio-technical transition analysis, this study systematically examines 30 EU CE legislative acts, mapping policy instruments across product lifecycle stages, circularity hierarchies (R9 framework), and business model strategies (ReSOLVE framework) to assess whether EU CE policymaking fosters systemic transformation or primarily optimizes existing linear regimes. The results reveal a pronounced downstream orientation: recycling, efficiency, and loop/optimize strategies dominate, while upstream prevention, sufficiency, sharing, and virtualization remain largely neglected. Instruments supporting niche development, demand-side transformation, and radical business model innovation are limited. From a multi-level perspective, the policy mix primarily stabilizes incumbent socio-technical regimes rather than enabling regime destabilization or the scaling of transformative niches. This study provides a comprehensive instrument-level mapping of EU CE policymaking and advances theory by operationalizing the tension between technocratic optimization and transformative circularity. It shows that limitations in the depth of the EU circular transition stem not only from implementation challenges but from structural design misalignment within the policy mix itself. The findings identify actionable multi-level policy levers addressing both regime transformation and niche support strategies to better align future EU CE policymaking with transformative transition pathways.

1. Introduction

In March 2020, the European Commission launched its second Circular Economy Action Plan (CEAP2), pledging to transform the European Union (EU) into a resilient and competitive economy by shifting from linear to circular production models. The plan set ambitious targets aiming to increase the EU circularity rate to 24% by 2030, and to achieve climate neutrality by 2050 (EU Commission, 2025a).

Government policies are crucial for the transition to a circular economy (CE), as they interact with business models (BM) in complex ways and must account for entrepreneurs' needs, technological innovation, and circular competitiveness (Wasserbaur et al., 2022). However, as Table 1 shows, most existing studies look at only one region, one part of policy, or one specific sector. They often ignore an important part of policymaking: the instruments themselves, and do not integrate EU policymaking into socio-technical transition (STT) frameworks.

This leads to an insufficient understanding of how policy instruments contribute to CE development. As a result, decision-making is hindered and the concrete impacts on EU industries remain unclear (Hartley et al., 2023). Policy instruments encompass various objectives, strategies and intervention types that shape the policy mix and the transition to sustainability (Rogge and Reichardt, 2016).

This paper addresses this gap by posing the following research question (RQ): *Is the EU CE policy mix structurally capable of enabling transformative circularity, or does it primarily reinforce incremental optimization within existing linear production regimes?* To operationalize this inquiry, the paper poses three research objectives: 1) what instruments constitute the EU CE policy mix? 2) do these instruments address the systemic changes that circularity requires? 3) do they create conditions for sociotechnical regime destabilization, or do they predominantly stabilize incumbent linear configurations?

To address this question, a four-layer analytical framework is constructed. Each layer builds on and complements the preceding one. The framework progresses from instrument identification, through circular target and BM transformation assessment, to sociotechnical regime analysis. The four layers are: 1) policy instrument theory that provides foundations for identifying and categorizing policy instruments; 2) R9 framework that hierarchizes CE policy instruments according to their contribution to CE objectives; 3) ReSOLVE framework that informs on the type of circular BM transformation that the instruments intend; and 4) the multi-level perspective (MLP) assesses how the mix of EU policies contributes to the transformation of existing linear production regimes

E-mail address: alexandre.coussa@unifr.ch.

https://doi.org/10.1016/j.cesys.2026.100445
Received 12 January 2026; Received in revised form 6 April 2026; Accepted 24 April 2026
Available online 26 April 2026
2666-7894/© 2026 The Author. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Table 1
Summary of recent articles on EU CE policymaking.

Study	Approach	EU CE related Findings
Alpdogan et al. (2026)	Regression of WM performance, R&D expenditures, and environmental tax revenues against economic growth in 17 EU countries from 2000 to 2021	WM rate negatively impacts economic growth, whereas per capita municipal waste, R&D expenditure and environmental tax revenues notably positively impact economic growth. The impact of these variables varies according to countries' income levels
Bocken et al. (2025)	Interview of US companies to estimate the effects of EU policy beyond its boundaries	Firms are influenced by both US and EU policies and actively work to influence both. EU policy framework might in the long run contribute to positively influencing US policy framework
Fortea et al. (2026)	Panel Vector Autoregressive model between CE practices, innovation, and environmental performance through from 2010 to 2022 in EU countries	Resource productivity is positively associated with reduced emissions. Circular materials and renewable energy stimulate innovation. Innovation is a key mediating mechanism. Significant cross-country heterogeneity suggests that structural and institutional conditions limit uniform policy approaches
Pinyol Alberich et al. (2023)	Content analysis of the EU CE policies between 2011 and 2022 through circular future lens	CE policies consist of combination of strong techno-optimism, competing and centralized governance visions that might lead to weak version of the CE
De Pascale et al. (2023)	Review of case studies on CE implementation in the EU	Recycling was the most used strategy. Technological, market, institutional and social barriers are discussed
Georgescu et al. (2025)	Panel data analysis of factors influencing the use of circular materials in the EU between 2010 and 2022	There isss a strong positive relationship between resource efficiency, recycling efforts, and the use of circular materials, but also significant regional differences across EU states. Infrastructure and technology play an important role
Pinyol Alberich and Hartley (2024)	Analysis of CE adoption by the EU through policy-learning perspective	CE is widely accepted in the EU policymaking as results of mutually reinforcing of constructed, championed, supported and pioneered learning dimensions
Mhatre et al. (2021)	Content analysis of academic articles on CE implementation initiatives in the EU	Recycling is the most widely used strategy. At the macro level, government and/or regional initiatives are CE main drivers. The best tools for CE development are governmental policies, infrastructure, technological availability, awareness, stakeholder collaboration and supply-chain integration
Zhang et al. (2025)	Content analysis of academic articles on CE policy implementation in China and EU	In contrast to China, EU's approach is more bottom-up, focusing on 'sustainable products'. The main priorities are consistency, coherence, stability and social dimensions
Arsova et al. (2022)	Bibliometric and content analysis of 82 journal articles from 1999 to 2021	Regions constitute the minimum optimal adoption level for building a functional CE but the research on this level is fragmented
Brusselaers and Gillabel (2024)	Overview of 315 policy initiatives at national level of EU countries	At national level, policy measures focus on a too limited number of lifecycle phases and apply a too limited set of different instruments that hinder CE development
Hondroyiannis et al. (2024)	Panel data analysis of macro-level CE rate against various macroeconomic variables across 28 European countries	Positive relationship between real GDP and the circularity rate over the long run. Higher environmental taxes are associated with increased circularity rate

Source: own elaboration

into systemic circular ones.

This paper makes three key contributions: 1) it provides a systematic, instrument-level mapping of EU CE policymaking across 30 policy documents; 2) it evaluates the alignment of these instruments within an integrated and comprehensive framework and reveals structural gaps between the intended design of EU policies and CE transition systemic requirements; 3) it maps actionable interventions across niche, regime and landscape levels to strengthen the transformative ambition and coherence of CE policymaking.

The remainder of the paper is structured as follows. Section 2 develops the conceptual and theoretical foundations of the four-layer framework. Section 3 details the systematic methodology, including instrument selection criteria and coding procedures. Section 4 presents the results of the instrument-level analysis. Section 5 discusses the results and their implications for EU CE governance. Section 6 concludes the paper.

2. Theoretical foundations and framework conceptualization

This section establishes the conceptual foundations for analyzing EU CE policymaking. It pursues two objectives. The first is to introduce the fundamental tension between transformative and technocratic approaches to CE implementation. The second is to present the theoretical lenses used, their integration logic, and their complementarity with the intermediary frameworks applied in the analysis.

2.1. Circular economy definition and evolution

Although the intuition underlying the CE is not new — humans have long sought to preserve and maximise the value of their resources and goods (Kuijpers, 2019) – it gained renewed attention during the 1960s following Boulding's (1966) reflections on the limits of economic growth within a finite system. Stahel and Reday-Mulvey (1981) presented policy reports to the EU Commission, advocating economic models that generate value through activities and services at all stages of product lifecycles, as well as through the production of goods.

Another strand on which the CE draws is industrial ecology (IE) and industrial metabolism research (Ghisellini et al., 2016). These concepts introduced by Frosch and Gallopoulos (1989) and Ayres and Ayres (2002) propose industrial systems that process materials and energy in ways analogous to biological organisms. Subsequently, Graedel and Allenby (1995) pursued the systematization and formalization of IE as a coherent scientific discipline by introducing quantitative tools in the analysis such as Material Flow Analysis (MFA) and Life Cycle Assessment (LCA). MFA enables the quantitative tracking of material stocks and flows through economic systems while LCA systematically evaluates the environmental consequences of product, process or service across its lifecycle. Building on these foundations, input-output frameworks integrate LCA and MFA at the macro level, enabling system-level quantification of inter-industry linkages, waste management (WM), and recycling processes (Nakamura, 2023; Nakamura and Kondo, 2009).

More recently CE has regained prominence as a distinct and rapidly expanding field of research, closely related to sustainability and IE, yet characterized by its own specificities (Kirchherr et al., 2023). Although CE has been influenced by IE and symbiosis, its current conception integrates additional strategies to prolong and retain the value of products (Blomsma and Brennan, 2017), transform BM by narrowing, closing and slowing resources and energy loops (Bocken et al., 2016; Geissdoerfer et al., 2020), reconsider consumer behavior and demand-side dynamics (Camacho-Otero et al., 2020; Koide et al., 2025) and the governance and policy dimensions of sustainable transitions (Hartley et al., 2023; Milios, 2018). This conceptual expansion reflects the recognition that material circularity extends beyond technical optimization and recycling schemes. Consequently, CE requires systemic transformation across production, use, consumption, and end-of-life systems (Geissdoerfer et al., 2020; Kirchherr et al., 2017; Webster and Pascucci, 2024).

The Ellen MacArthur foundation (EMAF) defines the CE as a system where materials never become waste and where products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting (EMAF, 2025). This definition calls for systemic change and finds concrete applications across levels ranging from individuals and firms to cities and national governments (Ghisellini et al., 2016). It advances the CE as an umbrella concept that unifies different frameworks to support a systemic transition that delivers values beyond technocratic implementation (Kirchherr et al., 2025).

Over the past decade, policy development has increasingly aimed to translate circular production and consumption principles into practice in a claimed ambition to support both environmental and economic objectives (Pinyol Alberich et al., 2023). Table 1 provides a structured non-exhaustive comparison of studies published over the last five years on EU CE policymaking. The body of literature on EU CE policymaking is characterized by diverse methodological approaches and analytical focuses. However, no recent study integrates EU policy instrument analysis within the STT framework; a gap the present paper addresses.

Table 1 also shows that, while quantitative studies highlight positive relationships between circular practices, innovation and economic performance, they also emphasize important heterogeneity across countries due to structural and institutional constraints (Alpdogan et al., 2026; Fortea et al., 2026; Georgescu et al., 2025). Another common feature is the overemphasis on recycling and WM (Brusselaers and Gillabel, 2024; Sardianou et al., 2024), as well as persistent technological, institutional and market barriers.

Overall, these findings suggest that, although EU CE policies lead to incremental improvements in resource efficiency and innovation, they do not address the systemic and structural changes needed for a genuine CE. EU's approach is characterized by a techno-optimistic and centralized orientation that risks producing a weak version of CE, unable to meet EU's own environmental ambitions (Pinyol Alberich et al., 2023). As a result, CE is frequently criticized as a “technocratic fix” that improves production efficiency at the margins while ignoring the systemic transformations industries require and the rebound effects such optimization may generate (Genovese and Pansera, 2021; Korhonen et al., 2018).

2.2. Theoretical lenses

Having established the conceptual evolution of CE and its systemic requirements, subsection 2.2 introduces the two theoretical lenses through which EU CE policymaking is analyzed. These lenses were selected because they operate at complementary levels of analysis. Policy instrument theory identifies and categorizes the instruments to determine the design and configuration of individual instruments and their combinations, while STT theory addresses the systemic dynamics within which those instruments operate.

Policy instrument theory examines how governments deploy individual instruments and arrange them into policy mixes to achieve specific objectives (Capano and Howlett, 2020; Howlett and Ramesh, 1993). The theory has been expanded by Bemelmans-Videc et al. (1998), who classify policy instruments into three types of intervention: 1) *economic* instruments influencing firms or citizens' behaviors via economic incentives or rewards; 2) *regulatory* instruments constraining or obligating behaviors and 3) *information* instruments aiming to meet policy objectives through the transfer of knowledge or moral persuasion. Howlett (2009) further addresses the design of policy mixes, emphasizing that effective mixes must be coherent, consistent, and carefully calibrated across instrument types.

In the context of CE policies, existing instrument-level analyses have predominantly focused on specific sectors or material streams (Entsalo et al., 2023; Maeder and Fröhling, 2024; Pfeffer et al., 2025). Earlier studies have revealed that CE instruments are too scattered, weak, and unevenly distributed across economic sectors to produce tangible systemic effects (Kautto and Lazarevic, 2020), and that persistent gaps exist in instruments targeting reuse, repair, and remanufacturing, green and innovation-oriented public procurement, and the development of secondary materials markets (Milios, 2018).

Hartley et al. (2023) argue that CE transition requires a fundamental evolution of production systems, necessitating a deep understanding of the policy instruments used and their interrelationships. Accordingly, the authors propose a taxonomy of 100 C E instruments, categorized either by product lifecycle or by overarching policy area. This taxonomy is the first component of the instrument identification layer and enables the systematic classification of instruments across lifecycle stages and policy axes.

This taxonomy is complemented by Rogge and Reichardt (2016) who developed the concept of sustainable policy mixes, arguing that the consistency, comprehensiveness, and credibility of the overall policy mix determine its systemic change potential. The authors further propose the type-purpose instrument typology, which classifies instruments along two dimensions: their purpose (technology push, demand pull and systemic) and their type (economic, information and regulatory). This typology reveals that different instrument categories operate at different levels of stringency and serve distinct functions, producing varied capacities to drive systemic change. Together, Hartley et al. (2023) and the Rogge and Reichardt (2016) frameworks constitute the first analytical layer, enabling both identification and qualitative characterization of CE instruments.

The second lens examines how policies contribute to systemic changes. It draws on STT theory which examines how large-scale socio-technical systems, such as energy, mobility, or production systems, evolve over time through interactions across different levels (Geels, 2011, 2018). Rather than treating technological or regulatory changes as linear and incremental, STT theory understands them as the outcome of complex multi-level dynamics (Markard et al., 2012; Rip and Kemp, 1998).

MLP is the primary analytical framework for STT analysis, positing that sustainable transitions emerge from interactions across three levels: niches (micro-level), where radical innovations emerge; the socio-technical regime (meso-level), the stabilized system of existing practices and institutions; and the sociotechnical landscape (macro-level), the exogenous context exerting pressure on regimes and creating openings for change (Geels, 2011, 2018).

In the CE context, MLP explains whether and how policies destabilize existing linear structures. Scholars have applied the STT lens to analyze CE transition, pointing out the importance of regulatory instruments while suggesting that information policies are of limited effectiveness (Entsalo et al., 2023; Webster and Pascucci, 2024). Kivimaa et al. (2019) demonstrate that combining STT and policy-mix analysis provides a valuable framework for understanding niche support and regime destabilization.

The combination of these two theoretical lenses offers complementary perspectives. Policy instrument theory without STT risks reducing the analysis to a typological exercise disconnected from systemic implications, while STT without policy instrument theory risks remaining at a level of abstraction disconnected from concrete policymaking realities. This combination also aligns with recent calls in CE scholarship to move beyond taxonomies toward rigorous evaluative analyses of CE implementation in practice (Pinyol Alberich and Hartley, 2024).

2.3. Intermediary frameworks

While policy instrument theory and STT theory provide analytical support for the study, they do not specify the substantive content of what a circular system entails. Two intermediary frameworks, the R9 classification and the ReSOLVE framework bridge this gap.

The R9 framework proposed by Morseletto (2020) differentiates and ranks CE strategies hierarchically based on their capacity to preserve value and achieve circularity, offering a comprehensive picture of what CE transition requires. CE development encompasses ten targets spanning three core objectives: 1) smarter product use and manufacturing, 2) extended product or component lifespans, and 3) improved recovery and recycling of materials, as defined on the left-hand side of Fig. 1. The R9 framework therefore constitutes the second analytical layer of the present study, capturing the circular targets that policy instruments aim to address and enabling an assessment of their relative ambition.

The third layer is ReSOLVE framework, which translates CE objectives into the strategic BM transformations firms must undertake to meet circularity requirements. ReSOLVE proposes to reconsider firms' strategies through six reconfigurations presented in the right-hand side of Fig. 1 (EMAF, 2021; McKinsey & Company, 2016). Since its introduction, the framework has been widely applied to assess circular transition of numerous industries or company as it helps to comprehensively understand how BM may evolve to meet CE requirements and what types of strategic changes policy interventions aim to induce (e.g. Dos Reis et al., 2025; Tedesco et al., 2022). Its limitations must nonetheless be acknowledged. The EMAF is not an academic institution, and its work is not subject to *peer review*. ReSOLVE does not engage with quantitative tools like MFA or LCA, and its categories remain qualitative and practitioners oriented. Finally, the framework does not engage with the systemic constraints IE proposes. These limitations are explicitly considered. ReSOLVE is used as a heuristic mapping tool for policy-induced BM change rather than as a *post hoc* assessment of policymaking outcomes.

Fig. 1 presents both R9 and ReSOLVE frameworks and illustrates their interrelationships. R9 framework captures material and products' lifecycle objectives while ReSOLVE framework shows BM involved. Interrelationships presented show that specific BM changes might contribute to several targets. Since CE policymaking acts on both dimensions, two distinct analyses are necessary to offer two different but complementary perspectives. For policymaking, this underscores the importance of a comprehensive strategy as well as well-designed instruments to redirect BMs transformation toward higher objectives.

As Morseletto (2020) and Fig. 1 demonstrate, instruments concentrated at lower R9 levels produce BM profiles dominated by optimization and looping, while higher-order targets activate more disruptive configurations spanning share, virtualize and regenerate strategies. The MLP layer synthesizes this combined evidence to deliver the overarching sociotechnical verdict on whether the policy mix destabilizes incumbent linear regimes or predominantly stabilizes them.

2.4. Final framework construction

The preceding sections have introduced the four analytical components, namely policy instrument theory, STT theory and the R9, and ReSOLVE frameworks. This section explains how they are hierarchically integrated into a single evaluative framework and defines the criteria by which transformative change is operationalized across all four layers. Within the present framework, transformative change is operationalized across three dimensions, each corresponding to one of the three preceding analytical layers. Together they constitute the explicit criteria against which EU CE policymaking is assessed.

First, at the instrument level, transformative instruments are those that carry sufficient stringency and enforceability to destabilize current regime configurations (Rogge and Reichardt, 2016; Webster and Pascucci, 2024). Second, at the R9 level, transformative instruments target higher-order strategies, namely refuse, rethink, reuse, and repair. Instruments confined to reduce, recycling and recovery do not challenge the fundamental structure of the linear economy and therefore cannot constitute transformative change on their own (Korhonen et al., 2018; Morseletto, 2020). Third, at the ReSOLVE level, transformative instruments are those that induce a comprehensive reconfiguration of firms' value creation and capture logic, spanning multiple ReSOLVE strategies and extending beyond the mere optimization of existing production processes.

As shown in Fig. 2, the four analytical layers are hierarchically organized into a comprehensive evaluative framework for EU CE policymaking, each operating at a distinct level of analysis. The policy instrument layer identifies and classifies the mechanisms through which CE transition is pursued. The R9 framework then assesses the circular ambition of those instruments. The ReSOLVE framework evaluates the business model transformations they operationalize. Finally, MLP

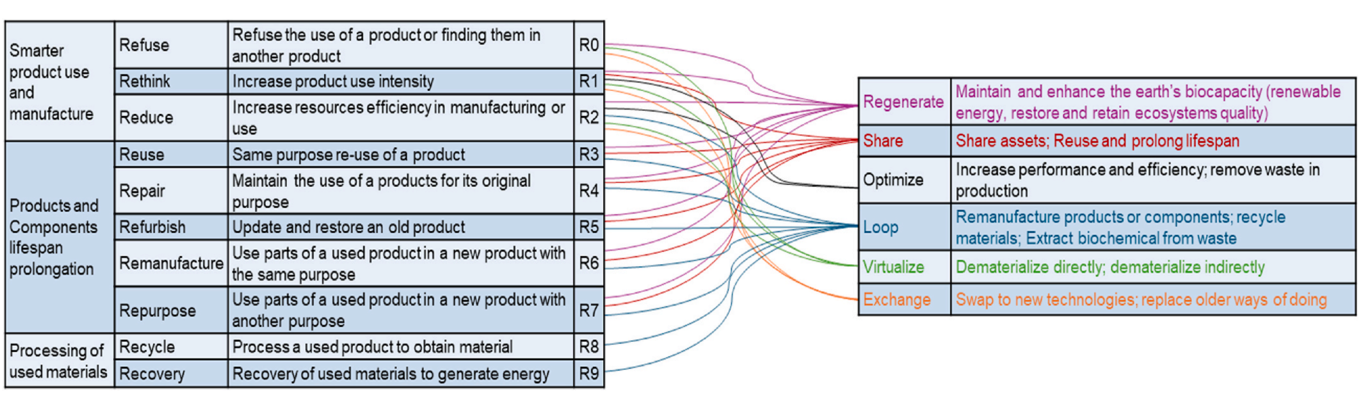

Fig. 1. Definitions and relationships between R9 classification and ReSOLVE framework.
Source: own elaboration based on McKinsey & Company (2016) and Morseletto (2020).

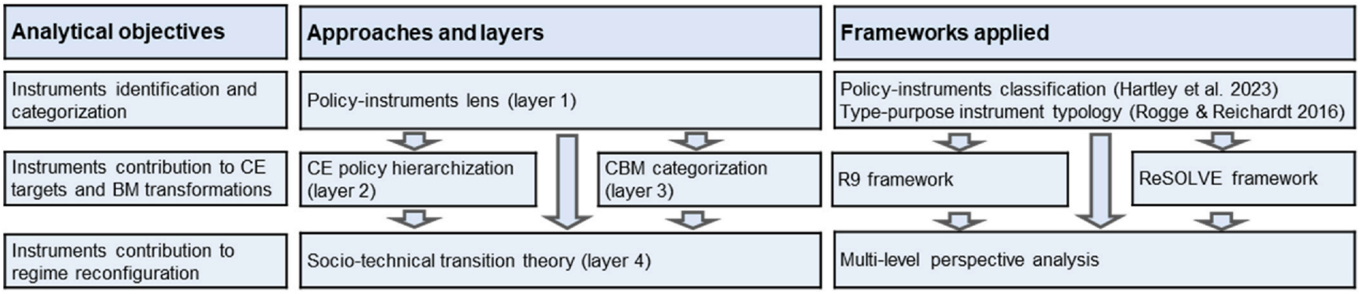

Fig. 2. Study framework schematization.
Source: own elaboration

delivers the overarching sociotechnical verdict: whether the instruments, taken together, are designed to destabilize incumbent linear regimes and support genuine circular transition, or whether they predominantly stabilize and optimize existing configurations. This hierarchical articulation ensures that each framework contributes a distinct and necessary analytical dimension, producing a structured and comprehensive assessment of EU CE policymaking.

3. Material and method

Section 3 details the procedure for selecting policy documents, identifying and coding instruments, and constructing the analytical layers presented in Fig. 2. The approach for each step, from the document selection to the coding of instruments, is presented in Fig. 3. It presents a logical and reproducible procedure resulting in an Excel sheet used for drawing the Figures presented in Section 4. A sample of this spreadsheet is provided in Appendix Table A3.

3.1. Selection of policy documents

The corpus includes strategic communications, regulations, and directives issued by the European Commission and Parliament that directly constitute EU CE policy. The inclusion of both regulatory and strategic documents follows Rogge and Reichardt (2016). Document identification is based on two complementary sources: the EU Commission's webpage dedicated to the CE, which lists CE policy documents; and a systematic review of five key scholarly articles on EU CE policy identified through the following approach: a targeted search on Google Scholar using the terms “circular economy” AND “European Union” AND “policy”; an assessment of article abstract's relevance and journal's reputation in CE and sustainability fields; and a content review retaining only articles that propose an explicit list of EU CE policy documents.

Following articles and EU website review, an initial corpus of documents, presented in Table A2, was constructed. It consists of every policy document mentioned by references articles, or EU's webpage, as part of EU CE policymaking, informed through a black dummy variable (●). Documents that are subsidiary mentioned are marked with an

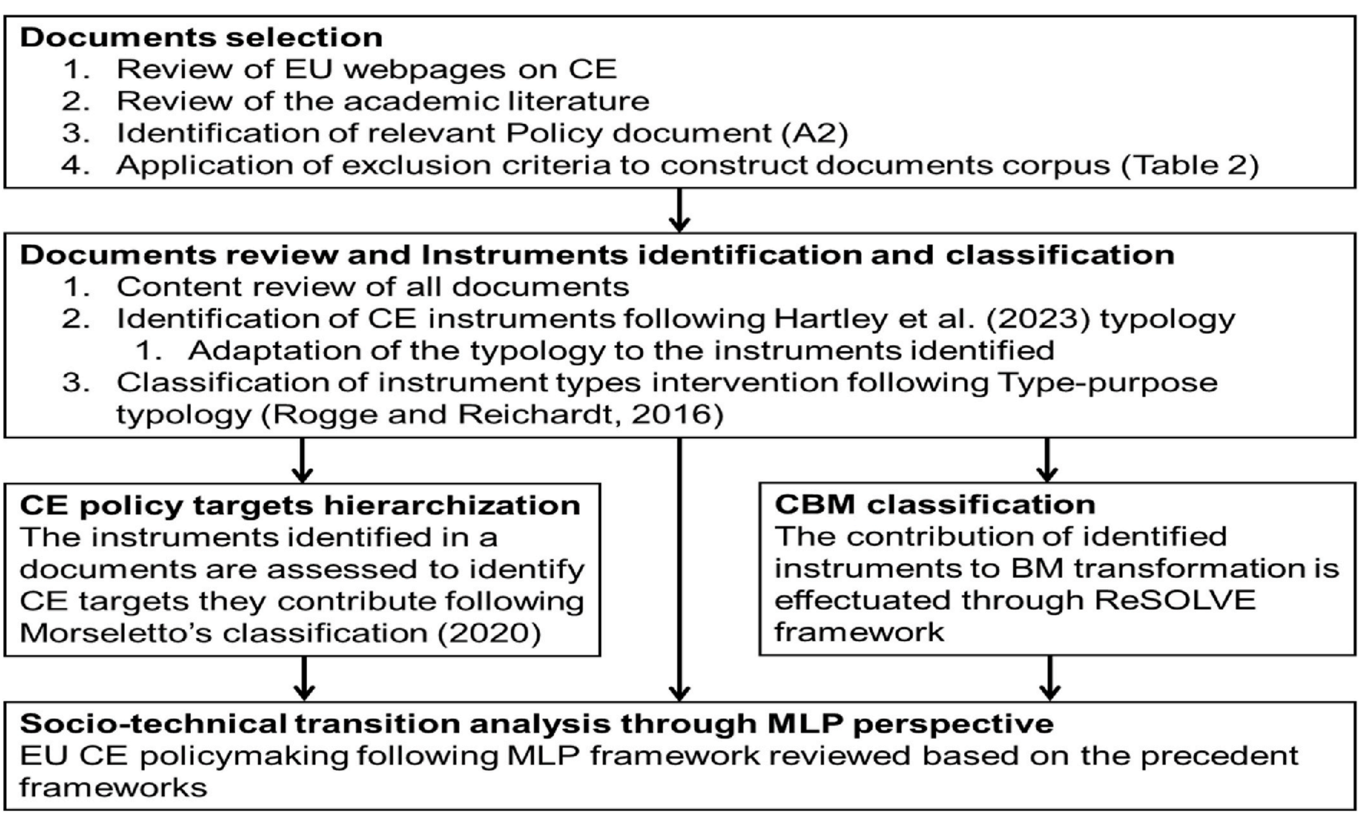

Fig. 3. Methodology presentation.
Source: own elaboration

orange dummy (●), but to avoid overcounting, they are not counted since they are alternative to principal document. The analysis is always conducted on the most recent version of each document.

Two validation criteria were applied sequentially to determine policy documents to include. First, a document was included if it appeared on the EU Commission's CE webpage. Second, documents that did not meet the first criterion were included if they had at least one citation in one of the five articles of reference if they were published in 2021 or later, or at least two citations if they were published in 2020 or earlier. The first criterion ensures that documents considered by the EU as part of its circular policy framework are included in the analysis. The second criterion incorporates documents that scholars consider to be part of EU CE policymaking, even if they are not mentioned by the EU Commission.

Nonetheless, since a document can amend or repeal other documents, and be amended or repealed by other documents, specific adaptations are required to ensure the analysis reflects the actual state of the EU policy framework, which is dynamic. Consequently:

- Documents repealed by another document (crossed out in A1) are excluded, even if they meet the selection criteria, as they are no longer in force.
- Documents repealing other documents receive no specific treatment: they are retained if they meet the selection criteria and removed if they do not.
- Amended documents are kept if they meet the selection criteria.
- Amending documents are kept if they meet the selection criteria. Those are marked by one asterisk (*) when they amend a document mentioned in A1 but not present in Table 2.
- When both the amended and amending documents meet the selection criteria, to avoid overlapping, amending document is not reviewed when amended updated version integrates the amending text. When the amended document has not been updated in a year able to integrate the amending document both are reviewed. In such cases, the amended document is marked by two asterisks (**) and the amending document is specified.

The final corpus of 30 documents is presented in Table 2. The temporal scope of the analysis was not defined *a priori* but emerges directly from the selection criteria applied. It results in a temporal scope spanning from 1999, where the first Landfill Directive was implemented, to mid-2025, capturing the full arc of EU CE policymaking according to the EU's website and scholars' contributions rather than an arbitrary periodization.

It is important to note that basing the analysis on public policy documents might capture policy intent rather than its effective enforcement. Such documents may present strategic or idealized representations of policymaking that do not reflect its implementation, interpretation, or real-world effects (Cardno, 2019). Moreover, focusing solely on regulatory and legislative instruments could result in the exclusion of documents that operationalize or fund CE transition. Examples include the Programme for the Environment and Climate Action (LIFE) or EU Cohesion Policy. Omitting these instruments could introduce bias into the analysis, particularly regarding demand-side measures and technology-push instruments. However, for a study concerned with policy design intent, regulatory and legislative instruments are the appropriate unit of analysis because they define what governments regulate or incentivize, thereby revealing the orientation of policy frameworks (Pinyol Alberich et al., 2023; Rogge and Reichardt, 2016).

Table 2
Corpus of policy documents analyzed.

Document	Label	Publication	Latest version	1	2	3	4	5
Strategic Documents (8)								
Second Circular Economy Action Plan	CEAP2	2020		●	●		●	
First Circular Economy Action Plan	CEAP1	2015		●			●	●
European Green Deal	GDEAL	2019		●	●			
Green Deal Industrial Plan	GDIP	2023			●			
EU Strategy for Sustainable & Circular Textiles	TEXT	2022		●			●	
Clean Industrial Deal	CLEAN	2025		●	●			
A European strategy for plastics in a circular economy	PLAST	2018					●	●
Communication on a monitoring framework for the circular economy	MONIT	2018	2023	●			●	●
Regulatory Documents (10)								
Ecodesign for sustainable products Regulation (2024/1781)	ESPR	2024		●			●	●
Batteries and waste batterie regulation (2023/1542) amended 2008/98	BWBR	2023		●	●		●	●
Critical raw materials act (2024/1252)	CRMA	2024			●			
Regulation on packaging waste (2025/40) *	PPWR	2025		●				
Regulation concerning the registration, evaluation, authorisation and restriction of chemicals (2006/1907)	REACH	2006	2025		●	●		
Waste shipment regulation (2024/1157) *	WSHIP	2024		●	●		●	
Regulation on microplastics (2025/2365)	MICRO	2025		●				
Regulation laying down harmonised rules for the marketing of construction products (2024/3110)	CONST	2024					●	
Regulation setting a framework for energy labelling (2017/1369)	ENLR	2017	2021				●	●
Regulation on reporting of environmental data from industrial installations, establishing an Industrial Emissions Portal (2024/1244)	PORTAL	2024					●	
Directive Documents (12)								
Directive on the Restriction of the use of certain hazardous substances in EEE (2011/65)	RoHS	2011	2025		●	●		
Directive on waste EEE (2012/19)	DWEE	2012	2024	●	●	●	●	
Landfill directive (1999/31) ** Amended by 2024/1785	LAND	1999	2024			●	●	●
Revised industrial and livestock Rearing emissions directive (2024/1785) Amend 1999/31	IED2.0	2024		●				
Right to Repair Directive* (2024/1799)	REPAIR	2024		●	●			
Green claims directive (Proposal)	GCD	2023		●				
Directive on end-of-live vehicles (2000/53)	ELV	2000	2023	●		●	●	●
Ecodesign Directive (2009/125)	DESIGN	2009	2012			●	●	
Directive on consumer rights (2011/83)** Amended by 2024/825	RIGHTS	2011	2022				●	●
Empowering consumers for the green transition* (2024/825) Amend 2005/29 and 2011/83	CONSO	2024		●			●	
Directive on port reception facilities for the delivery of waste from ships (2019/883)	DELIV	2019	2019				●	●
Waste framework directive (2008/98)** Amended by 2023/1542	WASTE	2008	2018		●	●	●	●

Sources: 1: EU Commission (2025a); 2: Rizos and Zambianchi (2025); 3: Milios (2018); 4. Pinyol Alberich et al. (2023); 5: Calisto Friant et al. (2021).

3.2. Instruments identification and framework construction through systematic coding

Once documents are selected, they are reviewed systematically to identify, classify, and code the CE policy instruments they contain. The procedure follows four sequential steps: 1) instrument identification; 2) instruments categorization; 3) intermediary frameworks coding; and 4) MLP analysis construction.

The full identification and coding were conducted by the author during a period of three months. A predefined codebook was constructed for each instrument, yet each measure was individually adapted to its document. Documents were reviewed twice during the identification and coding as well as a third time before submission and a fourth during revision. To cross-check the identification and coding, relevant academic literature and official supporting documentation for each document were also consulted where necessary.

Step 1: Instruments identification

A policy instrument is defined as a distinct provision establishing a specific obligation, incentive, prohibition, or information mechanism. An instrument may consist of several articles or paragraphs that together constitute one coherent policy mechanism or may consist of a single provision or clause that independently constitutes a distinct instrument. Instruments can be classified following the typology of CE instruments proposed by Hartley et al. (2023).

Each selected document was read in full in its official English version. Where a measure constitutes a circular instrument but does not correspond to any existing category in Hartley et al. (2023), a new category is introduced. To avoid excessive granularity some very closely related instruments were merged and renamed while instruments that at the end of the review were not used were removed. These exhaustive changes are presented in Appendix Table A2.

The first step in coding the document consists of identifying an instrument as part of CE policymaking and adding a row to the Excel sheet that distinguishes to which policy document it relates. Only instruments related to circular policymaking were extracted. Therefore, instruments such as institutional relationships, transitional dispositions and others were neglected. Symbolic instruments, defined as provisions that introduce an instrument with no binding obligation, quantitative target, or enforcement mechanism, were not counted. To cross-check the identification, relevant academic literature and official supporting documentation for each document were also consulted where necessary.

This approach captures policy intent of each document rather than the frequency with which its provisions appear. It avoids distortions in the analysis that would result from the overlap of closely related measures. For example, a document imposing multiple substance restrictions is recorded as deploying one restriction instrument. This provides information on the regulatory stringency and prohibitive intent of the document without inflating the number of instruments.

No temporal decomposition was applied. Temporal analysis could yield valuable insights into policy learning but would require a separate analytical framework. This constitutes promising avenue for future research but would move away from the present RQ, which focuses on assessing the structural design of EU CE policymaking rather than tracing its evolution.

Step 2: Instruments categorization

Once an instrument was identified, it was classified across overarching axes and product lifecycles, following Hartley et al. (2023) adapted taxonomy. Next, circular instruments are classified according to the type-purpose instrument typology (Rogge and Reichardt, 2016). This process uses a one-hot encoding method. It consists of building nine columns next to the instrument's columns, one for each available combination. A cell is set to one where the instrument matches the typology combination.

Instruments were not weighted. This analytical choice was made to assess the structural orientation of the policy mix while avoiding subjective judgments about the relative importance of instruments. The classification of instruments was instead conducted by applying the type-purpose instrument typology that enables to distinguish instruments across their contribution to sustainable transition (Rogge and Reichardt, 2016).

Step 3: Intermediary frameworks coding

The third step involves constructing the intermediary layers by coding the instruments identified against the R9 and ReSOLVE frameworks. This is achieved by adding ten columns for each R9 classification category and six columns for each ReSOLVE component to the Excel spreadsheet. Following the previously applied procedure, when an instrument relates to the transformation of one or more R9 targets or BM components, the relevant cell is coded accordingly by activating the dummy. As each component is a distinct variable that can be activated or not, this procedure allows instruments to be classified in multiple R9 and ReSOLVE components simultaneously.

To verify the identification of measures, the relevant academic literature and supporting web-based information were reviewed as necessary. Differences in definitions between the EU and scholars were noted. For example, the EU defines “recovery” as the process of reusing materials from waste or used products in new production processes, whereas Morseletto (2020) considers it to be the process of generating energy from waste. To ensure consistency throughout the paper, only terms defined in Fig. 1 are used. If academic articles or policy documents refer to a concept with a different definition, that definition is translated into the terminology of Fig. 1.

Step 4: Multi-level perspective analysis

The different levels at which instruments operate are presented in Table 3, which is based on Geels (2019, 2018), Kivimaa et al. (2019) and Webster and Pascucci (2024). The landscape level is exogenous as MLP posits. The niche level is divided into actions that aim to create radical innovations (new niches) or scale them up. At the regime level, measures consist of instruments that either stabilize the regime in its five dimensions or destabilize it in these dimensions to reconfigure the regime. This approach grounds MLP analysis in an empirical context rather than applying it as a post hoc interpretive lens.

The MLP analysis is reconstructed from the combined results of Steps 1 and 2 and includes a coding step that categorizes each instrument. For each instrument identified in a document, the attributes coded in previous steps are reviewed against the categorization scheme in Table 3. Then, the instrument is reviewed in the context of its document to determine its category at a defined level (based on R9, BM, and the instrument's type). Finally, a dummy variable is added to the coding spreadsheet to indicate the corresponding Table 3 category.

4. Results

This systematic analysis of 30 EU legislative acts identifies the policy instruments applied. Instruments were classified following their position along product life stages and overarching policy domains (4.1), their alignment with circularity hierarchies (4.2), their implications for BM transformation (4.3) and STT.

It shows that EU policy instruments predominantly target recycling, resource efficiency, and WM while upstream prevention, sharing, virtualization, and regenerative strategies remain marginal. These findings suggest that the EU CE policy mix favors a transformation pathway that does not destabilize the incumbent linear regime, reinforcing incremental optimization rather than enabling systemic CE transition.

4.1. Distribution of policy instruments across the product life cycle

Fig. 4 illustrates the EU instruments implemented throughout the value chain and across overarching axes within each EU document. Fig. 5 presents a heatmap displaying the distribution of instruments across the type-purpose instrument typology, R9 levels, and ReSOLVE strategies. This approach provides information on the intent of the design of EU CE policymaking rather than the intensity of individual provisions. Thus, it avoids the distortion that repeated provisions within a single document would introduce to the analysis.

Use-phase instruments account for 26% of identified measures. Most are informational measures that aim to improve users' awareness of circular performance (labels, certificates, information requirements) and to support reparability. Financial measures targeting consumption behavior are limited (5 of 76 use-phase instruments). Measures that would constrain consumption or actively promote alternative consumption modes are largely absent.

Design-related instruments are strongly represented, constituting 20% of identified measures. Main measures include ecodesign regulations, hazardous substance restrictions, and durability requirements aimed at improving recyclability, reparability, and resource efficiency. Circulation and leakage instruments account respectively for 21% and 24% of measures. Within the circulation category, most instruments focus on waste collection, sorting, and reprocessing targets, while instruments supporting industrial symbiosis, repair and reuse networks, or collaborative platforms remain limited. Leakage-related instruments similarly focus on regulating the treatment and disposal of waste.

In contrast, material and energy inputs (4%) and production-phase circularity (6%) receive comparatively limited regulatory attention. Main measures consist respectively of developing renewable energies and creating efficient and environmentally friendly production. Measures for enhancing or re-looping secondary raw or bio-sourced materials remain marginal. Energy inputs stage is also the single stage where economic instruments predominate while production phase emphasizes applying regulatory constraints on the production.

At the overarching level, EU CE policy emphasizes public procurement, innovation funding, monitoring frameworks, and market surveillance. While these instruments support diffusion and compliance, relatively few address social partnerships, or the development of shared-use infrastructure.

CE attractiveness is pursued through economic instruments targeting both demand-pull and technology push. Modulated economic incentives for efficient products and green public procurement are the most frequently used, while fiscal instruments such as pay-as-you-throw schemes, flexible taxes, and import tariffs remain underrepresented. CE development is supported through research and innovation funding, knowledge provision, best practice dissemination, awareness initiatives, and single-use restrictions. By contrast, few measures address the provision of infrastructure not related to WM, ecosystem regeneration, or the involvement of social actors. Finally, CE monitoring focuses predominantly on market surveillance and material passports, with standards oriented toward waste management and resource flow perspectives, leaving other dimensions of CE transition, such as repair rates, product lifespan extension, sharing, and collaborative economy practices, largely unmonitored.

4.2. Alignment with circularity hierarchies

Table 4 presents the contribution of identified instruments to CE transition following the R9 framework. Reduce and recycle targets predominate, present in 87% and 80% of documents respectively. Reuse and repair targets follow, addressed in approximately 45% of documents on average. Recovery and rethink targets are only marginally present, appearing in 33% and 23% of documents respectively. Finally, refusing,

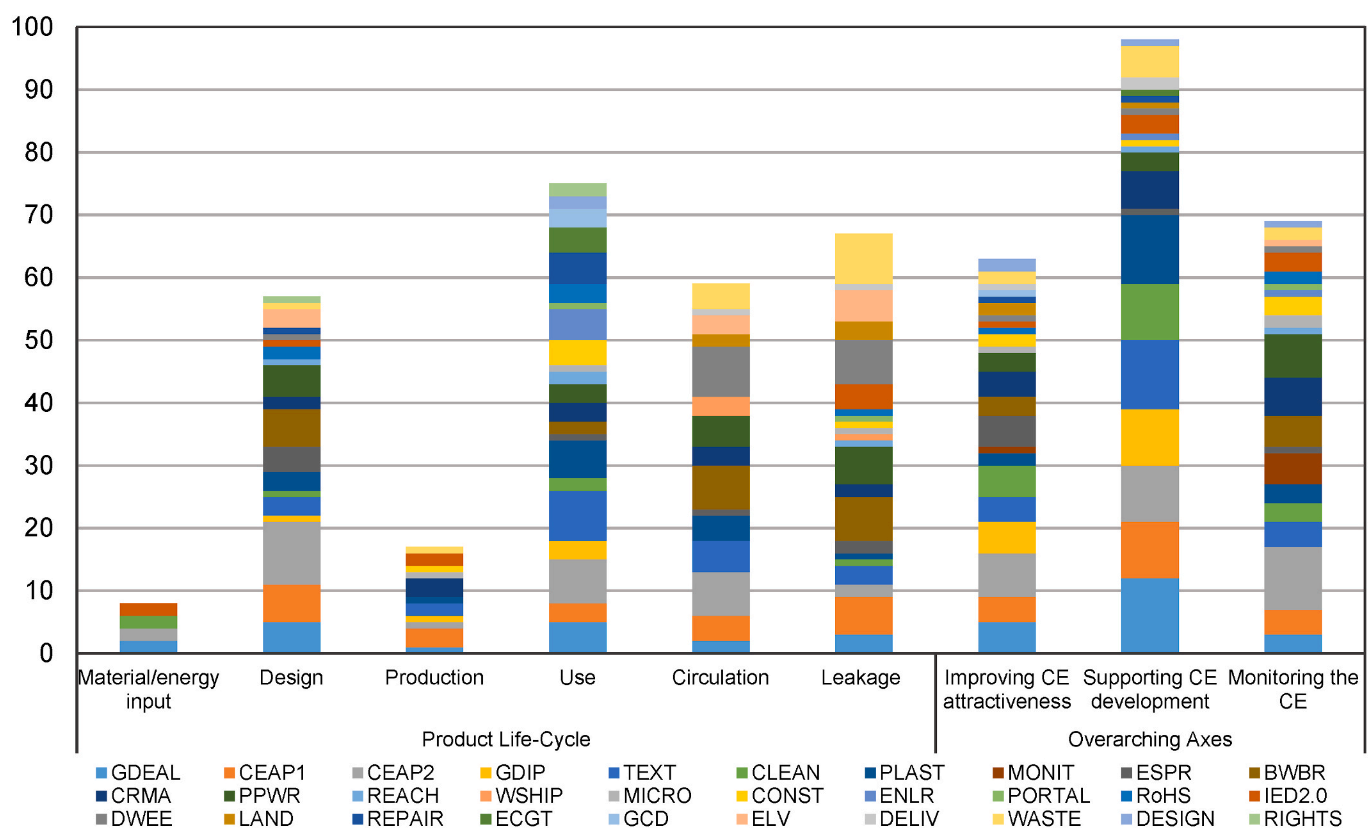

Fig. 4. Instruments distribution across product life-cycle and overarching axes.
Source: own elaboration

		Economic			Regulation			Information		
		Technology push	Demand pull	Systemic	Technology push	Demand pull	Systemic	Technology push	Demand pull	Systemic
Life-Cycle	Material/energy input	6	6	6	0	8	6	0	0	0
	Design	2	0	1	0	55	6	0	0	1
	Production	0	0	0	0	17	0	0	1	0
	Use	0	5	0	0	0	2	0	67	5
	Circulation	0	0	5	0	19	24	0	0	11
	Leakage	0	8	19	0	1	37	0	0	26
Axis	CE attractiveness	11	31	14	0	0	4	0	3	9
	CE development	20	0	15	0	0	9	38	13	48
	Monitoring the CE	0	0	0	0	0	11	0	8	50
R9	All targets (R0-R9)	39	50	60	0	100	99	38	92	150
	Higher-order (R0-R1)	1	2	5	0	0	8	0	8	0
	Reduce (R2)	37	47	35	0	74	39	36	74	75
	Reuse-Repair (R3-R4)	10	4	11	0	25	21	15	40	33
	Lower-order (R5-R9)	19	27	33	0	54	63	18	46	100
ReSOLVE	Regenerate	7	6	8	0	11	11	0	0	0
	Share	3	3	3	0	15	11	1	24	18
	Optimize	18	32	23	0	53	39	13	58	69
	Loop	22	17	30	0	48	54	29	29	97
	Exchange	34	22	28	1	25	12	35	20	31
Type	Strategic	32	28	31	0	50	33	31	44	75
	Legislative	7	22	29	0	50	66	7	48	75

Fig. 5. Heatmaps of instruments.
Source: own elaboration

the highest-order circularity strategy is entirely absent from the corpus.

These targets align with the identified measures. As Fig. A1 shows, recycling is made easier by removing hazardous substances that could make it more difficult, as well as by improving waste sorting and differentiation, providing infrastructure and limiting incineration and landfill. Regarding R2, numerous measures aim to eliminate components or chemicals in product design and production that could hinder recycling or reuse. A noteworthy objective is to prolong the lifespan of products by improving repair knowledge, ensuring products contain fewer hazardous components, and designing products to have a longer life expectancy.

4.3. Business model implications

Fig. 6 illustrates how the policy instruments map onto the BM transformation strategies, according to the ReSOLVE framework. The loop and optimize strategies, present in 80% and 90% of analyzed documents respectively, dominate the policy mix, reflecting a strong emphasis on material recovery, recycling facilitation and efficiency gains. Exchange strategies (73%) are also present, but to a lesser extent, mainly allowing either recycling or the use of safer materials through technological substitution and safer materials. Sharing (47%) is mainly addressed by improving product lifespan and reuse, rather than sharing assets. Regeneration (17%) is supported by a commitment to developing renewable energy but neglects the objective of regenerating ecosystems and developing green infrastructure. Finally, virtualization, despite supporting the most advanced targets, is not addressed in the reviewed documents.

The R9 and ReSOLVE results presented in Sections 4.2 and 4.3 reveal a policy mix concentrated at lower circularity levels and dominated by optimization and looping BM. However, as established in Section 2.4 and operationalized in Step 4 of the methodology, neither R9 nor ReSOLVE results alone are sufficient to determine the transformative potential of the policy mix. It is only by aggregating instrument stringency, circular ambition, and BM reconfiguration simultaneously that a comprehensive STT verdict can be reached.

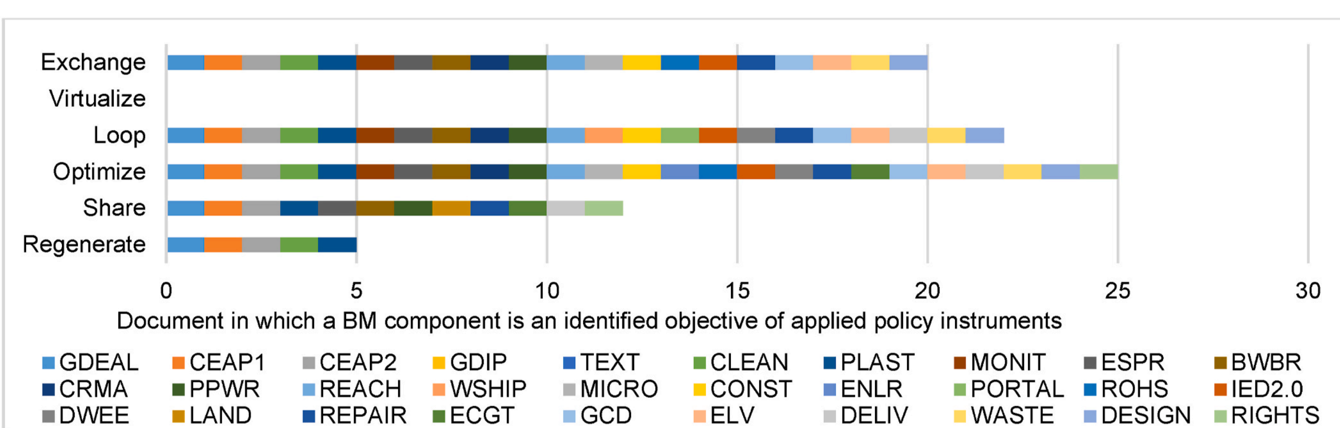

Fig. 6. ReSOLVE components aimed by European documents related to CE policymaking*.
Source: own elaboration

4.4. Contribution to sociotechnical transition

STT involves developing specific instruments that destabilize current regimes and support the formation of new, circular niches. As outlined in Section 2.4, transformative instruments are defined as those with sufficient stringency and enforceability to destabilize incumbent linear regime configurations. These instruments target higher-order R9 strategies and induce a reconfiguration of firms' BM that goes beyond incremental optimization. Fig. 7 presents, following MLP, the contribution of EU CE policy instruments at each sociotechnical level and dimension while distinguishing between transformative and incremental clusters.

At the niche level, 32 instruments contribute to its creation, and 57 contribute to its scaling. Both are dominated by economic and informational instruments. Binding regulatory instruments are absent at the niche creation level and limited at the niche scaling level. At the regime level, the incremental transition cluster is the most supported cluster, with 508 measures distributed across the five sociotechnical dimensions. Industry (136) and policy (194) receive the most coverage, followed by markets and users (93), culture (44), and technology (42). The transformative cluster is with 241 instruments substantially smaller. Related instruments are mainly concentrated in industry (67) dimension while policy (37) markets and users (29), culture (15), and technology (29) received more limited coverage. Finally, in both clusters, demand-side instruments receive limited support: cultural and market dimensions see fewer contributions than industry and policy, and the instruments used are mainly informational and non-binding.

5. Discussion

This discussion interprets the empirical results presented in Section 4 to explore the design intentions behind EU CE policymaking. Interpretive claims are grounded in the structural characteristics of policy instruments coded through the four-layer framework and academic literature and should not be read as assessments of implementation outcomes. It is organized around four analytical themes: the downstream orientation of policy instruments (5.1), the framing of demand- and supply-side policy interventions (5.2), the missing circular targets and BM components (5.3), regime destabilization and niche support from STT perspective (5.4). Consequently, the implications for developing actionable policy levers are proposed (5.5).

5.1. Downstream orientation of EU circular economy policymaking

Section 4 reveals a strong concentration of EU CE instruments targeting lower levels of the circularity hierarchy, such as recycling and recovery. Furthermore, the R2 target is predominantly composed of design-for-recyclability requirements, hazardous substance restrictions and efficiency standards, which serve to make production more efficient through the implementation of looping strategies. These findings are consistent with previous studies that demonstrate the predominance of recycling targets and the focus on ecodesign (De Pascale et al., 2023; Mhatre et al., 2021; Zhang et al., 2025).

Figs. 4 and 6 demonstrate that this downstream orientation is predominantly realized through regulatory and informational instruments acting on the industry and policy dimensions of the sociotechnical regime. This reflects the ambition to promote circularity by incorporating recycling requirements into the production process and streamlining end-of-life material recovery through product design. According to Pinyol Alberich et al. (2023), these are the result of a depoliticized vision of circularity enshrined in a technocratic approach aiming to improve the efficiency of downstream approaches.

This distribution contradicts waste hierarchy principles prioritizing upstream prevention over end-of-pipe measures. As the literature suggests, higher-order approaches preserve more energy and materials than recycling (Korhonen et al., 2018; Morseletto, 2020). EU evidence further suggests that repair and reuse activities are more labor-intensive and less capital-intensive than recycling, making them potentially more cost-effective and job-creating strategies (Llorente-González and Vence, 2020). Therefore, the empirical dominance of lower-order strategies represents a structural misalignment between the policy mix's

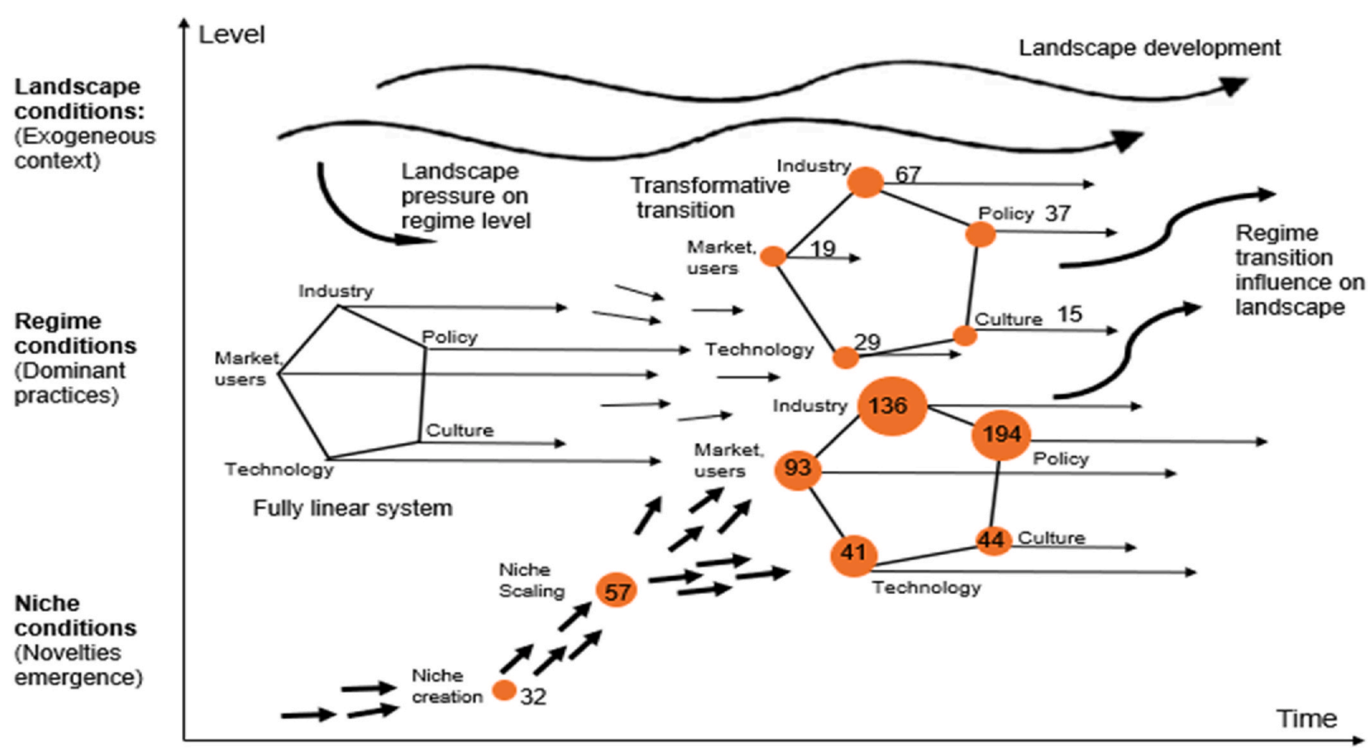

Fig. 7. Multi-level perspective schematization of circular economy policy instruments transformation.
Source: own elaboration

operational weight and transformative CE ambitions.

Indeed, downstream approaches raise three specific challenges that compound this misalignment. The first relates to the quality degradation and leakage in loop closure processes. Full waste collection remains practically unachievable, with reprocessing rates consistently falling below the theoretical threshold for recyclability. This implies that not all of the original material value can be recovered and, where possible, it remains expensive (Korhonen et al., 2018; Morseletto, 2020).

A second challenge concerns recycling quality definition. According to Tonini et al. (2022), to reduce the need for virgin resource extraction, quality criteria should surpass the criterion of being or not recyclable and introduce functionality requirements. In this context, the EU set requirements related to the use of chemicals and design, allowing more end-of-life treatment or reuse. However, gaps remain in the implementation of comprehensive policies, that propose harmonized, mandatory criteria, generating supporting demand and improving stakeholder coordination (Pfeffer et al., 2025). Finally, research also shows that downstream waste solutions and the promotion of recycling might shift attention away from sufficiency and reuse principles, favoring thus symbiotic rebound and stabilizing rather than disrupting linear systems (Figge and Thorpe, 2019; Zink and Geyer, 2017).

5.2. Supply and demand considerations on EU circular transition

A key feature of Fig. 5 is its strong emphasis on demand-pull instruments across all instrument types. This feature requires further consideration, as demand-instruments, following Rogge and Reichardt (2016), consist either of economic instruments such as subsidies, GPP and taxes designed to stimulate demand, or regulatory instruments such as technology and performance standards that shape the conditions under which products enter and compete within the market.

Section 4 reveals that the EU primary objective is to influence demand by regulating the supply of products that meet particular ecodesign or efficiency standards. Consequently, EU instruments target industry and policy dimensions, favoring lower-order CE targets over contributing to higher-order circular strategies or developing new, circular-oriented BM.

Fig. 7 illustrates this configuration. It shows that instruments acting on industry and policy dimensions are overrepresented in the incremental transition dimension, while niche-level instruments and those targeting markets, users, and culture are underrepresented in the transformative transition dimension. Tables 4 and 5 also show that the current demand-pull approach is outweighed by optimization and loop strategies, targeting R2 and R8. This directs the policy mix toward the supply of incremental circular optimization rather than a transformative reconfiguration of consumption and production systems.

This orientation aligns with literature claims advocating for GPP and design-oriented regulation that enhance repairability, durability, and remanufacturing (Milios, 2018). EU information requirements have delivered positive outcomes, like improving the common understanding of material efficiency (Bundgaard and Huulgaard, 2023). They also accelerate sustainability transitions by progressively raising minimum product standards, fostering efficient technologies innovation, destabilizing inefficient incumbent regimes, and making recycling and remanufacturing easier (Dalhammar, 2016; Entsalo et al., 2023).

However, economic incentives remain marginal and fragmented, insufficient to overcome price disadvantages of circular production (Creutzig et al., 2024; Domenech and Borrion, 2022). Economic instruments inadequately internalize the external costs of virgin raw materials, while insufficient support is provided for high upfront investments and the transition to circular-oriented BM (e.g. Grafström and Aasma, 2021; Zhang et al., 2025). Regulation also complicates producers' compliance and increases uncertainty, slowing the transformation (Dalhammar, 2016; Entsalo et al., 2023). The enforcement of EU CE policies compels firms to comply, however this implementation mainly affects small and medium enterprises (SME) due to lower financial and organizational capacities; thereby highlighting the need for complementary support mechanisms and enabling policy and market frameworks (Hermandi and Irrek, 2025).

Nevertheless, the scope of EU demand-side intervention is partly shaped by institutional and economic constraints. For instance, taxation and consumption regulation remain largely within member state competencies, limiting EU capacity for harmonized fiscal measures targeting consumption patterns (Domenech and Bahn-Walkowiak, 2019). The economic and institutional realities of countries and consumers also play a role in enabling the development of circular practices and explain the differences in adoption between countries or groups of consumers. This highlights the need for a clearer definition of who should bear the costs of CE activities (Fortea et al., 2026; Moreau et al., 2017; Teixeira, 2025).

This governance structure partly explains why EU CE policymaking focuses more on product regulation and design standards than on stronger consumption-oriented instruments. It also implies that member states have responsibilities in developing policy and economic measures supporting niche scaling and transformative changes through demand-oriented measures. Moreover, the exclusion of operational programs such as LIFE from the present corpus may additionally underrepresent demand-side intentions, though the inclusion of strategic documents partially compensates for this.

Regulatory constraints on the processes also generate competitiveness and trade challenges. A stringent regulation might redirect production to countries with lower regulation or more carbon-intensive energy mixes and lower production costs (Pianta and Lucchese, 2020). Another challenge lies in the importation of goods. Insufficient border adjustment mechanisms enable non-compliant imports. In 2024, 4.6 billion low-value items entered the EU, tripling 2022 figures (EU Commission, 2025b). This enforcement asymmetry creates negative competition for European manufacturers, who incur compliance costs under circular design mandates while competing with non-compliant imports.

Another strong demand-pull aspect is EU CE policies' heavy reliance on information requirements (eco-labels, product information requirements, green claims verification). These instruments aim to correct information asymmetries and enable more informed consumer choices, reflecting an information-deficit model, which posits that improved knowledge will lead consumers to adopt more sustainable purchasing behaviors.

However, empirical evidence shows that labels and packaging influence circular purchasing decisions only when they are consistent with prior beliefs and behaviors (Testa et al., 2020). As Koide et al. (2025) note, consumer segments respond differently to circular offers: while some are motivated by price attractiveness or prior environmental commitment, the largest segment, however, remains entrenched in linear practices. These findings suggest that information provision alone is insufficient and that cultural and economic change are necessary to significantly shift consumption patterns (Van Den Bergh, 2020). They align with reviews suggesting that consumer-driven demand enhances closed-loop supply chains performance but that cultural and technological enablers remain underexploited (Serra and Alfinito, 2025).

Demand-side instruments may involve designing more circular products, but they must also facilitate the reconfiguration of user behaviors by enabling new markets and consumption practices associated with circular use patterns (Chepeliev et al., 2026; Siderius and Zink, 2023). Without such complementary demand-side interventions targeting user behavior, market incentives, and cultural norms, EU circular economy instruments risk reinforcing lower-order circular strategies rather than catalyzing the systemic transformation of consumption patterns required for a circular transition (Mont et al., 2022).

Existing frameworks identify underexploited solutions. As Milios (2021) argues, fiscal and tax policies can contribute to a balanced policy mix by applying tax disincentivizing on raw material extraction and end-of-life disposal and tax relief for reuse/repair actions. Such schemes address cost asymmetries that penalize repair, reuse, and sharing regardless of consumer environmental values, generating greater demand for circular products. Furthermore, instruments targeting cultural norms and the perceived value of sustainable products appears underexploited (Rohsig Lopez and Legardeur, 2024). Similarly, consumption-restricting instruments, such as advertising regulation, sharing-economy approach are nearly absent.

5.3. The missing circular targets and business models components

EU CE policy instruments prioritize recycling and optimization strategies while largely excluding BM components associated with higher-order circularity targets. Virtualization is absent from reviewed documents, while sharing appear in 47%, primarily as product lifespan extension rather than collaborative consumption strategies. Refuse receives no policy attention, and rethink appears as a target in 20% of documents. Moreover, the provision of both physical and digital infrastructure that could enable sharing and virtualization receives little policy attention. A limited number of instruments support repair/collection networks, tool libraries or sharing platforms, fostering only a small number of sharing BM addressing R0-R1 targets.

While the ReSOLVE and R9 frameworks provide useful tools for classifying circular strategies and targets, their analytical value also lies in revealing potential interactions and tensions between different approaches. In practice, strategies such as optimizing and looping often reinforce incremental improvements within existing production and consumption systems, whereas virtualization, sharing, and regenerative approaches may enable more disruptive transformations of ownership structures, product-service relations, and resource use (Blomsma and Brennan, 2017; Bocken et al., 2022; Geissdoerfer et al., 2020). Similarly, higher-order objectives such as rethinking consumption and production systems, reusing or repairing products, or refusing certain forms of consumption may conflict with approaches that prioritize end-of-life recycling and material recovery. Recycling can, for instance, reduce incentives for prevention-oriented strategies if policy frameworks focus predominantly on downstream waste valorization (Morseletto, 2020; Zink and Geyer, 2017). These potential tensions highlight the risk that policy prioritization of lower-order strategies may generate systemic lock-ins that reinforce existing production and WM regimes rather than enabling more transformative circular pathways.

This contradictory dynamic needs therefore policy prioritization yet remains subject to policy and contextual pressure represented by landscape regime (Geels, 2019). Indeed, the dominance of optimize and loop therefore reflects a strategic prioritization of incremental improvements within established industrial regimes. This potential path dependency requires contextualization. Loop and optimization strategies that contribute to R2, R8-R9 targets tend to be more compatible with existing infrastructures, value chains, and regulatory frameworks, making them politically and economically easier to implement (Genovese and Pansera, 2021; Kębłowski et al., 2020). As Bauwens et al. (2020) note, they also reflect the preferences of lobby groups and short-termism technocratic political orientations that seek to optimize industrial process without destabilizing sociotechnical regimes.

By contrast, strategies such as sharing and virtualization often require deeper changes to the BM, user practices and supporting infrastructures, which current policy instruments do not facilitate. These differences create tensions between circular strategies. For instance, investments in recycling systems may stabilize the recovery of materials downstream while reducing the incentive for upstream strategies, such as refuse or rethink. Therefore, understanding these trade-offs is essential when interpreting policy priorities, as the predominance of optimization and looping strategies may reflect their compatibility with existing regimes, as well as the greater political and economic obstacles to more disruptive circular transitions.

Virtualization represents a high-order circular strategy that can directly contribute to refuse and rethink targets, for instance through e-books, streaming services, telemedicine or work (EMAF, 2025). Yet EU CE instruments contain no subsidies for the digital services transition, no regulatory preferences or GPP criteria for dematerialized alternatives and no direct significant innovation support.

Several factors help explain this gap. Digital technologies can contribute to environmental sufficiency; however policy frameworks tend to mobilize them primarily to enhance efficiency and consistency rather than sustainability, due to challenges related to competitiveness, stakeholder interests, and rebound effects (Santarius et al., 2023). Nevertheless, virtualization remains a key lever for circular transition and should not be dismissed. Rather, developing policies that explicitly address these risks could unlock significant sustainability gains (Lange et al., 2020; Santarius et al., 2023).

Sharing is another underexploited dimension. Sharing encompasses collaborative consumption, product-services-systems (PSS), and other models that directly support rethink through intensified use, as well as strategies promoting durability and reuse through longer individual ownership. Yet, EU instruments favor the latter while neglecting approaches that intensify use regardless of ownership. This reflects an entrenched, ownership-based logic, as well as a psychological perception of risk that values non-disruptive approaches (Hansmann and Binder, 2023). It also reflects the practical challenges of scaling sustainable sharing, including the coordination and provision of goods (Öberg, 2024). Moreover, as Hobson and Lynch (2016) argue, EU's depoliticized discourses and over-prioritization of technological regulation and consumer roles also contribute to the development of inconsistent practices, and that even among sharing strategies such as in the case of the sharing economy.

Finally, a striking and debatable finding is the absence of sufficiency-oriented instruments in EU CE policymaking. While sufficiency is academically debated, the political debate remains dominated by CE narratives centered on technological innovation and eco-efficiency (Mederake, 2023). Sufficiency could enable development of circular-oriented BM that address rebound effects, disrupt incremental innovation, and challenge throwaway practices to fully align with higher-order targets and share and regenerate BM. Implementing it might consist of fixing consumption cap, eco-taxes or subsidies, advertising restrictions, stringent regulations on obsolescence. The implementation of such instruments would however necessitate important debate to reshape dominant consumerist European imaginaries (Bocken et al., 2022).

5.4. EU policymaking considering circular niche development and regime destabilization

The MLP posits that sustainability transitions occur through dynamic interactions between niche innovations, established sociotechnical regimes, and broader landscape pressures (Geels, 2011, 2018). Present findings provide a direct answer to the overarching RQ. When situating present transition in Geels and Schot (2007) transition typology, the EU CE policy mix is most consistent with a transformation pathway while a reconfiguration pathway would, according to scholars, be more desirable for a genuine circular STT (Bocken et al., 2016; Geissdoerfer et al., 2020; Genovese and Pansera, 2021; Kirchherr et al., 2017; Pinyol Alberich et al., 2023; Webster and Pascucci, 2024).

The design of policy-mixes remains largely oriented toward incremental regime optimization. In this context, instruments capable of fostering regime destabilization and supporting niche development through higher-order circular strategies and BM reconfiguration are underutilized. This pattern reveals a technocratic policy approach that risks reinforcing path dependencies toward WM and efficiency-oriented production strategies. Therefore, addressing this imbalance is a central challenge for the next generation of EU CE policymaking.

Nonetheless, it matters to consider landscape pressures such as resource scarcity, geopolitical supply risks, and climate change that shape the context in which CE policies are developed. These pressures create incentives for resource efficiency, reuse and recycling (Hartley et al., 2024), reinforcing policy emphasis on downstream material recovery resulting in policies such as the BWBR or CRMA. However, this focus may simultaneously overlook opportunities to support more disruptive transitions in consumption systems, such as sharing, virtualization, or sufficiency-oriented models discussed in Section 5.3.

The analysis of EU instruments reveals important tensions. On the one hand, several regulatory instruments, such as ecodesign requirements, chemical restrictions, and product information obligations, can gradually destabilize existing regimes by raising minimum environmental performance standards and increasing compliance costs for inefficient production systems (Dalhammar, 2016; Entsalo et al., 2023). On the other hand, they tend to optimize existing regimes rather than destabilize or support transformative niches. This creates the risk of potential lock-ins and path dependency toward optimization strategies that fall short of higher-order, transformative targets. Moreover, merely providing information on product efficiency or circular features is unlikely to significantly alter entrenched consumption practices or cultural imaginaries, especially in the absence of complementary economic incentives and institutional changes (Webster and Pascucci, 2024).

From a transition perspective, the limited presence of instruments that support virtualization, sharing, and sufficiency reflects the challenges of fostering niche innovations that can challenge dominant sociotechnical regimes. As Fig. 7 shows, policy instruments and strategic documents rarely create protected spaces for emerging circular-oriented BM. This may represent a transformative gap, as frameworks such as ReSOLVE and the R9 hierarchy have broadened the conceptualization of CE by emphasizing various, potentially transformative configurations of production and consumption beyond traditional IE approaches.

Although some actions are of the competencies of states, or even lower levels of governances (regions, cities), EU policymaking could still exploit instruments proposed by Hartley et al. (2023) that remain underexploited, especially in the realm of digitalization, innovation, regenerative production models, regulation of PSS, collaboration platforms or the sharing economy. Without targeted support mechanisms niche innovations may struggle to scale and influence regime dynamics. Lessening, sharing and valorizing practices are crucial pathways in CE transition that face systemic lock-ins such as redundancy, overproduction, fast consumption (Morseletto, 2023).

Finally, energy represents another key variable in regime transformation, and CE policymaking plays a significant role by pushing toward renewable energies, carbon neutrality and energy security (Shobande et al., 2024). Currently, around 19% of European material footprints is linked to fossil resource (EUROSTAT, 2025). Lowering this figure will substantially advance a circular regime but also necessitate instruments beyond the optimization and looping, including sharing practices, ecosystem regeneration, and bioeconomy-based approaches (Schipfer et al., 2024).

Taken together, the four-layers framework reveals the importance of considering coherence and structural trade-offs embedded in current policy mix. A downstream focus creates infrastructure lock-ins that reduce political and economic incentives for upstream prevention. Extended producer responsibility as currently designed allows producers to meet obligations through end-of-life recovery rather than upstream design changes, inadvertently reinforcing the same downstream orientation. Meanwhile, heavy reliance on information instruments risks legitimizing continued consumption within existing patterns rather than challenging them, generating rebound effects that partially offset efficiency gains (Camacho-Otero et al., 2020; Figge and Thorpe, 2019; Zink and Geyer, 2017). The policy levers proposed in Section 5.5 explicitly account for these trade-offs by prioritizing instruments that avoid reinforcing downstream lock-ins while creating institutional conditions for higher-order circular strategies to emerge and compete with incumbent linear alternatives.

5.5. Actionable policy levers

Overall, the analysis shows that EU policy instruments are primarily used to optimize existing socio-technical regimes rather than transform them. Nevertheless, it remains possible to develop a coordinated set of transformative instruments that could target higher-order objectives and BM while addressing cultural and competitiveness barriers. For researchers, identifying leverage points within CE policymaking also offers opportunities to conduct new research, identify critical issues, or find new policy pathways.

Table 5 summarizes the policy levers for a more transformative CE across MLP levels, paying attention to prioritization and trade-off challenges. As illustrated, developing transformative and systemic changes that align with broader conceptions of CE requires instruments that target higher-order strategies and new BM. Additionally, it is necessary to implement regulatory and economic instruments concerning markets, users, cultural norms, transformative industry, technology, policy, and niche support.

Therefore, policy development should aim for a balanced and coherent mix of policies that combines targeted regime optimization with support for more transformative circular pathways. Where they contribute to EU competitiveness and industrial policy objectives while addressing exogenous landscape pressures such as resource scarcity and security or climate mitigation, optimization and looping regime-level interventions remain necessary.

At the same time, policy instruments should actively support the scaling of niche innovations and BM that can reshape production and consumption patterns. This includes developing alternative BM and infrastructures in areas where the CE can generate new, complementary value, thereby fostering higher-order circular strategies. These areas include regenerative production systems, sharing and virtualized models, and repair and reuse practices. In addition, policies should aim to promote a positive image of CE among innovation stakeholders (Garg et al., 2025). These practices contribute to upstream circular strategies and enable systemic transformation.

At the interaction between landscape and socio-technical levels, policy instruments are needed to align CE policymaking with exogenous pressures on lower-level regimes (Geels, 2018; Webster and Pascucci, 2024). Critical resource concerns, energy transition and trade competition challenge linear systems while offering an opening to develop more transformative CE systems (Baldassarre, 2025; Hartley et al., 2024; Pianta and Lucchese, 2020).

Trade instruments such as mandatory circular compliance verification, escalating import tariffs on non-circular goods are necessary conditions for supply-side regulatory ambition that could address the significant increase of low-value non-circular imports between 2022 and 2024 (EU Commission, 2025b; Pianta and Lucchese, 2020). Similarly regulatory and economic instruments contributing to lower resources and energy dependency should be pursued as they enhance EU competitiveness without contradicting its sustainability ambitions.

At the regime level, ecodesign requirements, efficiency standards, and end-of-pipe management instruments stabilize existing socio-technical structures while delivering incremental improvements. Where these improvements represent the technologically or economically most feasible pathway, they must be strengthened to produce significant results. However, careful calibration of these technocratic approaches is required to avoid regime lock-ins, enable the development of incumbent technologies, and favor the transition toward higher-order CE practices such as regenerating, repairing, reusing, or rethinking.

The present analysis identifies opportunities to adapt current policymaking by integrating instruments capable of destabilizing linear BM. The role of producers and distributors in enabling and supporting CE transformation is crucial in this regard (Campbell-Johnston et al., 2021; Zils et al., 2025). Extending the polluter-pays principle beyond end-of-life management might contribute to genuine destabilization that internalizes the full lifecycle costs and make them enablers of new

Table 3
Circular economy multi-level perspective instrument categorization.

Category	R9 Orientation	BM changes induced	Type of instrument	Example
Niche level condition; Circular niche support				
Niche creation	R0-R1 and R3-R4	Regenerate, Share, Virtualize, Exchange	Economic, Information	Support to circular innovation
Niche scaling	R0-R1 and R3-R4	Regenerate, Share, Virtualize, Exchange	Economic, Information	GPP supporting reused products
Regime condition, Incremental measure, stabilizing the regime toward weak CE				
Markets, user preferences	R2 and R5-R9	Loop, Optimize	Information, Economic	Labels; Recycling guidance
Industry	R2 and R5-R9	Loop, Optimize,	Information, Regulatory, Economic	Best available techniques guidance; voluntary industry agreements
Policy	R2 and R5-R9	Loop, Optimize,	Information, Regulatory	Monitoring frameworks; non-binding targets
Technology	R2 and R5-R9	Loop, Optimize,	Regulatory, Economic, Information	Research on efficiency; incremental performance improvements
Culture	R2 and R5-R9	Loop, Optimize	Information	Awareness campaigns; educational initiatives
Regime condition, Socio-technical reconfiguration destabilizing the regime toward systemic CE				
Markets, user preferences	R0-R4	Regenerate, Share, Virtualize, Exchange	Economic, Regulation	Significant tax reductions for circular products
Industry	R0-R4	Regenerate, Share, Virtualize, Exchange	Economic, Regulation	Binding phase-out of substance, mandatory design requirements
Policy	R0-R4	Regenerate, Share, Virtualize, Exchange	Economic, Regulation	Mandatory circular design standards; Single-use restriction
Technology	R0-R4	Regenerate, Share, Virtualize, Exchange	Economic, Regulation, Information	Economic incentives for circular technology; higher-order practices exchanges
Culture	R0-R4	Regenerate, Share, Virtualize, Exchange	Economic, Regulation, Information	Ban advertisement on non-circular practices, Legalization of the sharing economy

Source: own elaboration

Table 4
Summary R9 framework related to EU CE policymaking.

Targets	Number of documents where a policy target	Main mechanisms applied
R0 (refuse)	0 (0%)	- –
R1 (rethink)	7 (23%)	Refilling strategies; single-use restriction;
R2 (reduce)	26 (87%)	Efficient products design requirements; production standard; inclusion of recycled/bio-sourced requirement in production; transition toward renewable energies; design enabling a better reuse of materials in production
R3 (reuse)	16 (53%)	Durability requirements; design and product components requirements
R4 (repair)	10 (33%)	Ban hazardous components in products; repair information requirements, restriction on repair hurdles
R5 (refurbish)	11 (37%)	Disassembly design and ban of hazardous components in new products, targets for material reuse
R6 (remanufacture)	16 (53%)	*idem*
R7 (repurpose)	18 (60%)	*idem*
R8 (recycle)	24 (80%)	Banning hazardous substances in products; regulation on facilities treatments; (separate) waste collection measures; recycling targets; extended producer responsibility
R9 (recovery)	10 (33%)	Waste-to-energy regulation; landfilling restriction; banning hazardous substances in products

Source: own elaboration

circular practices like facilitating repairing, ownership shifts or reuse practices.

At the policy level, there are opportunities to extend IE principles towards higher-order CE objectives by deploying instruments such as eco-industrial parks, collaboration platforms and intermediary organizations, which enable the CE transition and the development of new, circular-oriented BM (Coussa, 2026; Kivimaa et al., 2019). Similarly, PSS frameworks, dedicated infrastructure, sharing platform liability regimes, and GPP targeting use-intensity or regeneration practices, would create institutional conditions for higher-order BM to compete with incumbent linear alternatives without relying solely on consumer willingness to change (Hannon et al., 2019; Siderius and Zink, 2023). Moreover, as the analysis of monitoring instruments reveals, the focus on WM and resources productivity, might leave critical dimensions of CE transition not sufficiently monitored, lacking of tools for efficient policymaking (Rashid, 2025).

At the niche level, local institutions play a crucial role in fostering networks, communities, circular cultures, and circular-oriented BM, as well as supporting their scaling while avoiding technocratic lock-ins (Coussa, 2025). Nonetheless, the EU can implement measures such as structural protection, R&D funding, and proposing institutional and cultural reconfiguration enabling circular innovations to compete and scale. Examples of interventions include deflated value-added tax on repair services or second-hand goods, EU-funded municipal infrastructure such as tool libraries, community workshops or urban agriculture initiatives, regulatory sandboxes or administrative simplification.

Dedicated support and research for virtualization and dematerialization strategies would unlock the sustainability gains meeting R0-R1 objectives as long as measures address rebound effects and digital infrastructure environmental costs simultaneously (Lange et al., 2020; Santarius et al., 2023). Finally, fostering circular skills, education and new consumption imaginaries would address the cultural and behavioral aspects of the CE transition that regulatory instruments alone cannot reach. CE transition requires social acceptance, which can be achieved by demonstrating the economic advantages of circular practices over consumerist ones and by offering a more desirable future.

Table 5
Policy-levers recommendations for transformative CE transition.

Policy lever	Policy rational	Potential instruments
Interaction Landscape-Regime levels		
Use CE policymaking to support resource security	Correct price distortions that favor linear production, virgin materials and critical raw material dependency	Escalating virgin material extraction taxes; mandatory recycled/biosourced content requirements, resource extraction limitations
Use CE policymaking to support energy transitions	Reduce fossil resource dependency and decarbonize the economy,	Definition of allowed energy mix and sources; efficiency requirements for usage phase
Integrate trade challenges into CE policymaking	Correct price distortions, overconsumption of uncircular products	Flat import tariffs, stricter importation controls; mandatory circular compliance
Regime level		
Expand stringent product regulation beyond recyclability	Shift policy focuses upstream on product longevity and reuse	Durability standards, right-to-repair legislation, mandatory repairability scoring; longer products guarantee
Strengthen extended producer and distributor responsibility toward upstream prevention	Redistribute end-of-life financial responsibility to incentivize rethink, repair, and reuse designs rather than recovery/recycling targets	EPR modulation rewarding circular design; repair obligation, single-use bans, stricter polluter-pays principle; modulation economic taxes
Develop high-order and more comprehensive industrial symbiosis	Use industrial park as higher order practices tools and strengthen incentives for industrial symbiosis	Broaden industrial symbiosis strategies; by-product exchange regulation and incentives;
Promote the development of existing collaborative economy	Create conditions for higher-order BMs to compete with linear alternatives	PSS regulation; sharing economy frameworks; liability regimes for collaborative consumption; GPP criteria
Promote regenerative practices	Support a green and regenerative BM that contributes transforming consumption and production practices	Ecosystem restoration requirements; green economy regulation and incentives; development of nature-based solutions
Restrict non-circular advertising and fast consumption patterns	Reshape cultural norms reproducing linear consumption imaginaries; address demand-side cultural lock-in	Regulation of public and digital platforms uncircular advertisement; banning fast fashion and single-use promotion; educational and awareness programs
Align CE monitoring with transition-relevant indicators	Make transformative transition more visible and accountable beyond WM metrics	Expanded monitoring frameworks to new features such as repair rates, product lifespan, regeneration performance
Niche level		
Support experimentation and research for new CE-oriented BM	Create protected spaces and support mechanisms for radical innovations beyond incremental optimization	Innovation funding; regulatory sandboxes; GPP; Research support, Financial startup and scale-up support toward new CE-oriented BM
Develop frameworks for collaborative consumption	Facilitate and generalize intensified product use and demand for linear consumption patterns	Digital platforms and infrastructure, circular industrial parks and facilities; repair-reuse networks; awareness
Develop EU funding and support policies for CE-oriented BM implementation at local level	Enable circular cultures and niche innovations to develop within communities	GPP; regulatory sandboxes; urban labs; fundings of social and community projects (urban agriculture, repair-reuse networks …)
Enable virtualization and dematerialized services	Substitute physical consumption with digital services	Innovation support, digital procurement criteria, teleworking policies
Foster circular skills and cultural imaginaries	Address the cultural and behavioral dimensions of CE transition	Education programs; upskilling/training programs for businesses and public institutions; awareness

Source: own elaboration

However, it should be noted that the effectiveness of these recommendations depends on the quality of implementation, political and economic conditions, and member state transposition. Prioritizing circular strategies requires significant trade-offs that policymakers must navigate according to their institutional, national, and political contexts (Arsova et al., 2022; Brusselaers and Gillabel, 2024).

Within EU competencies, actionable levers such as strengthening ecodesign requirements toward durability and repairability, extending producer responsibility toward upstream prevention, expanding GPP criteria to incorporate higher-order circular strategies, and developing monitoring frameworks beyond WM metrics could build on existing regulatory architecture without requiring new competencies or fundamental member state coordination (Dalhammar, 2016; Hartley et al., 2023; Milios, 2018; Rashid, 2025). In contrast, levers targeting consumption patterns, advertising regulation, sharing economy frameworks and fiscal instruments would require either deeper institutional reconfiguration at the EU level, or active coordination between member states that depends on political will and governance reform beyond the current EU CE framework (Chepeliev et al., 2026; Domenech and Bahn-Walkowiak, 2019; Milios, 2021).

6. Conclusion

This paper asked whether EU CE policy instruments enable transformative circularity that genuinely “closes the loop” or merely “curve” linear production. Through systematic analysis of 30 legislative acts mapped across circularity hierarchies and BM transformation requirements, it provides a comprehensive instrument-level assessment of EU CE policy architecture. The present study does not contradict the results of the recent studies on EU CE policy presented in Table 1. However, it offers a new perspective on the role of its instruments in MLP transition by assessing how EU policy design operationalizes the crucial tension between the incremental and transformative changes underlying CE transition.

Results suggest that current CE instruments contribute primarily to the optimization of existing socio-technical systems rather than enabling a higher-order shift that would fundamentally alter production and consumption patterns. Operational instruments predominantly target mid-to-low-order circularity through *loop* and *optimize* strategies, neglecting upstream prevention, as well as *share*, *virtualize* and *regenerate* BM components essential for paradigmatic change. From the MLP, such a transition follows a transformation pathway that avoids destabilizing the regime and potentially creating systemic lock-ins hindering the development of radical innovations and BM that could reconfigure linear systems.

Theoretically, this study advances CE scholarship by demonstrating how instrument level policy design shapes the depth of circular transition. Furthermore, it operationalizes the transformative-technocratic tension through systematic instrument-level analysis. It suggests that weak circularity and lock-ins reflect structural design misalignment, consistent with political economy dynamics favoring incremental optimization, rather than implementation failure alone, with incumbent regime stabilization systematically prioritized over niche support.

Closing the loop requires more than recycling and efficiency improvements. Instruments exist to adapt policymaking toward the development of new BM and higher-value objectives. Future CEAP should implement instruments enabling sufficiency-oriented, sharing-based, dematerialized alternatives capable of resource decoupling. This also implies measures at demand level and paradigm shifts in ownership norms, consumption cultures, and the use of varied circular BM.

For researchers, identifying opportunities for improvement in CE policymaking opens up new areas of research. This allows them to identify valuable technical and political levers, assess their drivers, barriers and outcomes, and expand the knowledge of scientists and practitioners about circular economy tools and strategies.

This study has several limitations that suggest avenues for further research. Firstly, the analysis focuses on EU-level policymaking. While the EU level remains particularly relevant due to its regulatory influence, the role of national and local instruments in shaping the CE transition could be explored further in future studies. Secondly, the study prioritizes the structural orientation of the policy mix over providing explicit instrument weighting or temporal analysis. Further research could investigate EU CE policymaking evolution and assess policy-learning dynamics over time. Third, the analytical frameworks applied emphasize material targets and BM dimensions, while giving less attention to social and justice aspects of the transition. Finally, this study does not quantify the outcomes of EU policymaking but instead examines how policy instruments are designed to support — or limit — transformative circular transition. Similarly, an analysis of documents might inform on the intended design while neglecting its concrete implementation or interpretation. Future research could build on this structural assessment to evaluate the effectiveness of the policy-mix in delivering measurable outcomes.

Despite these limitations, this comprehensive mapping provides robust evidence for understanding how EU instruments contribute to the objectives of CE transition and how policymaking is positioned between technocratic optimization and systemic transformation tensions. The findings offer practical and complementary value for both scholars and practitioners by identifying how EU policymaking can be complemented at local, national, and European levels and by highlighting actionable levers for future research and policy design.

Research data declaration

The coding matrix underlying this study will be deposited in an open repository still to be determined. Researchers willing to access it earlier can contact the corresponding author.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author used ChatGPT and Claude to proofread the text and identify alternative sources. After using these tools, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Alexandre Coussa reports a relationship with Université de Fribourg that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

I would like to express my gratitude to Professor Philippe Gugler (University of Fribourg) for his invaluable guidance throughout these years of doctoral research. I also would like to thank the anonymous Reviewers and Editors for their insightful comments on the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cesys.2026.100445.

Data availability

Data will be made available on request.

References

Alpdogan, H., Adiguzel, Z., Celebi Boz, F., Ayas, I., 2026. Circular economy and economic growth in Europe: analysis using the method of moments quantile regression. Sustainable Development sd, 70757. https://doi.org/10.1002/sd.70757.

Arsova, S., Genovese, A., Ketikidis, P.H., 2022. Implementing circular economy in a regional context: a systematic literature review and a research agenda. J. Clean. Prod. 368, 133117. https://doi.org/10.1016/j.jclepro.2022.133117.

Ayres, R.U., Ayres, L.W. (Eds.), 2002. A Handbook of Industrial Ecology. Edward Elgar Publishing. https://doi.org/10.4337/9781843765479.

Baldassarre, B., 2025. Circular economy for resource security in the European Union (EU): case study, research framework, and future directions. Ecol. Econ. 227, 108345. https://doi.org/10.1016/j.ecolecon.2024.108345.

Bauwens, T., Hekkert, M., Kirchherr, J., 2020. Circular futures: what will they look like? Ecol. Econ. 175, 106703. https://doi.org/10.1016/j.ecolecon.2020.106703.

Bemelmans-Videc, M.-L., Rist, R.C., Vedung, E., 1998. Carrots, Sticks & Sermons : Policy Instruments and their Evaluation. Transaction Publishers, New Jersey, United States. New Brunswick, N.J., U.S.A.

Öberg, C., 2024. Sharing economy models and sustainability: towards a typology. J. Clean. Prod. 447, 141636. https://doi.org/10.1016/j.jclepro.2024.141636.

Blomsma, F., Brennan, G., 2017. The emergence of circular economy: a new framing around prolonging resource productivity. J. Ind. Ecol. 21, 603–614. https://doi.org/10.1111/jiec.12603.

Bocken, N., Coffay, M., Dalhammar, C., 2025. The Brussels and California effects? Circular economy Policy influence across borders. Circ.Econ.Sust. 5, 1665–1688. https://doi.org/10.1007/s43615-025-00516-4.

Bocken, N.M.P., De Pauw, I., Bakker, C., Van Der Grinten, B., 2016. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 33, 308–320. https://doi.org/10.1080/21681015.2016.1172124.

Bocken, N.M.P., Niessen, L., Short, S.W., 2022. The sufficiency-based circular Economy—An analysis of 150 companies. Front. Sustain. 3, 899289. https://doi.org/10.3389/frsus.2022.899289.

Boulding, K., 1966. The economics of the coming spaceship Earth. In: Jarrett, H. (Ed.), Environmental Quality in a Growing Economy. Baltimore, MD.

Brusselaers, J., Gillabel, J., 2024. How Circular is the European Policy landscape? Circ. Econ.Sust. 4, 1559–1585. https://doi.org/10.1007/s43615-023-00334-6.

Bundgaard, A.M., Huulgaard, R.D., 2023. The role of standards in support of material efficiency requirements under the Ecodesign Directive. J. Clean. Prod. 385, 135599. https://doi.org/10.1016/j.jclepro.2022.135599.

Calisto Friant, M., Vermeulen, W.J.V., Salomone, R., 2021. Analysing European Union circular economy policies: words versus actions. Sustain. Prod. Consum. 27, 337–353. https://doi.org/10.1016/j.spc.2020.11.001.

Camacho-Otero, J., Tunn, V.S.C., Chamberlin, L., Boks, C., 2020. Consumers in the circular economy. In: Brandão, M., Lazarevic, D., Finnveden, G. (Eds.), Handbook of the Circular Economy. Edward Elgar Publishing. https://doi.org/10.4337/9781788972727.00014.

Campbell-Johnston, K., De Munck, M., Vermeulen, W.J.V., Backes, C., 2021. Future perspectives on the role of extended producer responsibility within a circular economy: a Delphi study using the case of the Netherlands. Bus. Strat. Environ. 30, 4054–4067. https://doi.org/10.1002/bse.2856.

Capano, G., Howlett, M., 2020. The knowns and unknowns of Policy instrument analysis: policy tools and the Current research agenda on Policy mixes. Sage Open 10, 2158244019900568. https://doi.org/10.1177/2158244019900568.

Cardno, C., 2019. Policy document analysis: a practical educational leadership tool and a qualitative research method. Educational Administration: Theor. Pract. 24, 623–640. https://doi.org/10.14527/kuey.2018.016.

Chepeliev, M., Aguiar, A., Farole, T., Liverani, A., Van Der Mensbrugghe, D., 2026. Circular economy transition in Europe requires ambitious policies beyond climate mitigation. Resour. Conserv. Recycl. 225, 108591. https://doi.org/10.1016/j.resconrec.2025.108591.

Coussa, A., 2025. What will a circular city look like? A systematic literature review of urban circular economy applications and their implications for research and practice. City Environ. Interact. 28, 100261. https://doi.org/10.1016/j.cacint.2025.100261.
Coussa, A., 2026. The Circular economy transformation of eco-industrial parks: developing new industrial parks for a new paradigm. Circ. Econ. Sustain. 6. https://doi.org/10.1007/s43615-026-00836-z.
Creutzig, F., Simoes, S.G., Leipold, S., Berrill, P., Azevedo, I., Edelenbosch, O., Fishman, T., Haberl, H., Hertwich, E., Krey, V., Lima, A.T., Makov, T., Mastrucci, A., Milojevic-Dupont, N., Nachtigall, F., Pauliuk, S., Silva, M., Verdolini, E., Van Vuuren, D., Wagner, F., Wiedenhofer, D., Wilson, C., 2024. Demand-side strategies key for mitigating material impacts of energy transitions. Nat. Clim. Change 14, 561–572. https://doi.org/10.1038/s41558-024-02016-z.
Dalhammar, C., 2016. Industry attitudes towards ecodesign standards for improved resource efficiency. J. Clean. Prod. 123, 155–166. https://doi.org/10.1016/j.jclepro.2015.12.035.
De Pascale, A., Di Vita, G., Giannetto, C., Ioppolo, G., Lanfranchi, M., Limosani, M., Szopik-Depczyńska, K., 2023. The circular economy implementation at the European Union level. Past, present and future. J. Clean. Prod. 423, 138658. https://doi.org/10.1016/j.jclepro.2023.138658.
Domenech, T., Bahn-Walkowiak, B., 2019. Transition towards a resource efficient circular economy in Europe: policy lessons from the EU and the member States. Ecol. Econ. 155, 7–19. https://doi.org/10.1016/j.ecolecon.2017.11.001.
Domenech, T., Borrion, A., 2022. Embedding Circular economy principles into urban regeneration and waste management: framework and metrics. Sustainability 14, 1293. https://doi.org/10.3390/su14031293.
Dos Reis, F.B., Da Fonseca, L.B., De Almeida, L.P.B.C., De Mello, A.M., 2025. The impact of internet of things configurations on the implementation of circular business models. Circ.Econ.Sust. https://doi.org/10.1007/s43615-025-00652-x.
EMAF, 2021. Delivering the Circular Economy: a Toolkit for Policymakers.
EMAF, 2025. What is a circular economy? URL. https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview, 2.25.25.
Entsalo, H., Kalimo, H., Kautto, P., Turunen, T., 2023. Analysing regulatory instruments in sustainability transitions: a combined 'intervention points' and 'roles of law' approach to the European Union's Ecodesign framework. Sustain. Prod. Consum. 42, 125–137. https://doi.org/10.1016/j.spc.2023.09.013.
EU Commission, 2025a. Circular economy. https://environment.ec.europa.eu/strategy/circular-economy_en, 11.18.25.
EU Commission, 2025b. A Comprehensive EU Toolbox for Safe and Sustainable e-commerce.
EUROSTAT, 2025. https://ec.europa.eu/eurostat/databrowser/product/page/ENV_AC_RME, 12.29.25.
Figge, F., Thorpe, A.S., 2019. The symbiotic rebound effect in the circular economy. Ecol. Econ. 163, 61–69. https://doi.org/10.1016/j.ecolecon.2019.04.028.
Fortea, C., Antohi, V.M., Hassan, R., Andrei, J.V., Erokhin, V., 2026. Circular economy, innovation, and environmental sustainability in the European Union: insights from Panel VAR analysis. Corp Soc Responsibility Env csr 70406. https://doi.org/10.1002/csr.70406.
Frosch, R.A., Gallopoulos, N.E., 1989. Strategies for manufacturing. Sci. Am. 261, 144–152. https://doi.org/10.1038/scientificamerican0989-144.
Garg, A., Raut, R.D., Kumar, M., Zhang, C., Gokhale, R.S., 2025. Does the circular economy transition aid to carbon neutrality? Examining net-zero policy and stakeholder impact from the environmental justice viewpoint. J. Clean. Prod. 491, 144851. https://doi.org/10.1016/j.jclepro.2025.144851.
Geels, F.W., 2011. The multi-level perspective on sustainability transitions: responses to seven criticisms. Environ. Innov. Soc. Transit. 1, 24–40. https://doi.org/10.1016/j.eist.2011.02.002.
Geels, F.W., 2018. Socio-Technical transitions to sustainability. In: Oxford Research Encyclopedia of Environmental Science. Oxford University Press. https://doi.org/10.1093/acrefore/9780199389414.013.587.
Geels, F.W., 2019. Socio-technical transitions to sustainability: a review of criticisms and elaborations of the Multi-Level Perspective. Curr. Opin. Environ. Sustain. 39, 187–201. https://doi.org/10.1016/j.cosust.2019.06.009.
Geels, F.W., Schot, J., 2007. Typology of sociotechnical transition pathways. Res. Pol. 36, 399–417. https://doi.org/10.1016/j.respol.2007.01.003.
Geissdoerfer, M., Pieroni, M.P.P., Pigosso, D.C.A., Soufani, K., 2020. Circular business models: a review. J. Clean. Prod. 277, 123741. https://doi.org/10.1016/j.jclepro.2020.123741.
Genovese, A., Pansera, M., 2021. The Circular economy at a crossroads: technocratic eco-modernism or convivial technology for social revolution? Capitalism Nature Socialism 32, 95–113. https://doi.org/10.1080/10455752.2020.1763414.
Georgescu, L.P., Fortea, C., Antohi, V.M., Balsalobre-Lorente, D., Zlati, M.L., Barbuta–Misu, N., 2025. Economic, technological and environmental drivers of the circular economy in the European Union: a panel data analysis. Environ. Sci. Eur. 37, 76. https://doi.org/10.1186/s12302-025-01119-4.
Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007.
Graedel, T.E., Allenby, B.R., 1995. Industrial Ecology. Prentice Hall, Englewood Cliffs, Ca.
Grafström, J., Aasma, S., 2021. Breaking circular economy barriers. J. Clean. Prod. 292, 126002. https://doi.org/10.1016/j.jclepro.2021.126002.
Hannon, J., Zaman, A., Rittl, G., Rossi, R., Meireles, S., Palandi, F.E.D., 2019. Moving toward zero waste cities: a nexus for international zero waste Academic collaboration (NIZAC). In: Leal Filho, W., Bardi, U. (Eds.), Sustainability on University Campuses: Learning, Skills Building and Best Practices, World Sustainability Series. Springer International Publishing, Cham, pp. 379–414. https://doi.org/10.1007/978-3-030-15864-4_24.
Hansmann, R., Binder, C.R., 2023. Promoting synergies for sustainability through peer-to-peer sharing: an analysis of drivers and barriers. Int. J. Sustain. Dev. World Ecol. 30, 792–813. https://doi.org/10.1080/13504509.2023.2205831.
Hartley, K., Baldassarre, B., Kirchherr, J., 2024. Circular economy as crisis response: a primer. J. Clean. Prod. 434, 140140. https://doi.org/10.1016/j.jclepro.2023.140140.
Hartley, K., Schülzchen, S., Bakker, C.A., Kirchherr, J., 2023. A policy framework for the circular economy: lessons from the EU. J. Clean. Prod. 412, 137176. https://doi.org/10.1016/j.jclepro.2023.137176.
Hermandi, C., Irrek, W., 2025. From awareness to action: do Decision-Makers' mindsets shape circular economy adoption in German SMEs? Circ.Econ.Sust. 5, 6255–6274. https://doi.org/10.1007/s43615-025-00708-y.
Hobson, K., Lynch, N., 2016. Diversifying and de-growing the circular economy: radical social transformation in a resource-scarce world. Futures 82, 15–25. https://doi.org/10.1016/j.futures.2016.05.012.
Hondroyiannis, G., Sardianou, E., Nikou, V., Evangelinos, K., Nikolaou, I., 2024. Circular economy and macroeconomic performance: evidence across 28 European countries. Ecol. Econ. 215, 108002. https://doi.org/10.1016/j.ecolecon.2023.108002.
Howlett, M., 2009. Governance modes, policy regimes and operational plans: a multi-level nested model of policy instrument choice and policy design. Policy Sci. 42, 73–89. https://doi.org/10.1007/s11077-009-9079-1.
Howlett, M., Ramesh, M., 1993. Patterns of Policy instrument choice: policy styles, Policy learning and the privatization experience. Rev. Pol. Res. 12, 3–24. https://doi.org/10.1111/j.1541-1338.1993.tb00505.x.
Kautto, P., Lazarevic, D., 2020. Between a policy mix and a policy mess: policy instruments and instrumentation for the circular economy. In: Brandão, M., Lazarevic, D., Finnveden, G. (Eds.), Handbook of the Circular Economy. Edward Elgar Publishing. https://doi.org/10.4337/9781788972727.00025.
Kębłowski, W., Lambert, D., Bassens, D., 2020. Circular economy and the city: an urban political economy agenda. Cult. Organ. 26, 142–158. https://doi.org/10.1080/14759551.2020.1718148.
Kirchherr, J., Jones, M.P., Geissdoerfer, M., Coffay, M., 2025. A defense of the circular economy. J. Ind. Ecol. 29, 1959–1976. https://doi.org/10.1111/jiec.70128.
Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005.
Kirchherr, J., Urbinati, A., Hartley, K., 2023. Circular economy: a new research field? J. Ind. Ecol. 27, 1239–1251. https://doi.org/10.1111/jiec.13426.
Kivimaa, P., Boon, W., Hyysalo, S., Klerkx, L., 2019. Towards a typology of intermediaries in sustainability transitions: a systematic review and a research agenda. Res. Pol. 48, 1062–1075. https://doi.org/10.1016/j.respol.2018.10.006.
Koide, R., Yamamoto, H., Amasawa, E., Nansai, K., Murakami, S., 2025. Consumer preferences regarding product acquisition, repair, and discharge towards a circular economy: a segment-specific market simulation based on conjoint analysis. J. Environ. Manag. 392, 126806. https://doi.org/10.1016/j.jenvman.2025.126806.
Korhonen, J., Honkasalo, A., Seppälä, J., 2018. Circular economy: the concept and its limitations. Ecol. Econ. 143, 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041.
Kuijpers, M., 2019. Circular economy: ancient populations pioneered the idea of recycling waste. The Conversation 9.
Lange, S., Pohl, J., Santarius, T., 2020. Digitalization and energy consumption. Does ICT reduce energy demand? Ecol. Econ. 176, 106760. https://doi.org/10.1016/j.ecolecon.2020.106760.
Llorente-González, L.J., Vence, X., 2020. How labour-intensive is the circular economy? A policy-orientated structural analysis of the repair, reuse and recycling activities in the European Union. Resour. Conserv. Recycl. 162, 105033. https://doi.org/10.1016/j.resconrec.2020.105033.
Maeder, M., Fröhling, M., 2024. Conceptualizing circular economy policy instruments: the case of recycled content standards. Sustain. Prod. Consum. 52, 333–346. https://doi.org/10.1016/j.spc.2024.11.009.
Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. Res. Pol. 41, 955–967. https://doi.org/10.1016/j.respol.2012.02.013.
McKinsey & Company, 2016. The Circular Economy: Moving from Theory to Practice.
Mederake, L., 2023. Without a debate on sufficiency, a circular plastics economy will remain an illusion. Circ.Econ.Sust. 3, 1425–1439. https://doi.org/10.1007/s43615-022-00240-3.
Mhatre, P., Panchal, R., Singh, A., Bibyan, S., 2021. A systematic literature review on the circular economy initiatives in the European Union. Sustain. Prod. Consum. 26, 187–202. https://doi.org/10.1016/j.spc.2020.09.008.
Milios, L., 2018. Advancing to a circular economy: three essential ingredients for a comprehensive policy mix. Sustain. Sci. 13, 861–878. https://doi.org/10.1007/s11625-017-0502-9.
Milios, L., 2021. Towards a circular economy taxation framework: expectations and challenges of implementation. Circ.Econ.Sust. 1, 477–498. https://doi.org/10.1007/s43615-020-00002-z.
Mont, O., Lehner, M., Dalhammar, C., 2022. Sustainable consumption through policy intervention—A review of research themes. Front. Sustain. 3, 921477. https://doi.org/10.3389/frsus.2022.921477.
Moreau, V., Sahakian, M., Van Griethuysen, P., Vuille, F., 2017. Coming full circle: why social and institutional dimensions matter for the circular economy. J. Ind. Ecol. 21, 497–506. https://doi.org/10.1111/jiec.12598.
Morseletto, P., 2020. Targets for a circular economy. Resour. Conserv. Recycl. 153, 104553. https://doi.org/10.1016/j.resconrec.2019.104553.

Morseletto, P., 2023. Sometimes linear, sometimes circular: states of the economy and transitions to the future. J. Clean. Prod. 390, 136138. https://doi.org/10.1016/j.jclepro.2023.136138.
Nakamura, S., 2023. A Practical Guide to Industrial Ecology by Input-Output Analysis: Matrix-Based Calculus of Sustainability. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-031-43684-0.
Nakamura, S., Kondo, Y., 2009. Waste input-output Analysis: Concepts and Application to Industrial Ecology, Eco-efficiency in Industry and Science. Springer, Dordrecht?
Pfeffer, D., Reike, D., Bening, C.R., 2025. Analyzing policy mixes for the circular economy transition: the case of recycled plastics in electronics. Environ. Innov. Soc. Transit. 56, 100982. https://doi.org/10.1016/j.eist.2025.100982.
Pianta, M., Lucchese, M., 2020. Rethinking the European Green Deal: an industrial Policy for a just transition in Europe. Rev. Radic. Polit. Econ. 52, 633–641. https://doi.org/10.1177/0486613420938207.
Pinyol Alberich, J., Pansera, M., Hartley, S., 2023. Understanding the EU's circular economy policies through futures of circularity. J. Clean. Prod. 385, 135723. https://doi.org/10.1016/j.jclepro.2022.135723.
Pinyol Alberich, J., Hartley, S., 2024. The Circular Economy in European Union Policy: explaining an idea's success through policy learning. Env Pol Gov 34, 363–374. https://doi.org/10.1002/eet.2088.
Rashid, A., 2025. How circular is the linear economy? Analysing circularity, resource flows and their relation to GDP. https://doi.org/10.48550/ARXIV.2505.13048.
Rip, A., Kemp, R., 1998. Technological change. In: Rayner, S., Malone, E.L. (Eds.), Human Choice and Climate Change. Batelle Pr, Columbus, Ohio.
Rizos, V., Zambianchi, V., 2025. Unpacking policy coherence: a network analysis of the EU policy mix for the circular economy. Sustain. Prod. Consum. 60, 52–63. https://doi.org/10.1016/j.spc.2025.09.003.
Rogge, K.S., Reichardt, K., 2016. Policy mixes for sustainability transitions: an extended concept and framework for analysis. Res. Pol. 45, 1620–1635. https://doi.org/10.1016/j.respol.2016.04.004.
Rohsig Lopez, N.S., Legardeur, J., 2024. Consumer behaviour in the context of circular economy: a systematic literature review. Proc. Des. Soc. 4, 1417–1426. https://doi.org/10.1017/pds.2024.144.
Santarius, T., Bieser, J.C.T., Frick, V., Höjer, M., Gossen, M., Hilty, L.M., Kern, E., Pohl, J., Rohde, F., Lange, S., 2023. Digital sufficiency: conceptual considerations for ICTs on a finite planet. Ann. Telecommun. 78, 277–295. https://doi.org/10.1007/s12243-022-00914-x.
Sardianou, E., Nikou, V., Evangelinos, K., Nikolaou, I., 2024. What are the key dimensions that CE emphasizes on? A systematic analysis of circular economy definitions. Environ. Syst. Decis. 44, 547–562. https://doi.org/10.1007/s10669-023-09956-5.
Schipfer, F., Burli, P., Fritsche, U., Hennig, C., Stricker, F., Wirth, M., Proskurina, S., Serna-Loaiza, S., 2024. The circular bioeconomy: a driver for system integration. Energy Sustain. Soc. 14, 34. https://doi.org/10.1186/s13705-024-00461-4.
Serra, L.S., Alfinito, S., 2025. Consumer behavior in the circular economy: a systematic review of high-impact studies. Circ.Econ.Sust. 5, 5315–5349. https://doi.org/10.1007/s43615-025-00679-0.
Shobande, O.A., Tiwari, A.K., Ogbeifun, L., Trabelsi, N., 2024. Demystifying circular economy and inclusive green growth for promoting energy transition and carbon neutrality in Europe. Struct. Change Econ. Dynam. 70, 666–681. https://doi.org/10.1016/j.strueco.2024.05.016.
Siderius, T., Zink, T., 2023. Markets and the future of the circular economy. Circ.Econ. Sust. 3, 1569–1595. https://doi.org/10.1007/s43615-022-00196-4.
Stahel, W.R., Reday-Mulvey, G., 1981. Jobs for Tomorrow: the Potential for Substituting Manpower for Energy. Vantage Press.
Tedesco, M., Simioni, F.J., Sehnem, S., Soares, J.F., Coelho Junior, L.M., 2022. Assessment of the circular economy in the Brazilian planted tree sector using the ReSOLVE framework. Sustain. Prod. Consum. 31, 397–406. https://doi.org/10.1016/j.spc.2022.03.005.
Teixeira, N., 2025. Circular economy perspectives: challenges, innovations, and sustainable futures. Discov Sustain 6, 738. https://doi.org/10.1007/s43621-025-01606-x.
Testa, F., Iovino, R., Iraldo, F., 2020. The circular economy and consumer behaviour: the mediating role of information seeking in buying circular packaging. Bus. Strat. Environ. 29, 3435–3448. https://doi.org/10.1002/bse.2587.
Tonini, D., Albizzati, P.F., Caro, D., De Meester, S., Garbarino, E., Blengini, G.A., 2022. Quality of recycling: urgent and undefined. Waste Manag. 146, 11–19. https://doi.org/10.1016/j.wasman.2022.04.037.
Van Den Bergh, J.C.J.M., 2020. Six policy perspectives on the future of a semi-circular economy. Resour. Conserv. Recycl. 160, 104898. https://doi.org/10.1016/j.resconrec.2020.104898.
Wasserbaur, R., Sakao, T., Milios, L., 2022. Interactions of governmental policies and business models for a circular economy: a systematic literature review. J. Clean. Prod. 337, 130329. https://doi.org/10.1016/j.jclepro.2021.130329.
Webster, K., Pascucci, S., 2024. From socio-technical innovations to ecological transitions: a multilevel perspective on circular economy. In: Ometto, A.R., Sarkis, J., Evans, S. (Eds.), A Systemic Transition to Circular Economy, Greening of Industry Networks Studies. Springer International Publishing, Cham, pp. 111–134. https://doi.org/10.1007/978-3-031-55036-2_6.
Zhang, A., Zhang, C., Munir, H., Seuring, S., 2025. Circular economy policies in China and Europe: a systematic literature review. Circ.Econ.Sust. https://doi.org/10.1007/s43615-025-00689-y.
Zils, M., Howard, M., Hopkinson, P., 2025. Circular economy implementation in operations & supply chain management: building a pathway to business transformation. Prod. Plann. Control 36, 501–520. https://doi.org/10.1080/09537287.2023.2280907.
Zink, T., Geyer, R., 2017. Circular economy rebound. J. Ind. Ecol. 21, 593–602. https://doi.org/10.1111/jiec.12545.