Resources, Conservation & Recycling 155 (2020) 104634

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Policies for transitioning towards a circular economy: Expectations from the European Union (EU)

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ARTICLE INFO

Keywords:
Circular economy
Sustainability
Public policy

ABSTRACT

The circular economy is a much discussed pathway towards sustainability. While some scholarly work has been carried out on barriers towards a circular economy, there are relatively few academic studies on policies that may accelerate a transition towards a circular economy. Those that focus on policies mostly scrutinize existing policies. The study at hand utilizes data from semi-structured interviews with 47 public and private sector circular economy experts from the European Union to explore expectations regarding circular economy policies, with expectations possibly going beyond existing policies. Expectations identified via this work include more robust standards and norms in production, expansion of circular procurement, tax relief for circular products, liberalization of waste trading and its facilitation through virtual platforms, support for eco-industrial parks, and awareness campaigns. The set of policy recommendations is presented from a life-cycle perspective that is necessary for a transition towards a circular economy. The study aims to contribute to the nascent body of circular economy literature concerning policies and may be of particular interest to practitioners.

1. Introduction

In the linear model of industrial production, inputs are extracted, combined and processed, consumed, and discarded (described by Merli et al. (2018 as "take-make-dispose" system). Policy efforts to promote sustainability have focused primarily on the last stage of the linear process, through waste management, recycling, and reuse. While linearity is deeply institutionalized, there is growing interest among producers, governments, and researchers in abandoning the linear model by adopting a circular economy (CE) model (definitions discussed in Section 2.1).

Despite wider in-principle support for CE transition, most academic studies find that uptake is lagging (Masi et al., 2018; Adams et al., 2017; Liu and Bai, 2014; Xue et al., 2010). The global economy is only nine percent circular (with Europe twelve percent and China two percent), and the linear model is still systemically "baked in" (Circle Economy, 2019; p. 8). This inertia invites a more robust understanding about facilitative public policies that promote CE principles. This article assumes the definition of public policy as "a theoretical or technical instrument that is formulated to solve specific problems affecting, directly or indirectly, societies across different periods of times and geographical spaces" (Estrada, 2011).

The related academic literature focuses primarily on existing policies (further outlined in Section 2.2), while few studies probe the realm of hypotheticals – policies that would have the support of stakeholders but are not yet in wide use. Utilizing data from 47 in-depth interviews with CE experts in the EU, this study elicits novel ideas about CE policies that have not been integrated holistically in academic studies or fully implemented in practice. The following research question guides this study: which policy measures do EU-based CE experts in business, government, and academia propose for facilitating CE transition?

The article proceeds as follows. The second section reviews the academic literature's treatment of the CE concept and policies to accelerate CE transition. The third section describes the methodology of data collection and analysis. The fourth section presents and discusses findings, organized into eight policy recommendations. The final section offers concluding remarks and outlines research implications.

2. Literature review

2.1. Definition of circular economy

This literature review begins with a brief synopsis of scholarly efforts to define CE. With roots in the "3R framework" (reduce, reuse, and recycle; see Pearce and Turner, 1990), the concept of CE has no

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https://doi.org/10.1016/j.resconrec.2019.104634
Received 3 June 2019; Received in revised form 8 November 2019; Accepted 3 December 2019
Available online 27 January 2020

scholarly consensus after nearly 30 years of development. Numerous studies have reviewed the academic literature to derive an operational definition (Lahti et al., 2018; Blomsma and Brennan, 2017; Geissdoerfer et al., 2017; Heshmati, 2017; Murray et al., 2017; Rizos et al., 2017; Lieder and Rashid, 2016; Ghisellini et al., 2016; Sauvé et al., 2016; Gregson et al., 2015). Merli et al. (2018); Masi et al. (2017), and Kirchherr et al. (2017) provide the most quantitatively comprehensive reviews of CE definitions currently available. Based on an analysis by Kirchherr et al. (2017) of 114 definitions in the literature, a core normative idea in the conceptualization of CE is that environmental sustainability, economic prosperity, and social equity are valid objectives of CE and should be treated accordingly in scholarship and practice. This study utilizes the meta-definition derived by the same study (p. 229): "[CE is] an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes."

2.2. Circular economy policies

The CE model prescribes that waste be not only minimized but also cycled back into production processes. Accordingly, studies of CE policies focus primarily on waste treatment, including production process-based approaches to eliminating waste (Saavedra et al., 2018; Hauschild et al., 2017; Reh, 2013; Zuo and Yang, 2006). Principal findings of the literature are that opportunities for waste reduction exist throughout the production process and product life-cycle, requiring producers to allot resources for analysis, industrial reconfiguration, and worker retraining. The contribution of government purchasing decisions to CE advancement, referenced primarily in the context of sustainable public procurement (SPP), is another principal topic in the literature and represents a direct conduit through which the policy-practice connection has been articulated. SPP and CE in combination have been explored from multiple analytical perspectives, including surveys and comparisons of practices (Wang et al., 2018; McDowall et al., 2017; Islam and Siwar, 2013; Roos, 2013; Walker et al., 2012a; Brammer and Walker, 2011; Perera et al., 2007) and reviews of SPP-related methodological and research trends (Adjei-Bamfo et al., 2019; Knebel et al., 2019; Korhonen et al., 2018; Cheng et al., 2018; Esposito et al., 2018; Cui and Zhang, 2018; Walker et al., 2012b). Fewer are examples of meta-level reviews or comparisons of CE policies; most studies are case- or industry-specific and focus on quality standards (Nußholz et al., 2019; Zhu et al., 2019; Lazarevic and Valve, 2017), public procurement (Witjes and Lozano, 2016; Wu et al., 2014), market mechanisms (Cruz-Pastrana and Franco-García, 2019), education, promotion, and upskilling (Schroeder et al., 2019; da Silva, 2018; Bicket and Vanner, 2016), infrastructure (Wilts and O'Brien, 2019; Silva et al., 2019), financial incentives (Geng et al., 2009), and labelling related to the quality of re-used and remanufactured products (Gåvertsson et al., 2018).

2.3. Economy-wide policy analyses for resource efficiency

In addressing economy-wide CE transition, research applying the concept of policy mix is relevant to this study's focus on a holistic policy orientation. Ekvall et al. (2016) propose a policy mix to stimulate resource efficiency, emphasizing both primary and supplementary policy instruments (e.g. materials taxes, extended producer responsibility, and technical requirements). A similar policy mix-based analytical approach for understanding resource efficiency in the EU is proposed by Wilts and O'Brien (2019), focusing on instrument design, policy synergies, and policy coherence. Likewise building on the concept of policy synergy, Hughes and Ekins (2018) argue that policy mixes for resource efficiency should be holistic and mutually reinforcing across policy domains, focusing on "win-win" scenarios economically and environmentally. Examining policy mixes for eco-economic decoupling, Watkins et al. (2016) provide qualitative environmental assessments of land use policy, metals policy, and general policy, concluding that conditions for cultural and behavioral change are an important target for monitoring and regulation. The analytical approach based on policy mixes implies that no single policy can promote the complementarities across sectors, industries, and policy domains needed for CE transition.

An extensive literature also addresses economy-wide policy analyses for resource efficiency, a crucial aspect of macro-level CE transition. Domenech and Bahn-Walkowiak (2019) provide an overview of EU-wide policies for resource efficiency, analyzed across policy frameworks, economic incentives, and policies shaping the context of CE adoption. The study finds that "policy binding objectives still largely concentrate on the output side of resource flows (i.e. emissions, waste) while the input side is either completely overlooked or addressed through aspirational, non-mandatory targets, scattered across policy documents" (p. 28). The authors argue that complex and competing goals within frameworks and policies compromise promotion of CE transition.

Other studies about CE transition through resource efficiency include a focus on material use in the Asia–Pacific region (Schandl and West, 2010), extended producer responsibility as a means to delegate power and responsibility to industry (Massarutto, 2014), public acceptability of the EU-based project DYNAMIX (Bicket and Vanner, 2016), the relationship between resource efficiency-based policy and resistance at systemic and institutional levels (Tukker and Ekins, 2019), acceptability and proposed business models across firm types that promote resource efficiency (Henry et al., 2019; Whalen, 2019), barriers to resource efficiency-based investments (Rentschler et al., 2018), and a multi-stakeholder framework for reverse logistics implementation (Govindan and Bouzon, 2018). Evident in the sizable and wide-ranging literature about CE, scholarly discussions are based principally on continuing efforts to identify best practices and a more universal understanding of resource efficiency.

In narrowing the scope of analysis to this study's EU context, it is useful to consider the 2015 introduction of the European Commission's Circular Economy Action Plan. The plan outlines a mix of policy futures across all stages of the product life-cycle, with the aim of ensuring resource efficiency in a holistic manner (Whicher et al., 2018). Against this backdrop, Milios (2018) maps existing policies related to life-cycle stages that in combination facilitate CE: production and product design, product use and consumption, product end-of-life and waste, and resource circulation. This perspective advocates for a policy mix focused on efficiency-based feedback loops and synergistic efforts across the entire product life-cycle, representing a holistic analytical frame. At a higher analytical level, this perspective illustrates how a mix of complementary policies with a systemic perspective can generate collective efforts towards systemic transformation. Based on a preliminary analysis for this study, it was determined that the Milios framework best fit the interview data and provided the best structure for presenting findings and recommendations.

3. Methodology

This study utilizes data from semi-structured interviews with 47 CE experts from the public and private sectors within the EU (see Table A1 in the Appendix A for more information about occupation, role, sector, and country of origin of interviewees). To the best of the authors' knowledge, this is one of the few medium-N qualitative studies published regarding CE policy issues (Kirchherr and van Santen, 2019).

A non-random judgment sampling approach (also known as purposive or deliberate sampling) was used to select interviewees. In this method, according to Marshall (1996; p. 523), "the researcher actively selects the most productive sample to answer the research question." The aim in utilizing judgment sampling for this study was to assemble a set of interviewees having the highest potential to contribute credible and current information about CE policies. To develop the sampling frame (see Morgan (2008) for justifications), this study began with a list

of 195 experts provided by *Circulair Ondernemen* (Circulair Ondernemen, 2019), of which 40 were interviewed in the first round. Using a snowball method (Kirchherr and Charles, 2018; Handcock and Gile, 2011), interviewees were then asked to suggest interviewees not yet identified, yielding 11 referrals and seven additional interviews for a total of 47. The duration of individual interviews was 45 – 60 min and each was conducted in person, by video-conference, or over telephone. The sampling procedure was terminated at the point of thematic saturation, when no new policies emerged over the course of three subsequent interviews (Francis et al., 2010).

The authors initially expected that interviewees would contribute differing insights based on their diverse backgrounds and experiences with CE. It was therefore decided to recruit from a stratified pool: policy users (17 interviewees from businesses), policy designers (15 from government), and policy observers (15 from academia). Policy users were expected to have novel insights about the limitations of current policies and preferences about policies that could address those limitations. Policy designers were expected to have experienced situations in which their ideas did not materialize into adopted policies, offering the potential for new ideas about feasibility and constraints to policy adoption. Policy observers were expected to have accumulated knowledge based on interactions with users and designers in research and teaching contexts (Kirchherr and Piscicelli, 2019). Although it was initially anticipated that the three interviewee groups would provide diverging insights, the analysis revealed that this was not the case and therefore the study's inferences are drawn from data pooled across interviewee groups.

An iterative process in which the treatment of interview data by available frameworks was compared revealed that suggested policies could be mapped most insightfully onto the previously referenced Milios (2018) framework (Fig. 1). Data were processed using an iteratively developed coding framework (Table 1). Coding dimensions relate to policy ideas that are classified into the four stages of the Milios framework. Prior to the first round of coding, initial coding dimensions were developed deductively based on the authors' existing knowledge about the topic. Additional coding dimensions were added inductively as they emerged during the coding process (see Haney et al. (1998) for a description of this method). All coding was performed by authors in Excel, according to the method used by Kirchherr et al. (2017). Dimensions were coded "1" for being present ("0" otherwise) as they were interpreted by the authors to have been mentioned by interviewees.

4. Results and discussion

This section presents interview findings and frames them into a holistic policy framework to promote CE transition. The four subsections correspond respectively to the four life-cycle stages, and together form the basis for eight policy recommendations applicable in the EU and similar contexts (Fig. 2).

4.1. Product design and production

Policy recommendation #1: Further adoption of circular design standards and norms at the EU level

Among the most commonly referenced strategies to promote CE is to reduce consumption, in particular by influencing consumer behavior and attitudes towards circular products. As individual behavior is often deeply embedded and thus resistant to change (Planing, 2015), a potentially less complicated policy lever is to encourage producers to embrace circular design principles through the establishment of design standards and norms. Such standards can facilitate the collective convergence of producer practices around CE-inspired methods of reuse and refurbishment, elevating sector capacity to achieve CE transition and helping stakeholders "embrace the concept [of CE]" (sustainability advisor). Many interviewees envision a role for governments in setting standards: "I wouldn't rely much on businesses…[standards] would need to come from policies" (scholar).

Fig. 1. Product life-cycle (Milios, 2018).

Design standards and norms can also support government efforts to promote fair competitive practices benefitting circular products. The wider availability and cost-competitiveness of circular-based materials neutralizes the commercial advantage of linear-based materials that have been "difficult to compete with" (policymaker); with the removal of this barrier, producers are able to more freely innovate with circular materials. In March 2019, the European Commission introduced the first of two CE design protocols (EN45558 and EN45559), constituting a framework for standards on "material efficiency that would establish future Ecodesign requirements on, amongst others, durability, reparability and recyclability of products" (CENELEC, 2019).

An EU Parliament-based interviewee argued that the process of standards-setting should be done in collaboration with stakeholders rather than through a top-down approach. Such an approach can ensure that related legislative frameworks do not undermine producer interests (scholar) or that standards, new or existing, are not contradictory (policymaker). The dissemination of information within and among producers not only increases awareness and understanding about standards but can also lessen the perception of risk about new design standards. According to a private sector interviewee, this type of risk aversion is common among conservative suppliers, particularly with reference to using non-virgin materials. Collaborations in the development of standards and norms can be facilitated through virtual platforms, live fora, dialogue sessions, and training programs (Table 2).

4.2. Product use and consumption

Policy recommendation #2: Expand circular procurement by the EU and member states

Circular public procurement (CP) is a component of green public procurement (European Commission, 2017) and has been applied in some EU countries. For example, in 2013 the Dutch government established the Circular Procurement Green Deal, stipulating that 45 public and private entities initiate CP pilot projects to build capacity, share insights, and demonstrate best practices among stakeholders. Over the next three years, more than 100 pilot projects were initiated, accounting for over EUR 100 million (One Planet Network, 2019).

Many interviewees expressed optimism about CP as a lever for accelerating CE transition. For example, one scholar states "putting conditions on public procurement would have a large stimulus effect on the [CE]." CP adoption also drew a positive response from interviewees from the public sector: "we want to…add to the tender procedure that we are looking for new and innovative ideas which we [can] then also co-finance" (program manager). This represents a vision of co-production in which government is not only a regulator or purchaser but also a participant in CE.

There is significant potential for CP implementation in the EU context. European national governments spend approximately EUR 2 trillion combined on procurement annually, accounting for 14 percent of EU GDP (European Commission, 2019a). This is indication of a potentially large market for CE products. Additionally, governments can build new CP markets by establishing, articulating, and revising norms, rules, and practices within the public sector.

Nevertheless, the tendering approach of governments is still often limited due to incomplete understanding of CP. With regards to

Table 1
Coding framework for life-cycle stage "production and product design".

Production and product design	
Policy idea Adoption of circular design standards and norms	Example data "…There need to be common standards and regulations for this…" (academic researcher) …"and that you can start to standardize [norms]…" (sustainability advisor)

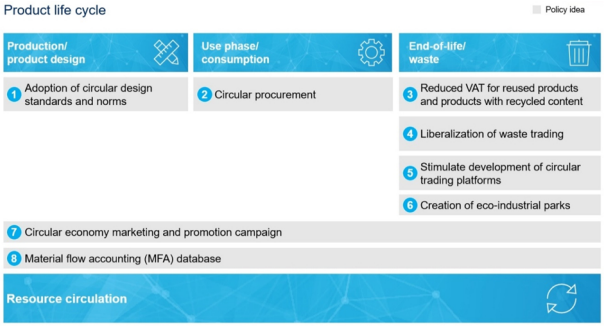

Fig. 2. Summary policy recommendations (adapted from Milios, 2018).

Table 2
Policy recommendation 1.

Further adoption of circular design standards and norms at the EU level
- Stakeholder engagement - Subsequent top-down establishment and dissemination of standards by the EU - Mandatory period (e.g. two years) for achieving compliance targets - Development and dissemination of guidance about how to incorporate standards Example: EN45558 and EN 45559 standards on durability, reparability, and recyclability of products

Table 3
Summary policy recommendation 2.

Expand circular procurement by the EU and member states
- Reorientation of procurement rules towards circular procurement (with circular products favored over linear alternatives) - Procurement standards through thresholds for percent of recycled content, reusability, and eco-efficiency (based on a holistic view of CE) - Continuous expansion of CP to create markets for circular product producers Example: Circular Procurement Green Deal initiated by the Dutch government and representing more than 100 circular procurement pilot projects

remanufactured products: "the [German] government hasn't a vision of the CE. Everything…is more focused on recycling and waste treatment…and not really focusing on the prevention of waste" (project manager). A private sector sustainability manager states "in many governments…they don't [expect] the use of remanufactured products…we hardly sell any remanufactured products to the governments." The pathway to a more holistic and durable CP regime involves not only revisions to tendering criteria but also a transformation in how governments conceptualize CE. In addition to performance-based criteria for CP concerning waste management, governments should also embrace and promote a circular life-cycle approach and life-cycle costing (Alhola et al., 2019) (Table 3).

4.3. Product end-of-life and waste

Policy recommendation #3: Alterations to taxes on CE-based products

According to neo-classical economic theory, private sector actors base decisions primarily on profit maximization (Primeaux and Stieber, 1994; Stormer, 2003). As such, pressures to alter production decisions come from price movements in input factors. However, if manufacturing products through CE-based practices lacks financial feasibility relative to that of linear products, producers will behave accordingly (Mont et al., 2017). Interview data support this: "[Secondary materials] cost much more than…virgin materials" (manager environmental affairs), while "recycling and sorting, gathering and treating of [reusable materials] is labour intensive" (scholar) and "therefore expensive" (co-founder of start-up). As such, "there is no incentive to move towards [CE]" (scholar).

These impressions are in contrast to the findings of some existing literature. Cost savings through reused materials have been found in studies across a variety of materials and industries, including wood-plastic composites (Keskisaari and Kärki, 2018), the "returned chain" resulting from rising primary material and energy costs (Lacy and Rutqvist, 2016), and improvements in supply chain synergies and reuse of by-products from photovoltaic (solar) panel construction (Brenner et al., 2018).

Many interviewees suggested that tax breaks may help boost the competitiveness of CE-based products and strengthen the financial case for CE transition. "We have now in Sweden the VAT on reused and repaired [materials] so … it is cheaper to repair and to reuse them" (scholar). Other tax policy options include a "negative impact tax" (CEO of start-up) and taxes on factors of production to raise price levels of virgin materials (scholar). "Scandinavian countries…decided to increase energy prices long-term. That creates a much more innovative business environment than in other countries" (managing director) (Table 4).

Policy recommendation #4: Liberalization of waste trading

Global trade systems exist for waste material destined for recycling, including dry recyclables such as plastics, paper, and metals (Velis, 2015). To facilitate CE transition, similar systems should be instituted to help producers trade a wider variety of manufacturing by-products. Interviewees reference efforts to access such waste streams but with regulation a significant barrier. This finding is likewise reflected in other studies including Kirchherr et al. (2018); Rizos et al. (2016), and van Buren et al. (2016).

Numerous interviewees indicate that existing legislation classifies waste only as waste rather than as a potential secondary resource. "When products are being given the label 'waste,' they fall under environmental laws [and] that can really hamper the reuse of waste streams" (program manager). Potential waste streams may also have limited recognition under current legislative frameworks, based on their origin and destination. One scholar describes how a company aimed to collect disposable coffee cups and recycle them into new cups,

Table 4
Summary policy recommendation 3.

Alterations to taxes on CE-based products
- EU-wide VAT relief for reused products and those having a certain percentage of recycled content - Increased VAT for linear-based products - Reduction of corporate taxes for firms engaging in CE-related behaviors (e.g. recycling, sorting, and treating) Example: Swedish VAT rates were reduced by 50 percent (from 25 percent to 12 percent) on repair jobs for a variety of goods including bicycles and clothing[a]

[a] https://www.theguardian.com/world/2016/sep/19/waste-not-want-not-sweden-tax-breaks-repairs.

Table 5
Summary policy recommendation 4.

Liberalization of waste trading
- Reduced regulations on trading and using waste where doing so does not compromise other policy goals such as protecting health and safety - Analysis of and reform to current related EU legislation Example: "Green listed wastes" have exemptions within the European Waste Shipment Regulation

but "the government said that once [the material] has been used for beverage or food it cannot be used for the same product anymore." In such an example, stringent food safety regulations limit reuse rates of materials, an obstacle also identified by Rood et al. (2017).

Revising or removing regulation can be challenging as many legislative frameworks exist to ensure health, societal, and environmental protections. Moreover, regulations differ across geographies so normalization at a regional or global level is complicated. However, many interviewees expect increased liberalization of cross-border waste trading for a wider variety of materials and products. For example, the European Waste Shipment Regulation outlines procedures regarding the shipment of waste but certain "green listed wastes" are exempt, reducing producers' administrative burden and acting to promote circularity (European Commission, 2019b). Therefore, one opportunity to advance CE transition would be to extend regulatory exemptions to waste products used in CE-based production (Table 5).

Policy recommendation #5: Facilitate development of circular trading platforms

CE uptake is dependent on demand for secondary rather than virgin resources as production inputs (World Economic Forum, 2016; Transport en Logistiek Nederland, 2015). Such demand could increase the volume of transactions in resource markets, complicating efforts to sort and monitor individual components by their characteristics. For example, Bastein et al. (2013) find that approximately two-thirds of electronic equipment is lost when associated waste materials are processed through varying channels. There is evident need for mechanisms to ensure unrestricted and transparent access by producers to new waste markets.

Numerous interviewees outline the potential usefulness of virtual platforms for circular trading. A scholar explains that "experienced recycling companies…know where the market issues are" and that they are "connected to designers that are looking for solutions." The scholar argues that the second-hand market should be more accessible and functional for producers that are not otherwise well-connected. Virtual trading platforms can play a role across all stages of the product lifecycle, as illustrated in Fig. 2. They provide a basis for producers to collaborate, interact with customers during the consumption stage, and connect with buyers and other partners in the disposal stage. Additionally, circular trading platforms can also act as sources of knowledge dissemination. For example, one scholar argues that producers should better understand how to "organize the reverse logistics loops so that they can have high quality secondary materials."

Virtual circular trading platforms can also be applied across differing trading scales, a valuable feature given the global structure of production markets. According to a policy-maker, "if you look at plastics, this is traded on a global level. So, it makes sense that…you shouldn't just look at a national approach. International companies need to [consider scale] to get this going." As standard business-to-business trading platforms (e.g. Alibaba) have been useful, interviewees highlight the need for government to serve as a catalyst for the emergence of a similar model for CE-based materials trade: "[the government should] …bring businesses together, creating a platform" (managing director circular start-up).

Despite the optimism of many interviewees, government efforts to develop such platforms have seen only mixed success. For example, France's government-funded Quaero, a search engine, was unable to achieve long-term viability in part because it was unable to compete with Google (Worldcrunch, 2008). An alternative strategy would be for governments to provide support (e.g. through matching funding) for the private sector to launch platforms. Tax modifications can also be used to support existing platforms, as in the case of Circle Market in the Netherlands (Table 6).

Table 6
Summary policy recommendation 5.

Facilitate development of circular trading platforms
- Fund-matching schemes and tax breaks for new and existing platforms - VAT exemption for products and resources sold through such platforms - Reduced regulations on trading and using waste where doing so does not compromise other policy goals such as protecting health and safety Example: The Netherlands' Circle Market, a virtual platform for connecting post-production, pre-consumer, and post-consumer excess materials to reuse and recycling markets[a]

[a] https://www.circle-economy.com/tool/circlemarket/#.XZSLl0YzaUk.

Policy recommendation #6: Creation of eco-industrial parks

Eco-industrial parks (EIPs) are considered a potential enabler of CE transition (Sacirovic et al., 2018; Mishenin et al., 2018). EIPs bring producers physically together, allowing them to share infrastructure and trade waste products in ways that other supply chain relationships might not. In so doing, EIPs "benefit the economy and substantially relieve environmental pressure in and near the location of its development" (Heeres et al., 2004). Additionally, EIPs play a role in facilitating inter-firm linkages for CE initiatives and can serve as test-beds and experimental platforms (i.e. "learning parks") for collaborative research, innovation, and experimentation (Park et al., 2019; Baldassarre et al., 2019). By early 2000, at least 100 EIP projects were in development or operation around the world (Sakr et al., 2011), with China a particularly enthusiastic adopter (Zhu et al., 2019; Mathews and Tan, 2011; Li et al., 2010). Examples of EIPs are the Sino-Singapore Tianjin Eco-City and Denmark's Kalundborg.

Many interviewees indicated an interest in the concept. "[EIPs] are very interesting because they are generating waste…passing it on to another factory" (research institute director). A government-based interviewee describes how EIPs are attracting producers to establish a circular hub: "we want companies that can exchange warmth or cold, heat, but also the waste of one company might be another source for another." Beyond connecting producers, EIPs are "also about producers, [as] re-users to get to know each other, trust each other, and have the same mindset" (associate professor).

On the other hand, according to a scholar interviewee, EIPs are "some kind of an ideal but actually operationalizing [them] is much more complicated." In reference to observations about EIP planning and strategizing, the scholar adds "there were a lot of good intentions but not a lot was happening on the ground." These findings reflect those of Shi and Yu (2014), who find that the majority of EIPs failed to deliver due to "diverse problems" (p. 6326). In light of such findings, enthusiasm about EIPs must be tempered by realistic expectations about how they can fit within regional economic contexts and industrial ecologie (Table 7).

Table 7
Summary policy recommendation 6.

Creation of eco-industrial parks
- Review and institutionalization of EIP success factors - EIP pilots and test-beds for experimentation - Replication and up-scaling of successful EIP pilots Example: Sino-Singapore Tianjin Eco-city, a collaboration between the governments of China and Singapore, that includes consideration of social, environmental, and economic dimensions[a]

[a] https://www.mnd.gov.sg/tianjinecocity/our-partners#building.

Table 8
Summary policy recommendation 7.

Circular economy marketing and promotion campaign
- EU-wide campaign focusing on the importance of CE, through traditional channels (e.g. TV, radio, and magazines) and non-traditional channels (e.g. social media such as Snapchat, Instagram, and Facebook) - Crowdsourcing competitions to generate ideas and ownership - Financial "top-ups" for CE awareness campaigns in operation Example: British mass media campaign against smoking, in which higher expenditures were shown to raise awareness and therefore higher rates of smoking cessation

Table 9
Summary policy recommendation 8.

Global material flow accounting database
- Funding for the development and operation of an MFA database, making access transparent, user-friendly, and available at minimal or no cost - Requirements for producers to collect information about the type, volume, and condition of their own waste outputs for feed-in to the database Example: UN Environment International Resource Panel Global Material Flows Database, which covers most countries and enables visualization and analysis for policymaking and research[a]

[a] https://www.resourcepanel.org/global-material-flows-database.

4.4. Resource circulation

Policy recommendation #7: Circular economy marketing and promotion campaign

Public awareness regarding CE transition has been studied among various user groups and industries, with a predominant focus on China.[1] A common finding is that awareness and willingness to act are alone insufficient to prompt CE transition; rather, a transition requires "a pervasive shift in consumer behavior" (Planing, p.3). The findings of such studies largely accord with those of this study.

Raising awareness and changing attitudes are crucial factors in stimulating CE transition. A government-based program manager argues for the "need to do a significant amount of 'pulling,' which is about raising awareness and talking to businesses on what [CE] can mean for them." Cultivating awareness among producers and consumers constitutes a "pull" strategy that induce behavioral change. "Making costumers aware that in a lifetime of a product [they are present at only] one of many stages" is an important lever to elevate demand for circular products (scholar). Governments are instrumental in this process as generators of programming, publications, and communications campaigns, while the private sector (managing director) and NGOs (project leader) also contribute.

The type of "cognitive fix" (Heberlein, 2012) envisioned by a CE awareness campaign targets changes in attitude that lead to altered behavior. However, "everything…is geared towards a linear model we have been optimizing for so long and that is everyone's mindset to do business" (sustainability manager). Changing that mindset is "the most difficult part" (policy-maker). A successful communications strategy should therefore aim to foster a sense of ownership regarding the impact of consumer behavior and should clarify not only what this ownership entails in terms of individual responsibility but also what it offers in terms of benefits (sustainability director). For example, government-run anti-smoking campaigns that adopt such an approach have been successful in generating public awareness (Kuipers et al., 2018). Indeed, larger expenditures for mass media over the past eight years, totaling roughly EUR 540,000 per month on average, have been associated with higher rates of success in smoking cessation, according to the study. This illustrates how a similar mass media campaign for CE may justify government intervention and could positively impact consumer awareness (Table 8).

Policy recommendation #8: Global material flow accounting database

Markets function most efficiently under a mix of conditions; of these, access by all parties to complete and accurate information is among the most crucial (Malmgren, 1961). According to an interviewee, "one of the main things that we are seeing is the lack of transparency. Being able to close the information gap between the stakeholders is pretty important." The functionality of the secondary market for reused materials is dependent on connecting buyers and sellers, but there exist limitations in buyer understandings about the type of materials available, the providers of such materials, and terms of sale. According to a scholar interviewee, "there may be problems in finding good destinations for the recycled materials to be separated. There you have the markets for secondary materials, [but] we do not know really much there."

The market for secondary resources appears not to enjoy the same level of fluidity and transparency as the market for newly manufactured component parts and for other virgin inputs. For example, in describing the information and market dynamics of recycling for cars and tires, an interviewee states that schemes "need to find the users of the secondary materials…there is not much known about who is using the 80–90 percent of [waste material] we have…there is no systematic analysis on that." Information would help producers understand the market potential of their own waste products and to identify opportunities for establishing loop-cycles in waste purchasing.

Material Flow Analysis (MFA) (Kalmykova et al., 2018) provides information crucial for monitoring the closed-loop processes on which CE is built. According to Brunner and Rechberger (2004), MFA provides a "systematic assessment of the flows and stocks of materials within a system defined in space and time" (p. 3). To take full advantage of material reuse, according to one scholar interviewee, producers must be aware of the availability of reusable materials and of the dimensions of their usefulness (e.g. type, condition, and modularity).

MFAs can exist at various conceptual and geographic scales. A global-scale understanding of material flows (i.e. an economy-wide MFA) is useful for policy-analytic efforts to understand systemic factors facilitating or impeding CE transition. Producers utilizing global supply chains could also benefit from a more thorough understanding of global-scale stocks and flows, particularly with reference to material reuse in service to CE models. According to an interviewee, "in a global economy a lot of resources are not coming from local sources but from global sources. So there are also political and economic constraints to this."

Harmonizing information about material flows presents some challenges. Producers rely often on production linkages across a complex combination of national, regional, and local settings, as confirmed by numerous interviewees. It is therefore necessary to consider the value of concurrent information capacities at multiple scales. Nevertheless, efforts to assemble a global or economy-wide MFA database face the challenge of varying standards, reporting requirements, and laws across political contexts. Accordingly, an MFA database should be a collaborative effort across jurisdictions in order to identify complementarity in institutional conditions. A multi-sectoral approach can facilitate this process, according to a government-based interviewee. Additionally, a researcher interviewee states "do not forget civil society. What you need is cross-sectoral platforms that can help exchange information." Any effort to systematically measure material flows, regardless of scale, can advance business and policymaking progress towards CE transition and can serve as a test-bed for later mainstreaming across scales.

Efforts to share information collected by governments, while in some cases facing regulatory constraints, may be less problematic than

[1] As of October 2019, search terms "circular economy" and "public awareness" return 2,810 results in Google Scholar. When excluding "China," 818 results return.

sharing information collected from competing producers, due to concerns about proprietary knowledge and confidential data. One way to overcome this challenge, according to a policymaker interviewee, is for governments to alter policies regarding competitive practices, including transparency and reporting standards, incentives to collaborate in ways that require deeper information sharing, and reforms to other competition policies as necessary (Table 9).

5. Conclusion

This study has derived insights into potential CE policies from interviews with 47 public and private sector professionals having direct experience with CE-related activities. The study focused on policies that are currently operational and on those with potential in some contexts. Eight policy recommendations were presented according to the stages of Milios' (2018) product life-cycle framework: design and production, use and consumption, end-of-life and waste, and resource circulation. The recommendations represent a variety of approaches including regulation, incentives, and provision of physical and virtual infrastructure. None is necessarily radical, as variants can be found across policy contexts. However, the value of considering the eight collectively is that a life-cycle view reflects the holistic perspective needed for CE transition; the common focus only on end-of-pipe factors is unduly narrow. For practitioners, the life-cycle perspective implies preparation of products for reuse, recycling, or remanufacturing, requiring an integrated strategy that begins with product design. As such, the recommendations address the design phase as well as the use and disposal phases.

The emergence of CE is an opportunity to develop system-wide efficiencies and practices that integrate reuse principles into production and render them commercially feasible. This study has focused primarily on policies that address institutional variables within organizations, the broader commercial environment, and the ecosphere shaping production system configuration and functionality. However, the study does not cover the totality of issues governing the prospects of CE transition. For example, cultural factors within organizations and individual psychological biases continue to be among the most significant barriers to CE adoption, according to Kirchherr et al. (2018). Further research should therefore identify mechanisms by which cultural and psychological factors obstruct CE transition and perpetuate linearity across the product life-cycle. Opportunities for further research also emerge from the primary limitation of this study: the geographical origin of interviewees impedes the external validity of the sample. Approximately 70 percent of interviewees are from the Netherlands. The institutional and societal contexts in this country can differ from that of other countries in the EU and around the world. Future research opportunities include the repeat of this study within other regional contexts or from comparative perspectives.

Declaration of Competing Interest

None.

Acknowledgements

The authors thank Ruben Bour for his contributions to this work, in particular for his data collection efforts.

Appendix A

Table A1
Overview interviewees.

#	Sector	Role	Organization	Country
1	Business	Chief Executive Officer	Circular start-up	NL
2	Business	Managing Director	Circular start-up	NL
3	Business	Chief Executive Officer	Circular start-up	NL
4	Business	Co-founder	Circular start-up	NL
5	Business	Manager Sales	Circular start-up	NL
6	Business	Managing Director	SME	NL
7	Business	Manager Environmental Affairs	SME	NL
8	Business	Managing Director	SME	NL
9	Business	Manager	Incumbent	NL
10	Business	Sustainability Director	Incumbent	NL
11	Business	Manager Business Intelligence & Innovation	Incumbent	NL
12	Business	Manager Sustainability	Incumbent	NL
13	Business	Advisor Business Development	Incumbent	NL
14	Business	Manager HSSE	Incumbent	NL
15	Business	Advisor Sustainability	Incumbent	NL
16	Business	Managing Director	Incumbent	NL
17	Business	Manager	Incumbent	NL
18	Academia	Scholar	University	NL
19	Academia	Scholar	Research Institute	NL
20	Academia	Scholar	University	SE
21	Academia	Scholar	University	BE
22	Academia	Founder	Research Institute	NL
23	Academia	Scholar	Research Institute	NL
24	Academia	Scholar	Research Institute	BE
25	Academia	Scholar	Research Institute	NL
26	Academia	Scholar	University	UK
27	Academia	Scholar	University	UK
28	Academia	Scholar	University	UK
29	Academia	Scholar	University	BE
30	Academia	Scholar	University	SE

(*continued on next page*)

Table A1 (*continued*)

#	Sector	Role	Organization	Country
31	Academia	Director	Research Institute	NL
32	Academia	Director	Research Institute	UK
33	Government	Policy-maker	County Government	NL
34	Government	Policy-maker	County Government	NL
35	Government	Program Manager CE	County Government	NL
36	Government	Advisor CE	County Government	NL
37	Government	Policy-maker	County Government	NL
38	Government	Program Leader	County Government	NL
39	Government	Program Manager	County Government	UK
40	Government	Advisor Sustainability	County Government	NL
41	Government	Project Manager	Government Council	DE
42	Government	Policy-maker	European Commission	BE
43	Government	Advisor Circular Procurement	National Government	NL
44	Government	Advisor Innovation	National Government	NL
45	Government	Policy-maker	National Government	PT
46	Government	Program Manager	City Government	NL
47	Government	Project Leader	National Government	NL

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