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A policy framework for the circular economy: Lessons from the EU

Kris Hartley [a], Steffen Schülzchen [b], Conny A. Bakker [b], Julian Kirchherr [c,d,e,*]

[a] Department of Public and International Affairs, City University of Hong Kong, Hong Kong, China
[b] Faculty of Industrial Design Engineering, Delft University of Technology, the Netherlands
[c] Copernicus Institute of Sustainable Development, Utrecht University, the Netherlands
[d] Department of Social Sciences and Business, Roskilde University, Denmark
[e] Cambridge Center for Environment, Energy and Natural Resource Governance, University of Cambridge, United Kingdom

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ABSTRACT

Transitioning from the 'take-make-dispose' linear production system to a circular economy can strengthen sustainability, and governments play a vital role. Recent scholarship has investigated policies for circular economy transition, but few studies take a perspective on circularity reform that spans geographies, industries, and product life-cycle stages. This article fills that gap by introducing a policy framework for the circular economy that includes over 100 policy instruments. The framework is developed from a review of 572 studies published in the academic and grey literature, along with policy databases and other documents. The findings are validated and supplemented by data from 33 semi-structured interviews with circular economy experts including scholars, policymakers, and representatives from NGOs and businesses. Derived primarily from the EU context but broadly applicable, the framework categorizes circular economy policies into nine groups. Six groups correspond to stages of the product life-cycle and three are overarching, capturing a holistic perspective mostly lacking in the literature. This study aims to promote a more structured discussion about circular economy policies and provides directions for future research by identifying topics where scholarship is thin. In addition to advancing theory, the framework can also serve as an assessment lens for designing circular economy policies.

1. Introduction

Transitioning from the current and embedded "take-make-dispose linear economy" (Bocken et al., 2017, p. 476) to a circular economy (CE)[1] has been promoted as a strategy "to develop a sustainable, low carbon, resource-efficient and competitive economy" (European Union, 2015, p. 2). Accordingly, the CE concept has received growing interest among scholars and practitioners (Hartley et al., 2020; Kirchherr and van Santen, 2019; Bocken et al., 2017; Geissdoerfer et al., 2017). For example, the latest Davos Manifesto (the first revision since initial publication in 1973) from the World Economic Forum views CE as a key dimension of modern capitalism and calls on companies to embrace the concept (Schwab, 2019).

Despite increasing interest in and support for CE, global production systems remain primarily linear. This perpetuation of linearity is due partly to barriers that prevent CE transition; studies by Hartley et al. (2022) and Kirchherr et al. (2018) classify these barriers as cultural, market, technical, and regulatory. Accordingly, a complex convergence of factors – often the result of path dependency and long-term accretion of practices and policies – incentivizes linearity by making CE transition costly and time-consuming. The consequences are measurable: at the global scale, circularity in production systems has declined from 9.1 percent in 2018 to 8.6 percent in 2021 (de Wit et al., 2021) and 7.2 percent in 2023 (Fraser et al., 2023). The Circularity Gap Report 2023 (Fraser et al., 2023) attributes this decline to rising material extraction and reliance on virgin materials.

It is clear that CE transition needs additional support, and public policy plays a key role. For example, the United Nations Sustainable

* Corresponding author. Copernicus Institute of Sustainable Development, Utrecht University, the Netherlands.
E-mail address: j.kirchherr@uu.nl (J. Kirchherr).

[1] This article adopts the meta-definition of CE proposed by Kirchherr et al. (2017, pp. 224–225), based on an analysis of 114 definitions from the literature (abbreviated quote): "A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes." Kirchherr et al. (2017, p. 229) further state that the objective of CE is to "accomplish sustainable development … to the benefit of current and future generations," thus framing CE as a key concept in fostering sustainability transition.

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Development Goals (SDGs) provide an overarching framework for societal transition towards sustainability, including goals applicable specifically to CE: #7 (affordable and clean energy), #9 (industry, innovation, and infrastructure), and #12 (responsible consumption and production); see Rodriguez-Anton et al. (2019) for a discussion about overlaps between CE transition efforts and SDG 'compliance.' Additionally, the Ellen MacArthur Foundation (2023) provides guidance to legislators and companies pursuing CE transition, including basic principles, examples from around the world, and media content aimed at awareness and education.

Despite the clear imperative to advance CE transition, CE policy scholarship has not provided a strong theoretical basis for reform at the macro level. As discussed in this article's literature review, most research either focuses on examples of CE transition within particular industries and policy contexts or catalogs mechanical processes for CE. A small number of studies addresses the conceptual dimensions of CE transition, including the role of socio-technical systems and the challenges of abandoning production linearity. Further, an emerging body of scholarship addresses barriers to CE transition (Hartley et al., 2021; de Jesus and Mendonça, 2018; Govindan and Hasanagic, 2018; Kirchherr et al., 2018), including policy application across multiple case contexts. Nevertheless, practical and theoretical progress in understanding macro-level CE transition suffers from inadequate conceptualization about how various CE activities fit together beyond individual firms or industries and involve interactions among producers, consumers, and policymakers across diverse market and regulatory conditions.

As argued by Milios (2018) and adopted for conceptual framing by Hartley et al. (2020), a life-cycle approach can be useful for understanding CE transition. As such, this study's framework combines the life-cycle perspective with a high-level perspective about policy conditions and institutional context. The regional focus is primarily the EU, but the framework is applicable to other contexts and at a system-level. The framework includes nine policy categories, six of which correspond to life-cycle stages and three to overarching policies that transcend any given life-cycle stage; over 100 suggested policy instruments are presented across these nine categories. The aim of the framework is not only to conceptualize how individual policies fit within a larger policy ecosystem but also to highlight topics where the CE scholarship needs further development.

The development of the framework is based on a review of 572 studies published in the academic and grey literature (see Appendix for a full list), along with policy databases and other documents. The review yielded a broad overview of CE policy instruments, and the resulting framework was discussed in expert interviews to further refine it and 'ground' it in the realities of CE transition practice. The framework adopts a mid-to high-level perspective and focuses primarily on strategies. The purpose of the framework is to provide initial guidance applicable to most policy contexts, as many CE principles can be considered universal. The mechanics of applying the framework – an issue for further research beyond this study – should flexibly accommodate the unique regulatory and institutional settings of a given context.

The remainder of the article is organized as follows. Section 2 provides a brief review of literature about CE, including metrics that suggest the limitations of current scholarship and opportunities for further research. Section 3 outlines the methodology, Section 4 presents and discusses results, and Section 5 concludes with a summary, implications for practice and theory, and a call for additional research.

2. Literature review

There is broad scholarly consensus that governments are crucial enablers of CE transition (Alberich et al., 2023; Taghipour et al., 2022; Xu et al., 2021; Hartley et al., 2020; Kazancoglu et al., 2021; Bolger and Doyon, 2019; Proskuryakova and Ermolenko, 2019; de Abreu and Ceglia, 2018; Su et al., 2013). For example, Kirchherr et al. (2018; p. 271) state that "targeted governmental interventions […] may provide a much-needed push for the CE." Despite general agreement that public policy plays a key role in facilitating CE transition, the literature lacks a supportive body of knowledge concerning higher-level CE policy insights that transcend geographies, industries, and product life-cycle stages. This gap is notable given that CE transition reflects a broader sustainability project that is itself comprehensive, interconnected, and collaborative. Further, the gap condemns the literature to its current state of fragmentation with regard to best practices. A more systemic understanding of circularity – particularly the impacts of production across broader societal contexts (e.g., economic, social, and technical; see Antwi-Afari et al., 2022) – calls for novel ways of thinking about the appropriate scope of policy influence in CE transition. These circumstances prompt the following research question: to what extent have CE policies been categorized and holistically integrated in academic research? We answer this question by introducing a strategic framework for CE policies – to our knowledge, the first of its kind – that is based on insights derived from the literature and policy content.

This study uses the broad but concise definition of 'policy' provided by Knill and Tosun (2012, p. 4): "a course of action (or non-action) taken by a government or legislature with regard to a particular issue." Correspondingly, CE policies can be conceptualized as the actions or non-actions taken by governments to foster and manage CE transition. Included in this definition are also policies that impact CE transition peripherally, such as numerous public sector efforts at global, national, and local levels that address sustainability (e.g., the United Nations SDGs).[2] Examples of CE policies are laws that target end-of-life waste management to keep resources within the loop (Govindan and Hasanagic, 2018), remove restrictive definitions of waste that prevent materials or components from being reused (de Jesus and Mendonça, 2018), and remove implicit or explicit subsidies for fossil fuels and other virgin materials (Kirchherr et al., 2018).

Despite scholarly consensus about the relevance of public policy to CE transition, less research has been conducted than might be expected. At the time of this study, a Scopus search for articles containing relevant terms in their titles, abstracts, or keywords returned 572 results.[3] Researchers are generally aware of a relationship between CE and public policies, but there exist relatively few studies dedicated solely to investigating this relationship. The attention received by this literature, as measured by citation counts, reveals some insights; of the 572 studies, 118 are uncited and the average number of citations for those cited at least once is 17. Five have more than 100 citations, with the highest (505) a study by Su et al. (2013) reviewing the state of CE transition in China. When adjusting for number of years (i.e., citations per year), the same study leads the group, with 56. Of the 28 studies with 10 or more citations per year, 29 percent relate to Europe and 25 percent to China (as against 30 percent and 11 percent, respectively, of the 572 studies overall); one study each relates to Turkey, Sweden, and India. The remainder of the top-28 cited are largely conceptual or non-case-based empirical studies of ring-fenced phenomena. Topics include a new model for CE scenarios (Donati et al., 2020), conceptual analysis of material flows (Mishenin et al., 2018), a framework for modeling

[2] Sustainability transitions are defined as "long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption" (Markard et al., 2012, p. 956). Since roughly 2000, a highly interdisciplinary and growing group of scholars has been investigating the sources of transformative change and factors that stabilize existing systems (Köhler et al., 2019).

[3] The coding command for our search was as follows: "(DOCTYPE (ar OR bk OR ch OR cp) AND TITLE-ABS-KEY ("Circular Economy" OR "Circularity") AND (TITLE (polic* OR regulat* OR law) OR AUTHKEY (polic* OR regulat* OR law)) AND TITLE-ABS-KEY ("Circular Design" OR "Product Design" OR "Service Design" OR "Design Requirement" OR "Design Obligation" OR "Ecodesign"))".

wastewater circularity (Tecchio et al., 2017), risk assessments for recycling of bio-based plastics (Alaerts et al., 2018), an interview-based study of tradeoffs inherent in CE transition (de Jesus and Mendonça, 2018), a proposed waste hierarchy for electric vehicle batteries (Richa et al., 2017), a summary of how the CE is a conceptually unique production model (Esposito et al., 2018), a discussion of CE and biomimicry in the context of a biorefinery (Venkata Mohan et al., 2019), and a review of emissions reductions resulting from material efficiency efforts (Hertwich et al., 2019). In addition to revealing a wide variety of topics and study contexts, the data also indicate that CE is a growing research interest; from 2015 to 2021, the number of related articles published was, respectively, 45 (1997–2015), 23, 33, 58, 75, 101, and 102. Given that most of these articles (i) investigate CE policies in specific geographies, (ii) focus on technical dimensions, or (iii) consider only certain stages of the product life-cycle (typically the end; for example, waste management and disposal), there is a dearth of studies taking a broader and more comprehensive perspective on policy enablers. Considering that both the policy landscape (Fitch-Roy et al., 2020) and the research field are growing rapidly (more than 50 percent of the identified studies were published since 2019), this gap deserves attention, and this study helps to chart that course.

3. Methods

The research question was addressed in a two-step process that involved combining data from literature reviews, policy reviews, and expert interviews. First, we analyzed policy documents and academic literature to generate an overview of CE policy instruments. This approach is similar to that used in the few meta-level reviews of CE policies (Zhu et al., 2019; Domenech and Bahn-Walkowiak, 2019; Milios, 2018). Based on this initial review, we developed a working version of the CE policy framework starting with the life-cycle perspective proposed by Milios (2018), whose framework we determined to be the most comprehensive for this purpose. Second, we conducted 33 semi-structured interviews with international policy experts to validate and refine the content and structure of the framework (an approach borrowing from Hartley et al. (2020) in a study of CE policies in the EU). This step was an effort to connect theory with practice, given that we determined the CE policy literature to be reliant primarily on literature reviews and ‘desktop’ research.

Policy documents from EU agencies and offices were used as a starting point to develop an overview of policy options. The EU is selected as a case context because, as a policymaking body, it has adopted some of the most advanced and detailed CE policy frameworks in the world (Friant et al., 2021; Mhatre et al., 2021; Peiró et al., 2020; Kovacic et al., 2019). The documents were identified through a review of references in EU policy papers such as the *Circular Economy Action Plan* (European Union, 2020). Additionally, academic and grey literature (e.g., policy reviews and case studies from NGOs such as Circle Hub (Circle Economy, 2021)) were used to identify additional policy documents and case studies outside of the EU. After a list of policies was collated, we undertook an iterative process of clustering policies according to life-cycle stages, using the approach of Milios (2018).

The Excel spreadsheets used for analysis included citation tallies for all examined academic articles, as obtained through a Scopus search. Specific CE policy instruments were assigned reference codes based on type (e.g., regulation/obligation/prohibition, financial deterrent/incentive, economic/social/political framing, norms/standards/best practices) and used to represent coverage in each of the examined policy documents. Categories were formed that contained unique clusters of keywords (determined through content analysis to be the most frequent and representative concepts), constituting the substructure of the framework.

The framework was developed based on the following process. First, we drafted a rough outline of the framework based on initial reviews of relevant scholarly and grey literature materials, synthesizing the findings into themes and testing them against our own experience-based observations. Next, we consulted interviewees about the validity and usefulness of the framework, and requested input about how it could be improved. This process led to several revisions in both the structure and individual content of policy instruments. Finally, we evaluated the revised framework for its practicality and intuitiveness. This process included examining the categories and other content against the standards of MECE (mutually exclusive and collectively exhaustive). The final version was deemed appropriate for the discussions in this article, including how CE thinking might emerge at a systemic level. We recognize that individual elements of the framework may be altered depending on context (see Table 1).

Interview insights helped specify the life-cycle stages that structure the framework and helped define policy categories not linked to life-cycle stages. Experts were identified according to judgment sampling (Marshall, 1996) and snowball sampling approaches (Kirchherr and Charles, 2018). The objective was to interview a diverse set of CE policy experts from various professional backgrounds (i.e., governments, businesses, NGOs, and academia) and relevant geographical backgrounds. As our desk research revealed few CE policy examples from the Global South, we included African countries, such as Kenya, that are showing some engagement with CE activities. We asked interviewees to recommend additional experts, reflecting the inter-network-based snowball approach of Kirchherr and Charles (2018). From this effort, 14 of those recommended responded and 11 were interviewed. We suspended sampling efforts when thematic saturation was reached (i.e., no new insights or additional changes to our framework emerged over the course of three consecutive interviews; for more information on this method, see Francis et al. (2010)). Overall, we contacted 54 experts, received replies from 44 (81 percent), and conducted interviews with 33 (61 percent). Table 2 details interviewee characteristics. Due to the Covid-19 pandemic, interviews were not conducted in person but through a video conferencing application. Most interviews lasted roughly 60 min and all were recorded for transcription. Anonymity was assured due to the potential sensitivity of public policy as a discussion topic (Lancaster, 2017).

On a final methodological note, most of the interviews were conducted in Europe. On the one hand, we acknowledge that this demonstrates a potential geographical bias. On the other hand, Europe has arguably taken the most aggressive concrete steps – in both business practice and policy – to pursue circularity. We maintain that there is potential to tailor the framework to the contexts and exigencies of other

Table 1
Overview of selected literature on CE policy and frameworks.

Topic	Authors
Empirical case studies of and frameworks for CE	Pollard et al. (2023); Antwi-Afari et al. (2022); Donati et al., 2020; de Jesus and Mendonça, 2018; Domenech and Bahn-Walkowiak (2019); Hertwich et al. (2019); Venkata Mohan et al., 2019; Zhu et al. (2019); Alaerts et al., 2018; Esposito et al., 2018; Milios (2018); Mishenin et al., 2018; Richa et al., 2017; Rogge et al. (2017); Tecchio et al., 2017; Rogge and Reichardt (2016); Jacobsson and Bergek (2011)
Governments and public agencies as enablers for CE transition	Alberich et al. (2023); Xu et al. (2021); Hartley et al. (2020); Kazancoglu et al., 2021; Bolger and Doyon (2019); Proskuryakova and Ermolenko (2019); de Abreu and Ceglia (2018); Kirchherr et al. (2018); Su et al. (2013)
Overviews of CE policy by targeted stage of the product life-cycle	de Jesus and Mendonça (2018); Govindan and Hasanagic (2018); Kirchherr et al. (2018)
Critiques of CE concept	Dzhengiz et al. (2023); Hartley and Kirchherr (2023); Reich et al. (2023); Corvellec et al. (2022); Larrinaga and Garcia-Torea (2022); Skene (2022)

Table 2
Overview of expert interviewees.

#	Interviewee	Organization	Geography of expertise
1	Consultant	Management Consultancy	Europe
2	Consultant	Management Consultancy	Europe
3	Scholar	University	Europe
4	Policy officer	Government agency/ministry	Europe
5	Researcher	Government agency/ministry	Europe
6	Advisor	Think Tank/NGO/Intl. Org.	Europe
7	Consultant	Management Consultancy	Europe
8	CEO	Circular Business	North America
9	Consultant	Management Consultancy	Europe
10	Scholar	University	Europe
11	Scholar	University	Europe
12	Scholar	University	North America
13	Consultant	Management Consultancy	Europe
14	Policy officer	Government agency/ministry	Europe
15	Scholar	University	Europe
16	Department head	Think Tank/NGO/Intl. Org.	Europe
17	Department head	Government agency/ministry	Europe
18	Consultant	Management Consultancy	Europe
19	Senior executive	Think Tank/NGO/Intl. Org.	Europe
20	Policy officer	Government agency/ministry	Europe
21	Scholar	University	East Asia
22	Scholar	University	Europe
23	Scholar	University	Southeast Asia
24	Department head	Think Tank/NGO/Intl. Org.	Europe
25	Researcher	Government agency/ministry	Europe
26	CEO	Circular Business	Africa
27	Program officer	Government agency/ministry	Africa
28	Program officer	Think Tank/NGO/Intl. Org.	Africa
29	Expert	Government agency/ministry	Africa
30	Researcher	Government agency/ministry	Europe
31	Project lead	Government agency/ministry	Europe/Africa
32	Scholar	University	Southeast Asia
33	Project lead	Think Tank/NGO/Intl. Org.	Africa

parts of the world. As such, we take the approach of presenting this framework as more a strategic one than a policy one. Future research is needed that tests the framework's usefulness in other contexts and, if warranted, takes a 'grounded' approach to building a new framework based on the experiences of non-European countries.

4. Results and discussion

This article continues by introducing the framework. Based on the data analysis, we identified nine policy categories: six pertaining to the life-cycle and three pertaining to overarching themes. We established a set of keywords related to each category and used them to conduct a search in Scopus. This section describes the results, including how the framework is structured, examples of policy tools in each category, and the degree to which each category has been addressed in the literature.

The framework is structured along four levels, reflecting increasing degrees of specificity. Level 1 includes two policy pillars: policies specific to each life-cycle-stage (Pillar 1) and overarching policies (Pillar 2). Level 2 includes nine policy categories: six in Pillar 1 and three in Pillar 2. Level 3 includes 30 policy groups, and Level 4 includes over 100 policy instruments, representing the most granular level of the framework. Fig. 1 shows the overall framework, with two policy pillars, their respective policy categories, and policy groups within each category. Table 3 (a, b, c, d, e) shows policy instruments associated with each policy group. To the Milios (2018) framework this framework adds two dimensions: (i) granularity with regard to the variety of policy instruments associated with each policy group, and (ii) incorporation of overarching cross-cycle policy categories (incentives, ancillary institutional support, and monitoring and evaluation). Furthermore, the review exercise helped identify relative levels of research attention across policy categories, illuminating pathways for further research (see Fig. 2).

The framework categories and associated policy instruments fit together holistically to reflect a cohesive strategic orientation towards systemic and comprehensive transition. Overall, the life-cycle-stage-specific policies accord with the long-running discourse about how materials progress through a production system. This life-cycle approach is intuitive in that it bears a generally chronological order from inputs through design, production, consumption, circulation, and leakage. As such, this element of the framework does not present itself as a substantial departure from how material flow is commonly conceptualized. The value-added is the specificity of elements, including policy instruments, and the connections among them that emphasize circulation not only as a *post hoc* activity but as a concept that is embedded into all stages of the life-cycle. Pillar 2 takes a higher-level perspective by situating the life-cycle perspective in the context of what incentivizes action from firms and governments: increasing competitiveness (e.g., through subsidies, grants, and regulation), supporting CE action in quantity and quality (e.g., through research, awareness, education, and consultancy), and measurement of progress (e.g., internal indicators and reporting requirements). Each element of Pillar 2 has practical application but also presents an opportunity to engage scholarship about government support for industrial upgrading and transformation, knowledge economies and research policy, and data-driven or evidence-based management and governance (for a critical discussion about the use of data and modeling in CE transitions, see Hartley and Kirchherr (2023)).

Pillar 1: life-cycle-stage-specific policies

Policies in Pillar 1 address life-cycle-stages of products or services. Life-cycle-stages include material and energy input, design, production, use/consumption, circulation, and leakage. The remainder of this subsection discusses each of these categories, including the policy groups classified within them, examples of associated instruments, and an overview of existing research.

The material and energy input category (Table 3a) comprises activities related to provision of (raw) materials, energy, and other resources newly added during the production system. The two policy groups in this category are (i) resource extraction/distribution and (ii) energy generation/distribution. The category represents the earliest stage of production, where inputs are obtained (including used or repurposed materials cycled-in under a CE system). Examples of energy policies are regulatory stipulations and definitions of allowable energy types, additions to the energy mix like solar, wind, and biomass generation, and the creation of an 'energy union' that fosters transnational collaboration on energy sustainability. Topics in this category are relatively under-researched, with only four of 572 studies (Contreras et al., 2020; Proskuryakova and Ermolenko, 2019; Biernaski and Silva, 2018; de Zwaan et al., 2016).[4]

The design category (Table 3a) includes activities related to defining the following characteristics of products or services: (i) inputs (e.g., materials), (ii) physical layout and aesthetics, (iii) processes through which the product or service is offered, (iv) production process, and (v) the way a product or service is treated at the end of its life-cycle. The framework's emphasis on design illustrates the value of linking policies with specific aspects of the life-cycle, as there exist certain needs and issues unique to each cycle stage that overarching policies may fail to fully address. The two policy groups in this category are (i) circular product design requirements and (ii) producers' liability for durability of products and reduction of premature obsolescence. This category emphasizes that CE transition is dependent not only on incidental substitution of sustainable practices but also on systemic re-orientation in how producers conceptualize products and production systems overall. Examples of circular product design requirements include mandatory standards to focus on resource efficiency and recycling (Dalhammar,

[4] Some studies are classified under multiple categories.

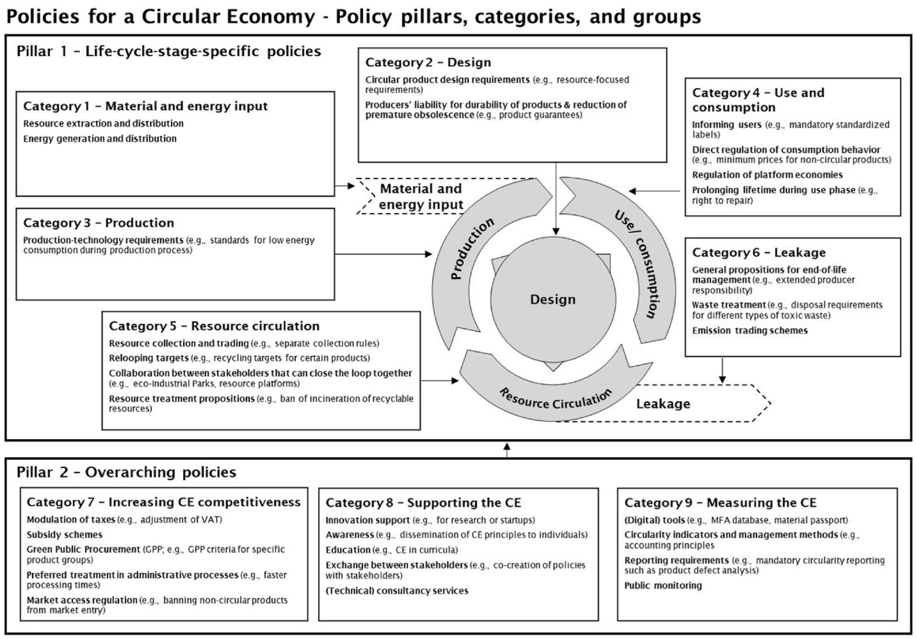

Fig. 1. Overview of policy clusters and policy groups (source: authors).

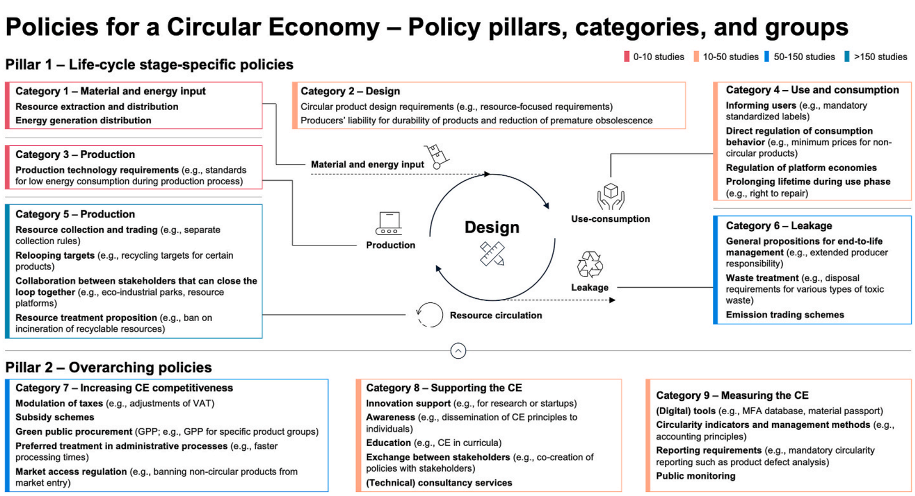

Fig. 2. Overview of literature coverage by policy cluster and policy group (source: authors).

2016), treatment of waste as a resource (Wilts et al., 2016), ease of product disassembly (Peiró et al., 2020), and data deletion (Peiró et al., 2020). Examples of producer liability and design obsolescence policies are provisions for particular types of materials (e.g., non-ferrous and precious metals; Hagelüken et al., 2016) and 'product-as-a-service' (Paas) business models (Kerdlap et al., 2021). 48 of 572 studies address this category; notable and well-cited studies include Tecchio et al. (2017), Dalhammar (2016), Hagelüken et al. (2016), and Wilts et al. (2016).

The production category (Table 3a) includes (i) activities associated with the creation of a product (e.g., manufacturing) or carried out for the provision of a service, (ii) logistics activities between producers and customers, and (iii) reverse logistics (from consumers to producers). The lone policy group in this category pertains to production technology requirements, with examples being restrictions on particular types of emissions (e.g., 'unintentional persistent organic pollutants'; Wu et al., 2020) and the integration of new technological knowledge, more rigorous environmental impact assessment, and monitoring of production activities (Radelyuk et al., 2021). This category is directly addressed by only two (previously cited) of 572 studies examined.

The use/consumption category (Table 3a) includes activities carried out by consumers when interacting with a product or service. This category begins with the acquisition (e.g., purchase or renting) and ends when the product or service becomes obsolete for the needs of the original consumer. This category also includes upgrades, repairs, and sharing/reselling a good or service. The four policy groups in this category are (i) informing users, (ii) regulating consumption behavior, (iii) regulating platform economies, and (iv) prolonging product lifetime during use phase. Example policies related to this group are product content labeling schemes (Gåvertsson et al., 2020), 'green public procurement' focused on environmental over economic criteria (Braulio-Gonzalo and Bovea, 2020), material efficiency (e.g., provision of spare parts and reverse disassembly; Cordella et al., 2020), and regulatory strategies differentiated across hierarchies of consumer or consumption behavior types (Maitre-Ekern and Dalhammar, 2019). Of 572 studies, 39 were classified into this category, with notable and highly-cited contributions by Hertwich et al. (2019), Sabbaghi and Behdad (2018), and Arushanyan et al. (2017).

Table 3a
Policy instruments by cluster and category (material/energy input, design, production, use).

Policy category	Policy group	Policy Instruments
Material/ energy input	**Resource Extraction and Distribution**	• Resource extraction limitations to keep ecosystems in balance; propositions on circular resource extraction processes
	Energy Generation and Distribution	• Definition of allowed energy mix; energy sources; their relative weight in the energy mix
Design	**Circular product design requirements**	• Resource-focused design requirements; discouragement/prohibition of certain components; encouragement/obligation to include certain components; efficiency requirements for usage phase • Design-focused design requirements (e.g., durability, upgradability, repairability, recyclability, uniform components)
	Producers' liability for durability of products & prohibition of premature obsolescence practices	• Product guarantees: duration of minimum guaranteed life-time; coverage during minimum guaranteed life-time; allowed modifications/repairs by third parties during guarantee period • Product-as-a-service models • (Software) upgrading services
Production	**Production technology requirements**	• Production standards for reduced emissions • Production standards for reduced resource consumption in production process (e.g., CO2, polluted water) • Production standards for re-looping waste (e.g., ways to reduce required energy or water during production; ways to reuse residues in metal production processes)
Use	**Informing users**	• Mandatory standardized labels/certificates (e.g., for efficiency, repairability; specific to stages or across the entire life-cycle) • Voluntary standardized labels/certificates (e.g., Energy Star Label, Ecolabel); verification procedures for environmental claims
	Influencing consumption behavior	• Financial measures to influence consumption behavior; minimum/increased prices for non-circular products; maximum/lowered prices for circular products • Non-financial measures to influence consumption behavior; preferred access to public infrastructure for circular products/services (e.g., special lanes or parking spots for EVs/carsharing)
	Regulation of platform economies	• Regulation of platform economies to use circular principles in their offering
	Prolonging lifetime during use phase	• Right-to-repair: availability and open source for repair manuals; access to repair manuals for third-party repair shops; minimum time availability for spare parts; access to tools and digital systems • Right-to-upgrade: availability of updates (e.g., software); performance requirements for upgrades

Table 3b
Policy instruments by cluster and category (circulation, leakage).

Policy category	Policy group	Policy Instruments
Circulation	**Resource collection and trading**	• Separate collection of different wastes/materials (e.g., household waste; can deposits) • Destruction/disassembly of goods before recycling • Regulation of waste shipments; proposition for waste trading; return-deposit schemes
	Relooping targets	• Relooping targets for product groups/industries (e.g., required share of old vehicles that need to be recycled) • Relooping targets for organizations (e.g., required share of total waste of a municipality or business to be recycled)
	Collaboration between stakeholders that can close the loop together	• Eco-industrial parks • Collaboration platforms (e.g., material flow accounting (MFA) database)
	Resource treatment propositions	• Bans on the incineration of recyclable materials
Leakage	**General propositions for end-of-life management**	• Extended producer responsibility; producers responsible for collecting products at the end-of-life; consumers return certain products free of charge for recycling • Polluter-pays principle • Differentiation of materials and waste types • Basic propositions to protect human health and environment from adverse effects of waste (e.g., waste treatment performed without risk to water, air, soil, plants, or animals, without causing nuisance through noise or odors, and without adversely affecting land or places of special interest) • Waste tracking and reporting (e.g., control of waste shipments (esp. cross-border); reporting requirements for nuclear waste)
	Waste treatment	• Propositions on how certain waste management facilities are to be run (e.g., landfills and waste incineration plants) • Definition of waste hierarchy and treatment requirements per waste type (e.g., special treatment of hazardous materials)
	Emission trading schemes	• Earmarking proceeds of ETS for circular practices; adjusting permitted emissions based on circular practices

Table 3c
Policy instruments by cluster and category (incentivizing CE).

Policy category	Policy group	Policy Instruments
Incentivizing the CE	**Modulation of taxes or similar fees**	• Pay-as-you-throw pricing; flexible fees for waste (e.g., dependent on amount of mixed waste delivered to the waste management system or on the overall weight of waste) • Tax incentives for engaging in specific circular activities (e.g., tax credits for remanufacturing firms; tax incentives to use public transport) • Modulation of administrative fees (e.g., discounts on inspection fees for registered companies; rebates on waste management fees for home-based composters) • Tax disincentives for engaging in specific non-circular activities • Imports tariffs for new goods
	Subsidy schemes	• Subsidies to purchase more circular products/services (e.g., vouchers for replacement of inefficient home appliances for households)
	Green Public Procurement (GPP)	• GPP criteria for product groups; integration of criteria into management systems • GPP targets; definition of required indicators and mandatory monitoring reports • GPP trainings; GPP co-operation across public institutions
	Preferred treatment in administrative processes	• Modulation of processing times of administrative requests (e.g., participating waste disposal organizations receive privileged processing) • Modulation of number of corporate inspections
	Market access regulation	• Banning non-circular products/services from market entry • Allowing market access for circular products/services

The resource circulation category (Table 3b) comprises activities for the relooping (i.e., reusing, recycling, or recovering) of obsolete resources (including those in obsolete products). This category pertains to activities such as remanufacturing, refurbishing, and reverse logistics. The four policy groups in this category are (i) resource collection and trading, (ii) relooping targets, (iii) collaboration between stakeholders to close loops, and (iv) resource treatment propositions. Examples of relooping policies and initiatives are South Korea's Resource Circulation Act and Plastic Waste Control Plan (Shin et al., 2020), efforts to encourage repair and recycling within particular industries and product lines (e.g., surgical instruments (van Straten et al., 2021) and electronic waste[5] (Chen and Ogunseitan, 2021)), scrap utilization, higher intensity of product usage, and production process design (e.g., as part of 'end-of-life' vehicle regulations; Soo et al., 2021). Of 572 studies, 159 address this category, representing a significant share of the literature. Notable and highly-cited studies include McDowall et al. (2017), Su et al. (2013), Richa et al. (2017), and Hartley et al. (2020).

The leakage category (Table 3b) includes activities associated with the treatment of resources that are not relooped into the circular system (e.g., waste disposal). The three policy groups in this category are (i) general propositions for end-of-life-management, (ii) waste treatment, and (iii) emissions trading schemes. Example policies and policy-relevant analysis are forecasts of waste flow for 'mature' electronic products (Althaf et al., 2019), subsidies, tax-credits, and pay-back programs for agricultural plastic pollution (Pazienza and De Lucia, 2020), and the use of social-scientific and humanities perspectives in 'environmental ethics' approaches to policy ideation (Birat, 2019). Of 572 studies, 64 address this category, representing a moderate level of coverage relative to that of other categories. Notable and highly-cited

Table 3d
Policy instruments by cluster and category (supporting CE).

Policy category	Policy group	Policy Instruments
Supporting the CE	**Innovation support**	• Research support (financial and non-financial) • Financial startup and scale-up support (e.g., direct public investment; equity investment; loan provision, salary/living cost coverage; cost coverage) • Non-financial startup and scale-up support (e.g., coaching; experience exchange; hackathons; scholarship (non-financial); prizes and awards) • Support for other innovation projects
	Awareness	• Upskilling/training programs for businesses and public institutions • Creating awareness among and training consumers (e.g., house-visits to identify energy saving potentials; on- and offline promotion campaigns; guides for circular businesses; events)
	Education	• Education programs for secondary school students (e.g., fostering sustainable start-up cultures through real-life projects) • Awareness (e.g., public information campaigns) • Including circularity in educational/academic curricula
	Exchange between stakeholders	• Co-creation of CE policies with stakeholders (e.g., advisory boards/expert panels; online hackathons) • Best practice dissemination between organizations (e.g., sharing of best practices among public authorities and among companies from similar industries) • Voluntary pledging campaigns; industrial stakeholders pledge to support CE transition (e.g., EU campaign to boost uptake of recycled plastics)
	Provision or improvement of physical and non-physical infrastructure	• Increasing efficiency of existing infrastructure to reduce environmental impact (e.g., installation of intelligent traffic systems aiming to reduce congestion) • Provision of infrastructure with reduced environmental impact (e.g., expansion of rail networks using green energy sources)

[5] The EU (European Union, 2012) rules on 'Waste from Electrical and Electronic Equipment (WEEE)' aim to (i) reduce WEEE, (ii) encourage reuse, recycling, and recovery, and (iii) improve environmental performance of actors along the product life-cycle for electrical and electronic equipment.

Table 3e
Policy instruments by cluster and category (measuring CE).

Policy category	Policy group	Policy Instruments
Measuring the CE	**Digital tools**	• Material passport (including information on product origin, durability, composition, reuse, repair and dismantling possibilities, and end-of-life handling) • Modelling of the environment and effects on the environment • Raw material database; material flow analysis (MFA) database
	Circularity indicators and management methods	• Standards and indicators for measuring circularity; standards for product life-cycle-analyses; standards for organizational footprint analysis; standards for waste management statistics • Management and audit schemes; training for participating organizations; publication rules • Accounting and valuation principles; classification scheme of green economic activities used by investors; 'Green Bond' standard
	Reporting requirements	• Modulation of financial reporting obligations based on circularity of business (e.g., organizations using EMAS in France don't have to do CSR reporting) • Circularity reporting obligations (e.g., mandatory reports on durability of products and causes of product defects)
	Public monitoring	• Publication of progress reports, for example, by independent experts

studies include McDowall et al. (2017), Richa et al. (2017), and Halkos and Petrou (2019).

4.2. Pillar 2: overarching policies

Policies in this pillar cut across some or all of the aforementioned life-cycle stages. We differentiate among three categories: (i) policies increasing the (economic) competitiveness of the CE, (ii) policies actively supporting the CE through mostly soft measures, and (iii) policies that help to measure the CE.

The category for increasing CE competitiveness (Table 3c) concerns the creation of direct and mostly financial incentives for stakeholders to adopt circular practices by increasing the relative competitiveness of the CE as against the linear economy. The five policy groups in this category are (i) modulation of taxes, (ii) subsidy schemes, (iii) green public procurement, (iv) preferred treatment in administrative processes, and (v) market access regulation. Example policies are tax relief on renewable resources and higher taxes on non-renewable resources (Stahel, 2013), weight-based waste tariffs on households and food-specific waste collection programs (Andersson and Stage, 2018), and tax credits and 'pay-back' tools for plastic pollution abatement in agricultural production (Pazienza and De Lucia, 2020). Of 572 studies, 60 address this category, with principal contributions by Yu et al. (2015), Stahel (2013), and Mo et al. (2009).

The category for supporting the CE (Table 3d) concerns efforts to foster the CE through strategic and mostly long-term actions such as facilitating knowledge exchange among stakeholder groups and strategic financial and non-financial investments. The five policy groups in this category are (i) innovation support, (ii) awareness, (iii) education, (iv) exchange between stakeholders, and (v) consultancy services (including technical input). Example policies are resource management systems involving public-private sector collaborations (Molina-Giménez, 2018), introduction of interdisciplinary and sustainability-focused perspectives in education (Hudima and Malolitneva, 2020), and novel approaches for translating technical knowledge into policy inputs (including development of strategic plans and provision of opportunities for participation; Longato et al., 2019). The analysis identified 49 out of 572 studies pertaining to this category, with key contributions by Colombo et al. (2019) and Matus et al. (2012).

The category for measuring the CE (Table 3e) focuses on allowing effective monitoring and steering/guiding of CE activities. The four policy groups in this category are (i) digital tools, (ii) circularity indicators and management methods, (iii) reporting requirements, and (iv) public monitoring. Example policies are incentives for firms to disclose information about CE practices (Kuo and Chang, 2021) and to improve relevant analytics capabilities (Kristoffersen et al., 2021), tighter alignment between policy goals and implementation conditions across scales (e.g., macro (European Union) and micro (local); Foster et al. (2020)), and 'product passports' and product registration databases (de Römph and Cramer, 2020). Of 572 studies, 43 pertain to this category; salient contributions include those of Domenech and Bahn-Walkowiak (2019) and Kalmykova et al. (2016).

5. Conclusion

This study introduces a strategic framework for CE policy intervention by deriving insights from a review of 572 published studies. The framework highlights practical pathways for pursuing CE transition at a holistic level. It also highlights opportunities for additional research based on the unevenness of CE literature coverage found across life-cycle stages. At a conceptual level, the framework illustrates how scholars and practitioners can move beyond spot-level initiatives to envision CE transition as a fundamental reconfiguration of production systems. This transition, in turn, requires deeper scholarly reflection about how policy instruments fit together within policy mixes and assemblages (see Hartley and Howlett, 2021). The policy instruments within the framework leverage various intervention types (i.e., direct regulation, economic incentives, and soft measures), underscoring the need to consider CE transition policy as a system-wide endeavor. In practice, CE often continues to be seen as a discrete product or an *ad hoc* process; in contrast with this view, the framework suggests that CE is achievable only with a more transformational and comprehensive perspective that informs all aspects of business and productive activities. In bringing practical action to this transformational perspective, it is crucial not to accept a 'tweaked' business-as-usual. Marginal tinkering with processes may yield some small measurable progress on ring-fenced metrics, but can obscure the need for a more rigorous and potentially inconvenient transformation in production systems. Existing policies appear, in general, to be less systematic than the approach suggested by the framework. To accelerate CE transition, further research is needed on areas identified by the framework as under-addressed and on systemic approaches to policy intervention and change.

The framework is theoretically novel because it integrates the life-cycle perspective with an accompanying set of high-level policy domains relevant to CE transition (i.e., incentives, ancillary institutional support, and monitoring and evaluation). The greatest gaps in the literature, according to the study, concern (i) production processes and (ii) material and energy input, followed at considerable distance by (iii) monitoring and evaluation and (iv) ancillary institutional support. While we maintain that the framework offers a fresh perspective on CE transition policy, there are three limitations. First, our review of research is not exhaustive because (i) we reviewed only German and English documents, (ii) our expert sample is not fully representative (i.e., it has limited exposure to other parts of the world embracing the CE, including Asia), and (iii) the policy landscape is constantly changing, rendering our findings potentially outdated (depending on the degree of policy change). Second, we focused exclusively on policy instruments and did not conduct a similarly deep exploration of policy mixes as suggested by broader-reaching frameworks (e.g., those that include policy processes, characteristics, and contexts). Finally, any claim to exhaustiveness accompanying the introduction of a new framework should be made with caution; our effort is, by our estimation, the most comprehensive to date but should be tested, refined, and augmented as other issues arise and research methods evolve.

There are several avenues for further research. Studies can achieve deeper comprehensiveness by investigating other geographies and pursuing more granular detail about policies identified in this study. This study has also identified instruments that policymakers can use to foster CE transition. Correspondingly, studying policies that are already in place but hinder CE transition would illuminate new options to reform, 'layer,' or 'patch' existing frameworks. The process of merging new policies with old offers the most realistic prospect for governments that cannot wholly abandon incumbent and entrenched policy regimes. The process of identifying which policies to retain, revise, and eliminate is discussed in the literature on policy effectiveness assessments. Finally, the framework can help guide research towards a more holistic perspective about policy enablers for CE transition – not only the characteristics of individual policies but also how they fit together across a panoply of policy domains like infrastructure, education, and commerce. This high-level perspective is crucial for facilitating the systemic change needed in CE transition.

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Kris Hartley: Writing – original draft, Writing – review & editing. **Steffen Schülzchen:** Conceptualization, Writing – original draft. **Conny A. Bakker:** Conceptualization, Writing – review & editing. **Julian Kirchherr:** Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix

Authors	Year	Source title	Citations
Su B., Heshmati A., Geng Y., Yu X.	2013	Journal of Cleaner Production	505
McDowall W., Geng Y., Huang B., Barteková E., Bleischwitz R., Türkeli S., Kemp R., Doménech T.	2017	Journal of Industrial Ecology	188
Wu H.-Q., Shi Y., Xia Q., Zhu W.-D.	2014	Resources, Conservation and Recycling	138
Gold B.G., Mobley W.C., Matheson S.F.	1991	Journal of Neuroscience	123
Ranta V., Aarikka-Stenroos L., Ritala P., Mäkinen S.J.	2018	Resources, Conservation and Recycling	121
Sigona N.	2005	Journal of Ethnic and Migration Studies	119
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Meehl P.E.	1950	Psychological Bulletin	104
Yu F., Han F., Cui Z.	2015	Journal of Cleaner Production	94
Lange M.	2009	Laws and Lawmakers Science, Metaphysics, and the Laws of Nature	92
Stahel W.R.	2013	Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences	84
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Matus K.J.M., Xiao X., Zimmerman J.B.	2012	Journal of Cleaner Production	74
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Kalmykova Y., Rosado L., Patrício J.	2016	Journal of Cleaner Production	61
Hajimohammadi A., Ngo T., Mendis P., Sanjayan J.	2017	Materials and Design	58
Dalhammar C.	2016	Journal of Cleaner Production	58
Tecchio P., McAlister C., Mathieux F., Ardente F.	2017	Journal of Cleaner Production	56
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Wilts H., von Gries N., Bahn-Walkowiak B.	2016	Sustainability (Switzerland)	35

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Authors	Year	Source title	Citations
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Wang Y., Zhou L., Wu Y., Yang Q.	2018	Powder Technology	34
Kunz N., Mayers K., Van Wassenhove L.N.	2018	California Management Review	33
Jiao W., Boons F.	2017	Resources, Conservation and Recycling	33
Hekkert M.P., Janssen M.J., Wesseling J.H., Negro S.O.	2020	Environmental Innovation and Societal Transitions	32
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Emami Z.	1990	American Journal of Economics and Sociology	1
Wakiru J., Pintelon L., Muchiri P.N., Chemweno P.K.	2021	Reliability Engineering and System Safety	0
Condotta M., Zatta E.	2021	Journal of Cleaner Production	0
Zerbino P., Stefanini A., Aloini D., Dulmin R., Mininno V.	2021	International Journal of Production Economics	0
Abdul Manaf N., Milani D., Abbas A.	2021	Journal of Cleaner Production	0
Yildizbasi A.	2021	Renewable Energy	0
Lee Y.-R., Tsai W.-T.	2021	Fermentation	0
Demidova S., Balog M., Chircova T., Kulachinskaya A., Zueva S., Akhmetova I., Ilyashenko S.	2021	Economies	0
Kristoffersen E., Mikalef P., Blomsma F., Li J.	2021	International Journal of Production Economics	0
Albertsen L., Richter J.L., Peck P., Dalhammar C., Plepys A.	2021	Resources, Conservation and Recycling	0
McNeill P., Woodard R., Williams M.	2021	Journal of Cleaner Production	0
Taušová M., Čulková K., Tauš P., Domaracká L., Seňová A.	2021	Energies	0
Zarbà C., Chinnici G., La Via G., Bracco S., Pecorino B., D'amico M.	2021	Sustainability (Switzerland)	0
Zhang Z., Zhang L.	2021	Arabian Journal of Geosciences	0
Ramírez-Sagredo A., Quiroga C., Garrido-Moreno V., López-Crisosto C., Leiva-Navarrete S., Norambuena-Soto I., Ortiz-Quintero J., Díaz-Vesga M.C., Perez W., Hendrickson T., Parra V., Pedrozo Z., Altamirano F., Chiong M., Lavandero S.	2021	FASEB Journal	0
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Tsai C.-H., Shen Y.-H., Tsai W.-T.	2021	Materials	0
Ekman Burgman L., Wallsten B.	2021	Sustainable Production and Consumption	0
Milios L.	2021	Environmental Policy and Governance	0
Otwong A., Jongmeewasin S., Phenrat T.	2021	Journal of Cleaner Production	0
Bening C.R., Pruess J.T., Blum N.U.	2021	Journal of Cleaner Production	0
Mbah M., Franz A.	2021	Sustainability (Switzerland)	0
Zhou Y., Liu X.-Q., Wong K.-H.	2021	Sustainability (Switzerland)	0
Ungerman O., Dědková J.	2021	Review of Economic Perspectives	0
De Rosa M., Di Pasquale J., Adinolfi F.	2021	Animals	0
Dawson L., Ahuja J., Lee R.	2021	Environmental Law Review	0
Spinosa L., Doshi P.	2021	Journal of Environmental Management	0
Selvaggi R., Valenti F., Pecorino B., Porto S.M.C.	2021	Sustainability (Switzerland)	0
Adisorn T., Tholen L., Götz T.	2021	Energies	0
Ignatyeva M., Yurak V., Dushin A., Strovsky V., Zavyalov S., Malyshev A., Karimova P.	2021	Sustainability (Switzerland)	0
Chen X., Cao J., Kumar S.	2021	Energy, Ecology and Environment	0
Beheshti R.	2021	Journal of Property, Planning and Environmental Law	0
Fidélis T., Cardoso A.S., Riazi F., Miranda A.C., Abrantes J., Teles F., Roebeling P.C.	2021	Journal of Cleaner Production	0
İzmirli D., Ekren B.Y., Kumar V., Pongsakornrungsilp S.	2021	Sustainability (Switzerland)	0
Lv H., Li Y., Yan H.-B., Wu D., Shi G., Xu Q.	2021	Clean Technologies and Environmental Policy	0
Ren Y., Zhang Y., Liu J., Liu P., Yang J., Guo D., Tang A., Tao J.	2021	Biochemical and Biophysical Research Communications	0
Guzzo D., Rodrigues V.P., Mascarenhas J.	2021	Technological Forecasting and Social Change	0
Sani D., Picone S., Bianchini A., Fava F., Guarnieri P., Rossi J.	2021	Sustainability (Switzerland)	0
de Arquer M., Ponte B., Pino R.	2021	Central European Journal of Operations Research	0
Yaoteng Z., Xin L.	2021	Journal of Enterprise Information Management	0
Kovacs D.M.	2021	Canadian Journal of Philosophy	0
Ampe K., Paredis E., Asveld L., Osseweijer P., Block T.	2021	Policy Sciences	0
Pomázi I., Szabó E.	2021	European Spatial Research and Policy	0
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Ezeudu O.B., Oraelosi T.C., Agunwamba J.C., Ugochukwu U.C.	2021	Environmental Science and Pollution Research	0
Yakovleva I.V., Skryabin K.G., Kamionskaya A.M.	2021	Biotekhnologiya	0
Hjaltadóttir R.E., Hild P.	2021	European Planning Studies	0
de Boer B.F., Rietveld E., Rodrigues J.F.D., Tukker A.	2021	Journal of Industrial Ecology	0
Sutcliffe T.E., Ortega Alvarado I.A.	2021	Journal of Environmental Policy and Planning	0
Dinis Ferreira A.J.	2021	Advances in Science, Technology and Innovation	0
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Kavals E., Gusca J.	2021	Environmental and Climate Technologies	0
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Tang O., Liu Y., Guo Z., Wei S.	2021	International Journal of Production Research	0
Boto Álvarez A.	2021	Revista General de Derecho Administrativo	0
Duguid C.	2021	Synthese	0
Borkowski K.	2021	Polimery/Polymers	0
Oltean A., Taber L.A.	2021	Journal of Elasticity	0
Tapia C., Bianchi M., Pallaske G., Bassi A.M.	2021	European Planning Studies	0
Dalhammar C., Milios L., Richter J.L.	2021	Sustainable Production, Life Cycle Engineering and Management	0
Kistenkas F.H., Smits M.-J., Kamphorst D.	2020	European Energy and Environmental Law Review	0
Micklitz H.W.	2020	Revue Internationale de Droit Economique	0
Hansen H.T.R., Lynge K.	2020	IOP Conference Series: Earth and Environmental Science	0
Yang M., Chen H., Long R., Hou C.	2020	Sustainability (Switzerland)	0
Compagnoni M.	2020	Environmental Engineering and Management Journal	0
Drosi G., Lorandi M., Bossi A., Villani F., Avakian J.	2020	Environmental Engineering and Management Journal	0
Tsai C.-H., Shen Y.-H., Tsai W.-T.	2020	Resources	0
Zhao Y.	2020	Journal of Property, Planning and Environmental Law	0
Zhang C., Cai W., Liu Z., Wei Y.-M., Guan D., Li Z., Yan J., Gong P.	2020	Geography and Sustainability	0
Ivanović B.	2020	Spatium	0
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PrÃiÅiek J., Å Auer P., KeprtovÃi K.	2020	International Journal of Global Environmental Issues	0
Crisostomi V.	2020	WIT Transactions on Ecology and the Environment	0
Guerrini A., Manca J.	2020	H2Open Journal	0
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Lee Y.-R., Tsai W.-T.	2020	Fermentation	0
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Morales Gámiz F.J., Martín-Portugués Montoliu C., Ávila Freire C., Miranda Pérez M.L., Martín Cano M.	2018	Carreteras	0
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De Römph T.J.	2015	Legal Aspects of Sustainable Development: Horizontal and Sectorial Policy Issues	0
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Gordeeva Y.M.	2015	Journal for European Environmental and Planning Law	0
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Liu H., Wang X.-L.	2014	Advanced Materials Research	0
Liu G.F., Zhang S.B., Zhang L.	2014	Advanced Materials Research	0
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Bárány E.	2011	Sociologia	0
Jackson A.L.	2010	Journal of Macroeconomics	0
Li C.	2010	Key Engineering Materials	0
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