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*The Circular Economy Principles: A Theoretical and Definitional
Exploration within the European Union Framework*

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Abstract

Theoretical background: The concept of circular economy (CE) emerged in 1970 and gained popularity in the early 21st century, particularly in European Union (EU), China, and India. CE is a response to resource depletion and environmental degradation. As CE aims to maintain the usability of products and materials while minimizing waste, its incorporation into regulations and policies is driven by the need for sustainability and effective waste management. The study analyses main scientific papers from 1970 to 2024 to show changes in terminology, understanding, and interpretation of the main components of the idea of circularity.

Purpose of the article: This paper examines the consistency of CE research principles with the regulatory framework, assessing the conceptual aspects and scope of the CE as presented in EU documents.

Research methods: The research method was desk-based, using formal regulations and research frameworks based on the Scopus and Web of Science databases. Mainly academic studies and legal acts were evaluated.

Main findings: Over time, the scope of the CE definition changes. Among other things, a significant increase in formal and legal regulations for companies can be seen from 2020 onwards. The number of studies has also grown rapidly in recent years. While the definition of CE has not changed significantly, there have been major changes in the key areas of activity and scope. We systemize the regulatory aspects of CE by: CE definition boundaries, values, targets and reporting. The original nature of this article is to organise the knowledge on CE contained in the literature and source documents of the EU. The study will enable the promotion of knowledge on circularity by structuring the terminology and indicating the thematic scope of CE in different documents. Given the social context, the article can be used to raise awareness of the CE among consumers, enabling them to make more informed choices when selecting products and services.

Introduction

If current trends continue, global resource extraction could double by 2050, resulting in severe environmental degradation. CE strategies can decouple economic growth from resource use. (UNEP, 2011)

The idea of circular economy (CE) is increasingly recognized as essential for the entire world due to its role in promoting sustainability, reducing environmental degradation, and improving resource efficiency. United Nation Environmental Programme (UNEP) highlights that during time of increased pressure on natural resources, the CE offers a rational solution of maximizing value of resources, while minimizing waste (Bieńkowska, 2023). Ellen MacArthur Foundation proves that the CE may reduce the negative impacts of waste, such as pollution, land loss and degradation, or huge amounts of plastic worldwide (Ellen MacArthur Foundation, 2013). The CE is also critical to fight against climate change, as it lowers greenhouse gas emissions by reducing extraction and manufacturing.

The CE appears in many European Union documents, but also in the research as a desirable business model for sustainable organisations (Próchniak, 2025). It means moving away from a linear economic model that relies on the consumption of resources to make products that end up in landfills. The circular approach assumes that what was previously waste can still be a resource or product through circular processes such as recovery, but also reuse, refurbishment, reuse and repair (Potting et al., 2017).

One element of the introduction of the CE is the European Green Deal – a package of policy initiatives aimed at ESG reporting, which is intended to put the EU on the path to a green transition and ultimately achieve climate neutrality by 2050 (Official European Council of the European Union). Over the past few years, more Green Deal-related regulations have gradually been introduced. One of the most recent documents is the Corporate Sustainability Reporting Directive – CSRD (Directive (EU) 2022/2464) and the European Sustainability Reporting Standards, which set standards for environmental, social and governance (ESG) reporting to ensure transparency of companies' operations (Próchniak & Płoska, 2022). ESG reporting relates to the transition to a CE and resource use in the Environment (E) area of the European Sustainability Reporting Standard (ESRS). Therefore, the transition already applies to companies at the level of their business model and development strategy from 2024 onwards. The purpose of this paper is to assess the relationship between CE theory and the perspective derived from EU documents related to business. Due to formal regulations, an analysis of foundational data was adopted as the main method. Mainly academic studies and legal acts were assessed.

This research contributes to the existing literature in two key ways. First, it bridges the gap between CE theory and legal-institutional practice by tracing how theoretical constructs are translated into enforceable corporate obligations. Second, it offers a timely analysis of a rapidly evolving regulatory environment, providing insights that can support both academic debate and business adaptation. By contextualizing CE within the framework of ESG reporting, this study advances the discourse on sustainability and corporate accountability, particularly in the face of Europe's ambitious green transformation agenda.

Literature review

The CE is a very broad concept, which has grown rapidly in international research since 2018. More than 45,000 research papers containing “circular economy” have been indexed in the Scopus database from 1990 to Q12025. Until 2002, no more than 10 articles per year were indexed, 100 articles were exceeded in 2009 and 200 in 2015, with 1,400 exceeded in 2018. The sudden surge of interest in the topic brought the indexing of more than 11,000 scientific articles in 2024.

A relatively compliant growth curve applies to the number of indexed scientific publications in the fields of economics and finance and management and accounting sciences. Using the VOSviewer software tool (version 1.6.20) and Scopus database, current research topic areas related to the CE were extracted based on the co-occurrence of keywords (full-counting). Due to limitations of the use of records in VOSviewer, articles from 2016 (article diffusion) and in the areas of: Business management and accounting, and Economics, econometrics and finance were chosen for the study.

1990s. The origin of the term is assigned to the economic model created by Pearce and Turner in 1990 in the context of the principle that “everything is an input to everything else” (Glover et al., 2014; Rizos et al., 2017). However, in the prevailing opinion of studies, the circular concept initiated in the 1960s, regarding the environmental risks (Piwowski-Sulej, 2021) and industrial ecology (Le Tellier et al., 2019). Another approach identifies as a base date the 1970s tracing the oil crisis (Chatterjee et al., 2021; Ciulli & Kolk, 2019; Davies et al., 2017; Durst & Zieba, 2020; Garretson et al., 2017).

Despite the time, there is no consensus on defining circular economics. The term is most often presented as a combination of reduction, reuse, and recycling activities, while it is often not emphasized that CE requires systemic change (Kirchherr et al., 2017). Researchers notice that CE is a “regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops through Rs strategies” (Geissdoerfer et al., 2017, p. 579). Those strategies were integrated by the 3Rs concept of (reduce, reuse, recycle) (Bai et al., 2020; Korhonen et al., 2018; Piwowski-Sulej, 2021), then the 7Rs (rethink, reduce, reuse, repair, refurbish, recover, recycle) and 10Rs by adding refuse, remanufacture and re-mine (Alvarez-Risco et al., 2022; Shevchenko et al., 2023). Yet, the concept is still being developed and changed, what effects with a change among Rs (Potting et al., 2017). In Figure 3, the levels of Rs in CE are related to the three areas. These fields illustrate stages of a product’s lifespan: designing, usage and consumption, and end of life.

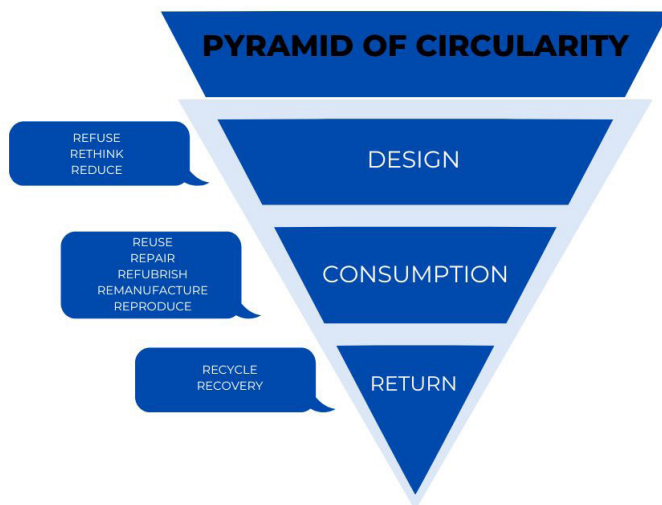


Figure 3. Levels of circularity: 10Rs

Source: (Cramer, 2022).

Another approach shows circular economy in the business models of companies, in which context it refers to a change in entities. This economic model leads to a waste-free system that adheres to three principles: (1) preserve natural capital, (2) optimize resource yields by circulation of products and components at the highest utility, (3) foster system effectiveness by reducing the negative externalities (Ellen MacArthur Foundation, 2015). In the business model, the circular economy is linked to technological development. One of the needs in the transition to CE is eco-innovation, which closes the loop of products' lifecycle, gets value from waste, and addresses the need for environmental resilience despite growth trends (Prieto-Sandoval et al., 2018). Many business practices and considerations are being analysed in terms of circularity, such as digitalization and digital technologies (Gregori & Holzmann, 2020; Luzzini et al., 2015; Piwowar-Sulej, 2021), sustainable innovation (Brix, 2020), sustainable consumption (Curtis & Mont, 2020; Frostenson et al., 2022; Viciunaite & Alfnes, 2020; Witjes & Lozano, 2016), managing resource loop (Dijkstra et al., 2020; Hess, 2014; Heyes et al., 2018; Le Tellier et al., 2019;), closed-loop systems (Ciulli & Kolk, 2019; Mellor et al., 2014; van Rijnsoever, 2022; Zhao et al., 2022), cradle-to-cradle product approach (Dijkstra et al., 2020), or shared services, green human resource management.

The CE received a lot of attention in the context of sustainable organizations and their dynamic capabilities to implement new business models in a complex environment (Curtis & Mont, 2020; Santa-Maria et al., 2022). The relationship between sustainable development goals (SDGs) and the CE is increasingly recognized as a synergy for achieving sustainable development. The CE promotes resource efficiency and waste reduction, which directly supports various SDGs, while the SDGs provide a framework for measuring the impact of CE initiatives. This interplay is crucial for fostering social change and environmental sustainability. CE practices enhance the efficiency of resource use, contributing to SDG 12 (Responsible Consumption and Production) by minimizing waste and promoting recycling (Gallardo-Vázquez et al., 2024). CE can drive social change by creating jobs and fostering inclusive economic growth, aligning with SDG 8 (Decent Work and Economic Growth) (Gallardo-Vázquez et al., 2024). The concept of the circular economy is widely recognized as a trigger for the transformation of business models (Tura et al., 2019), leading to circular business models (CBMs) (Heyes et al., 2018) that include circular products, reverse cycles, new frameworks, and transition in consumption models from owners to end-users. Sustainability reporting serves as a bridge between CE practices and SDGs, allowing organizations to communicate their contributions effectively (Gallardo-Vázquez et al., 2024). CE acts as a mediator in the SR–SDGs relationship, enhancing the visibility of sustainability initiatives and their alignment with SDGs (Gallardo-Vázquez et al., 2024).

The CE includes the transition from linear to sustainable practices (Brix, 2020). Among the crucial aspects, restorative and regenerative production, and industrial systems that should lead to resource efficiency are emphasized (Frostenson et al.,

2022; Heyes et al., 2018; Korhonen et al., 2018). Hence, the CE is most commonly seen through the prism of manufacturing and production (Piwowar-Sulej, 2021; Tecchio et al., 2017; Weissbrod & Bocken, 2017) with a focus on cleaner production (Brix, 2020; Durst & Zieba, 2020). Transportation (Bögel et al., 2019), building and construction sectors (Le Tellier et al., 2019; Tecchio et al., 2017), food (Bai et al., 2020; Berg, 2000; Glover et al., 2014), services (Frostenson et al., 2022), fashion and textile industry (de Brito et al., 2008) or agriculture (Dubey et al., 2017) are mentioned widely in terms of CE.

Some studies indicate CE implementation barriers such as: high production and marketing costs, lack of consumers' interest, limited knowledge of CE design, limited availability of circular supply streams, regulatory barriers, and limitations of experimental practices (Hartley et al., 2022). Depending on the place where barriers appear, they may be divided into internal (company's policies and strategies, financial, technological, lack of resources, collaborations, product design, internal stakeholders) and external (consumers-related, legislative and economic, supply chain-related, socialism cultural, and environmental) (Hina et al., 2022). The external barriers are often extended to market, institutional, and regulatory, as well as economic (Bianchini et al., 2019; Hart et al., 2019), while internal ones may be associated with the managerial approach, policy and regulatory, customers, and performance indicators (Galvão et al., 2018). Nevertheless, academics notice insufficient knowledge about the adoption and implementation of the circular approach, especially in different sectors and small companies (Heyes et al., 2018; Stål & Corvellec, 2018). Furthermore, CE issues are not sufficiently taken into account in strategic thinking.

Research methods

This study adopts a desk-based research approach to provide an explanation of the CE concept and its integration within EU regulations and policies. The primary aim is to explore the coherence between CE theory and its regulatory manifestations, while also systematising the associated terminology. This methodological choice is appropriate for synthesising both theoretical insights and formal legislative developments. To conduct this analysis, two key sources of information were used: 1) academic literature indexed in the Scopus database; 2) EU policy documents and legal acts.

The literature review was supported by findings from an analysis of the themes that co-occurred with the term "circular economy" using the Scopus database and the VOSviewer tool. A strategic and critical reading method was employed to analyse a range of EU documents, including directives, regulations, and strategic frameworks. These were examined for their references to CE principles, values, goals, and reporting requirements.

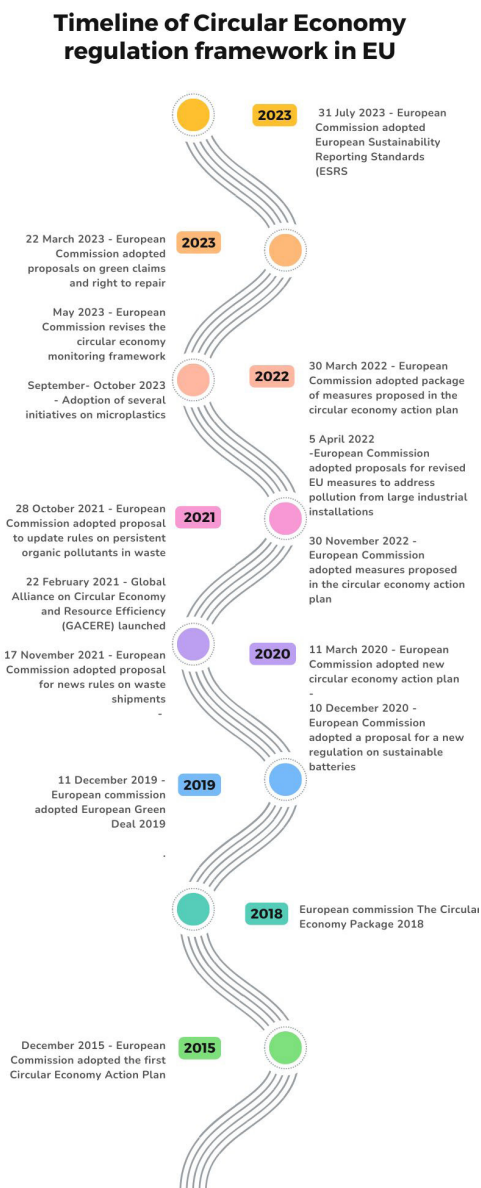


Figure 4. Timeline of Circular Economy regulation framework

Source: Authors' own study based on Circular Economy action plan.

The selected documents were systematically reviewed and categorised to enable structured thematic analysis. Regulatory findings were grouped into four key topics:

1. Definitions
2. Underlying values

3. Strategic goals
4. ESG reporting requirements

The temporal progression of these documents is illustrated in Figure 4, which presents the chronological development of EU CE-related policies and acts.

The academic findings were then compared and cross-referenced with the regulatory insights, in order to highlight convergence and divergence between theory and policy. This comparative approach enhances the study’s contribution by linking conceptual understandings with practical regulatory implementation.

Results

The analysis of EU legislation gives a picture of a well-thought-out policy that has evolved over time. The first documents focus on defining the idea and role of the EU in achieving sustainable development goals through the implementation of a CE. Over time, the documents specify the concepts, objectives and individual tasks to be implemented by individual EU member states and their subordinate bodies. The most recent documents not only relate to organizations at the macro scale, but also go down to the micro level – they oblige companies operating in the EU to take action for circularity. Taken together, the documents create a holistic vision of a European economy that is environmentally friendly, provides resources for entrepreneurs and cares for the quality of life of society. Analysis of the EU documents reveals changes in the approach to circularity, summarized in Figure 5.

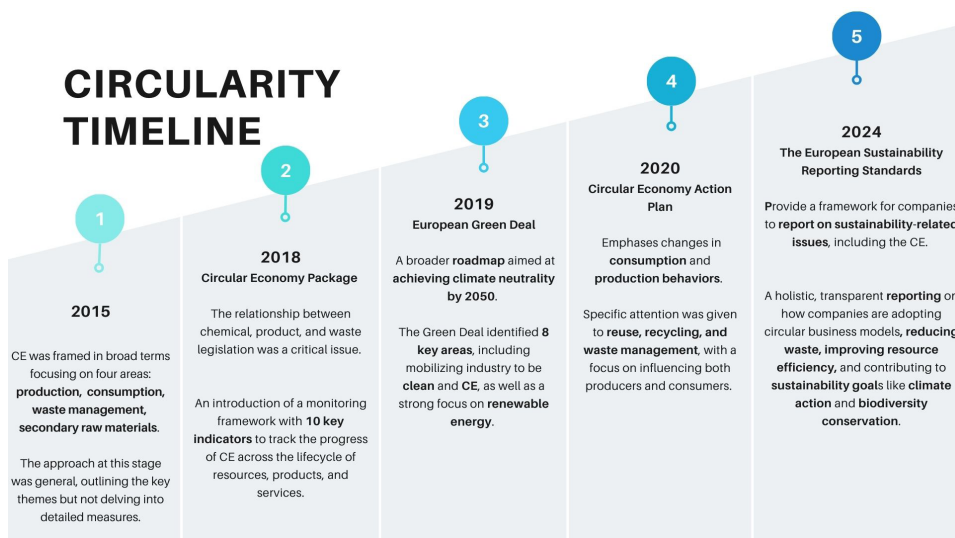


Figure 5. Circularity timeline diagram

Source: Authors’ own study based on Circular Economy regulation framework.

Analysis of the text of EU documents allows us to outline four key areas of legislative focus. The first is the limits of CE regulation, which define circularity and thus the scope of regulation. The next important area is values, which identify areas where circularity plays an important role. Objectives define the main goals that the European Union wants to achieve by implementing the idea of a CE. The last, but equally important, area is reporting, which is the most prominent in the legislation and allows us to monitor the degree and direction of implementation of the above areas.

CE concept boundaries

The concept of the CE has been defined and redefined in various EU documents, each highlighting slightly different aspects of the framework depending on the context and objectives of the document. The Circular Economy Packages of 2015 and 2018 focus on resource loops and waste minimization, presenting a fundamental view of CE. This approach is related to the 10Rs theory mentioned above. The 2020 Action Plan includes more societal and economic dimensions, suggesting that CE is critical for climate neutrality and digital innovation. The ESRS E5 (2023/2024) provides the most comprehensive definition, focusing on preserving the value of resources, minimizing environmental impact and efficient use in a broader economic context. In summary, definitions are evolving from a primarily resource-focused approach in earlier documents to a systemic and economic approach in more recent documents, integrating environmental, social and technological dimensions.

Values

The values and key action areas related to CE in EU documents reflect the evolving priorities and broader objectives of the EU, which is in line with the EU's overall sustainable development policy. The 2015 and 2018 packages focus on the basics of waste reduction and efficient resource management, with the 2018 version extending to regulatory measures. The European Green Deal broadens the scope of circularity to include climate, energy, biodiversity and pollution issues, integrating CE principles into broader environmental and economic policies. The 2020 Action Plan prioritises key value chains and emphasises sector-specific actions in industries such as electronics, textiles and construction, while aiming to change consumption and production patterns. The ESRS E5 document presents the most holistic and systemic vision of the CE, emphasising the need for a resilient, sustainable and regenerative economic system that decouples growth from resource extraction and creates new economic opportunities. In conclusion, the EU's CE values are evolving from a waste reduction framework (2015) to a comprehensive, climate-linked strategy (Green Deal, 2020 Action Plan) and finally to a holistic economic transformation model (ESRS E5, CSRD).

Goals

The goals out in the EU's CE policy documents reflect their specific focus and the broader context in which they were developed. The 2015 Circular Economy Package focuses on setting regulatory targets for landfill, reuse and recycling, with specific measures to be achieved by 2030. The 2018 Circular Economy Package shifts towards addressing a critical environmental issue – plastic waste – by focusing on transforming its design, production and recycling processes. The European Green Deal has broader ambitions, aiming to transform the entire European economy for a sustainable future, with a strong focus on climate neutrality, innovation and financing the green transition. The 2020 Action Plan emphasises closing the loop by transitioning to a fully CE, focusing on sustainable business models and increasing Europe's competitiveness through circular practices. The ESRS E5 (2023/2024) has the most specific targets, focusing on corporate reporting and transparency, with a focus on understanding the financial and strategic implications of resource use and CE practices for companies. It sets standards for disclosure to ensure alignment with circular principles. In summary, previous documents (2015, 2018) focus on sector-specific targets such as waste management and plastics transformation. The Green Deal and the 2020 Action Plan aim for broader systemic change, focusing on the transformation of the whole economy. ESRS E5 sets corporate accountability as its main objective, ensuring that companies align their strategies with CE principles and report on the financial impact of these practices.

Reporting

Reporting on circularity varies significantly across EU documents, reflecting the evolving complexity of the CE agenda and the mechanisms for tracking progress. The 2015 Circular Economy Package focuses on action plans and legislative proposals, with little emphasis on detailed reporting. The 2018 Circular Economy Package takes a reporting approach, assessing the implementation of the original 2015 action plan, making it more analytical and reflective of progress. The European Green Deal provides a strategic roadmap, focusing on the investments needed for long-term goals, but does not provide detailed reporting specific to the CE. The 2020 Action Plan focuses on the systemic transformation of product policy and consumption patterns, offering a set of initiatives rather than a structured reporting or evaluation mechanism. ESRS E5 (2023/2024) is the most comprehensive in terms of reporting, with a structured annual report based on a large set of quantitative indicators to track CE progress in detail. In summary, the earlier documents focus on action plans and strategic initiatives, while the latest reports, such as ESRS E5, introduce more detailed, quantitative reporting frameworks to systematically monitor and evaluate CE progress.

Discussion

Given the historical overview, it is clear that legislative work on the transition to a CE is intensifying. In the first period (2015–2019), only three documents were published on the CE in the *Economy*. Between 2020 and 2023, there was a significant increase in the number of regulations introduced, with two to four papers appearing per year (12 in total). The increase in the number of papers is reflected in the growing number of scientific publications – and thus in the growing interest in the topic of CE in the scientific world. A dynamic growth can be observed from 2020 onwards (2018: ~1,400 articles, 2021: ~5,300, 2022: ~6,500, 2023: ~8,000).

Approaches to CE have changed over time. In terms of key action areas, in 2015 these were very broadly defined as production, consumption, waste management and secondary raw materials. The Circular Economy Package 2018 takes a more concrete approach (e.g. the relationship between chemicals, products and waste legislation; a set of ten key indicators to assess the progress of the transition to a CE at each stage of the life cycle of resources, products and services). The European Green Deal (2019) focuses on a roadmap to improve efficiency in resource use, restore biodiversity, reduce pollution and outlines the investments needed to transition to a climate neutral Europe by 2050. The CE context is again taken up in a broader sense. In addition, renewable energy sources have also received a lot of attention. In the Circular Economy Action Plan (2020), the focus of the approach is on changing consumption and production behaviour through reuse and recycling, as well as waste management. The approach shifts from a generic nature to specific detailed changes in the behaviour of producers and consumers. It is interesting to see a two-pronged approach to the problem – from both the producer's and the consumer's perspective.

It is not only the increasingly complex regulatory environment and the growing number of publications that demonstrate the relevance of the issue. The transition to a CE will be one of the most challenging elements of the changes in the business environment introduced by the ESG. The ESRS E5 directly requires companies' business plans to adapt their strategies and business models to the principles of the CE (such as minimizing waste, maintaining the value of products, materials and other resources at their highest value by increasing their efficient use in production) (ESRS E5, 2024).

Circular approach contrasts with the linear economy that has been in place since the Industrial Revolution. The concept is now progressing faster than before. Table 1 shows how CE has changed in recent years. There is clearly a shift in focus from efficient management of resources and reduction of waste generation towards a comprehensive management approach. The shift from general terms characterising CE to the level of strategy and business model is noticeable.

Table 1. Summary of literature review on circularity concepts

Category	2015 CE Package	2018 CE Package	European Green Deal (2019)	2020 CE Action Plan	ESRS E5 (2023/2024)
CE concept boundaries	Focus on re-source loops and waste minimization. Related to the 10Rs theory	Extended legal approach, links between chemicals, products, and waste	Integration of climate, innovation, and digitalization aspects into CE	Economic and social dimensions included, focus on climate neutrality	Most comprehensive definition – preserving resource value, minimizing impact, resource efficiency
Values	Efficient resource management, waste reduction	Waste legislation, implementation monitoring	CE as part of broader environmental and economic strategy	Transformation of value chains, change in production and consumption patterns	Systemic, regenerative economy decoupled from resource extraction – resilience and innovation focus
Goals	Legislative targets: recycling, landfill – to be achieved by 2030	Focus on plastic: design, production, recycling	Climate neutrality, innovation, green transition financing	Closing the loop, circular business models	Corporate reporting obligations, understanding strategic and financial CE implications
Reporting	Action plan and legislative proposals, no advanced reporting system	Analysis of 2015 action plan implementation – reflective approach	Strategic roadmap – no specific CE reporting system	Set of initiatives, no structured monitoring or evaluation system	Annual reports, quantitative indicators – most advanced reporting system
Approach to CE	Broad areas: production, consumption, waste, secondary raw materials	Concrete areas: chemicals, products, waste, 10 progress indicators	8 key areas (energy, industry, clean economy), emphasis on sustainable investment	Shift from generic to specific actions for producers and consumers	Business model and strategy transformation, new ESG reporting requirements
Significance	Start of formal CE concept development in the EU	Strengthening legal and monitoring foundations	CE embedded in main EU development strategy (green transition)	From theory to practical action in key sectors	Economic transformation and corporate obligations – key ESG reporting document

Source: Authors' own study.

In summary, the most significant change is taking place at the level of moving from a more macroeconomic conceptual position to the management level of individuals. This shift is an implementation which requires companies to create their own framework for the transformation towards a CE based on existing legislation.

Conclusions

CE is a very important area of ongoing change in the European market. Its main objective is to reduce the resource intensity of production and to become less dependent on resource extraction. The idea seems legitimate and its implementation is moving

closer – through a series of legislative measures. There is also a clear shift from a more generic approach to one that forces changes in companies' business models.

However, it is important for companies to understand that the CE is becoming the business standard. In order to manage “closing the loop”, entrepreneurs must first realise what the CE is related to. This first step is described in detail in this article. Once the problem is understood, it is ideally to measure it. Depending on the type of product and the environmental burden generated and the purpose of the enterprise, different indicators can be used to monitor environmental impact. In Table 2 there are provided some suggestions that can support the transformation towards a CE.

Table 2. Examples CE metrics and disclosure

Indicator category	Example metric or disclosure
Resource use	Percentage of recycled materials used in production
Waste management	Tonnes of waste diverted from landfill
Product circularity	Percentage of products designed for disassembly and reuse
Strategy & governance	CE targets in product design, procurement, or supply chain
Water footprint	Amount of water used to produce good or service
Carbon footprint	Total amount of GHG (greenhouse gas emissions) generated during the product life cycle (from extraction of raw materials through manufacturing, transport, use phase and disposal)
LCA (life cycle assessment)	A method of assessing the environmental impact of a product (process or service) throughout its life cycle
European sustainability reporting standards (ESRS 5)	Potential impact of CE-related policies on business model

Source: Authors' own study.

The most extensive description of CE is provided in ESRS E5 – Resource Use and Circular Economy, which focuses on resource management and the transition to a circular economy, and includes both qualitative and quantitative disclosure requirements. Based on the indicators given in ESRS E5 standard, one can conclude that the main recommendation for business in implementation of CE are Policies and Actions related to resource efficiency and circularity. One of the requirements is creation of the strategies for design for reuse, recyclability, reduction of resource consumption, and product lifetime extension. This standard also forces entrepreneurs to look at resource Inflows and Outflows. The main objectives in this regard are reducing the total weight or volume of raw materials used (renewable and non-renewable), increasing the percentage of recycled or reused materials used in production, increasing the amount of secondary raw materials used as input and lowering the total waste generated.

Moreover, the standard indicates product and material circularity, defined as introducing design for circularity (durability, reparability, reusability, recyclability, modularity and availability of spare parts) and business models supporting CE (e.g. product-as-a-service, take-back schemes). The introduction of time-bound, measurable targets is required to increase resource efficiency, reduce virgin material use, increase use of secondary materials, or reduce waste. The main advantage of

introducing targets is the ability to control the progress made toward these targets over time. Finally, what is important from an ownership and management point of view, i.e. financial effects, is visible by measuring CE-related risks and opportunities and integrate them into the company's financial planning and risk assessment and assessing the potential financial impacts of transitioning to a circular model.

Considering analysis of CE definitions and changes and the proposed indicators, the role of science seems to be to conduct further research into business and process modelling in the context of the move towards "closing the loop" at business unit level. This is a major challenge as each company will have to adapt to the model individually and according to its capabilities.

References

- Alvarez-Risco, A., Rosen, M.A., Del-Aguila-Arcentales, S. (2022). Closing remarks. In A. Alvarez-Risco, M.A., Rosen, & S. Del-Aguila-Arcentales (Eds.), *Towards a Circular Economy. CSR, Sustainability, Ethics & Governance* (pp. 347–350). Springer. https://doi.org/10.1007/978-3-030-94293-9_19
- Bai, C., Dallasega, P., Orzes, G., & Sarkis, J. (2020). Industry 4.0 technologies assessment: A sustainability perspective. *International Journal of Production Economics*, 229. <https://doi.org/10.1016/j.ijpe.2020.107776>
- Berg, S.V. (2000). Sustainable regulatory systems: Laws, resources, and values. *Utilities Policy*, 9. www.elsevier.com/locate/utilpol
- Bieńkowska, J. (2023). The issues of fashion brand equity in a circular economy. *Annales Universitatis Mariae Curie-Skłodowska, sectio H – Oeconomia*, 57(1), 41–59. <https://doi.org/10.17951/h.2023.57.1.41-59>
- Bögel, P., Pereverza, K., Upham, P., & Kordas, O. (2019). Linking socio-technical transition studies and organisational change management: Steps towards an integrative, multi-scale heuristic. *Journal of Cleaner Production*, 232, 359–368. <https://doi.org/10.1016/j.jclepro.2019.05.286>
- Brix, J. (2020). Building capacity for sustainable innovation: A field study of the transition from exploitation to exploration and back again. *Journal of Cleaner Production*, 268. <https://doi.org/10.1016/j.jclepro.2020.122381>
- Chatterjee, I., Cornelissen, J., & Wincent, J. (2021). Social entrepreneurship and values work: The role of practices in shaping values and negotiating change. *Journal of Business Venturing*, 36(1). <https://doi.org/10.1016/j.jbusvent.2020.106064>
- Ciulli, F., & Kolk, A. (2019). Incumbents and business model innovation for the sharing economy: Implications for sustainability. *Journal of Cleaner Production*, 214, 995–1010. <https://doi.org/10.1016/j.jclepro.2018.12.295>
- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A new Circular Economy Action Plan For a cleaner and more competitive Europe. https://eur-lex.europa.eu/resource.html?uri=cellar:9903b-325-6388-11ea-b735-01aa75ed71a1.0017.02/DOC_1&format=PDF
- Consolidated text: European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste; Access current version (04/07/2018). <http://data.europa.eu/eli/dir/1994/62/2015-05-26>
- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste; Current consolidated version: 04/07/2018. <http://data.europa.eu/eli/dir/1999/31/oj>
- Cramer, J. (2022). *Building a Circular Future. Ten Takeaways for Global Changemakers*. Amsterdam Economic Board.

- Curtis, S.K., & Mont, O. (2020). Sharing economy business models for sustainability. *Journal of Cleaner Production*, 266. <https://doi.org/10.1016/j.jclepro.2020.121519>
- Davies, I.A., Chambers, L., Maplecroft, V., & St, H. (2017). Integrating hybridity and business model theory in sustainable entrepreneurship. *Journal of Cleaner Production*, 177, 378–386. <https://doi.org/10.1016/j.jclepro.2017.12.196>
- Dijkstra, H., van Beukering, P., & Brouwer, R. (2020). Business models and sustainable plastic management: A systematic review of the literature. *Journal of Cleaner Production*, 258. <https://doi.org/10.1016/j.jclepro.2020.120967>
- Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting.
- Directive (EU) 2018/849 of the European Parliament and of the Council of 30 May 2018 amending Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment (Text with EEA relevance); PE/9/2018/REV/1.
- Directive 2000/53/EC on end-of life vehicles; European Parliament and Council of the European Union: Brussels, Belgium, 2000. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0053> Accessed 30 June 2020.
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance). <http://data.europa.eu/eli/dir/2008/98/2018-07-05>.
- Durst, S., & Zieba, M. (2020). Knowledge risks inherent in business sustainability. *Journal of Cleaner Production*, 251. <https://doi.org/10.1016/j.jclepro.2019.119670>
- Ellen MacArthur Foundation. (2013). *Towards the circular economy. Vol. 1: An Economic and business rationale for an accelerated transition*. <https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an-accelerated-transition>
- Ellen MacArthur Foundation. (2015). *Towards a circular economy: Business rationale for an accelerated transition*. <https://www.ellenmacarthurfoundation.org/towards-a-circular-economy-business-rationale-for-an-accelerated-transition>
- ESRS E5. (2024). European Sustainability Reporting Standard E5 Resource Use and Circular Economy, EFRAG official document.
- European Commission. (2015a). Communication of the Commission to the European Parliament, Council, European Economic and Social Committee and Committee of Regions Closing the loop – the EU Action Plan for Circular Economy (COM 2015)614 final, Brussels.
- European Commission. (2015b). *Closing the Loop, Circular Economy: Boosting Business Reducing Waste*. http://ec.europa.eu/growth/toolsdatabases/newsroom/cf/itemdetail.cfm?item_id=8260&lang=en&title=Closing-theLoop---Circular-Economy%3A-boosting-business%2C-reducing-waste
- European Commission. (2015c). *Roadmap: Circular Economy Strategy*. DG ENV (A1, A2, A3, F1); DG GROW. http://ec.europa.eu/smartregulation/impact/planned_ia/docs/2015_env_065_env+_032_circular_economy_en.pdf
- European Commission. (2020). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A New Circular Economy Action Plan. For a Cleaner and More Competitive Europe, COM(2020)98 final; European Commission: Belgium, Brussels. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0098>
- Frostenson, M., Helin, S., & Arbin, K. (2022). Organizational sustainability identity: Constructing oneself as sustainable. *Scandinavian Journal of Management*, 38(3). <https://doi.org/10.1016/j.scaman.2022.101229>
- Gallardo-Vázquez, D., Scarpellini, S., Aranda-Usón, A., & Fernández-Bandera, C. (2024). How does the circular economy achieve social change? Assessment in terms of sustainable development goals. *Humanities & Social Sciences Communications*, 11(1). <https://doi.org/10.1057/s41599-024-03217-9>

- Galvão, G.D.A., de Nadae, J., Clemente, D.H., Chinen, G., & Monteiro de Carvalho, M. (2018). Circular Economy: Overview of Barriers, *Procedia – CIRP*, 73, 79–85.
<https://doi.org/10.1016/j.procir.2018.04.011>
- Garretson, I.C., Mani, M., Leong, S., Lyons, K.W., & Haapala, K.R. (2017). Terminology to support manufacturing process characterization and assessment for sustainable production. *Journal of Cleaner Production*, 139(part A).
- Geissdoerfer, M., Savaget, P., Bocken, N.M.P., & Hultink, E.J. (2017). The circular economy – a new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768.
- Glover, J.L., Champion, D., Daniels, K.J., & Dainty, A.J.D. (2014). An Institutional Theory perspective on sustainable practices across the dairy supply chain. *International Journal of Production Economics*, 152, 102–111. **<https://doi.org/10.1016/j.ijpe.2013.12.027>**
- Gregori, P., & Holzmann, P. (2020). Digital sustainable entrepreneurship: A business model perspective on embedding digital technologies for social and environmental value creation. *Journal of Cleaner Production*, 272. **<https://doi.org/10.1016/j.jclepro.2020.122817>**
- Hart, J., Adams, K., Giesekam, J., Tingley, T.T., & Pomponi, F. (2019). Barriers and drivers in a circular economy: the case of the built environment. *Procedia – CIRP*, 80.
<https://doi.org/10.1016/j.procir.2018.12.015>
- Hartley, K., Roosendaal, J., & Kirchherr, J. (2022). Barriers to the circular economy: The case of the Dutch technical and interior textiles industries. *Journal of Industrial Ecology*, 26, 477–490.
- Hess, D.J. (2014). Sustainability transitions: A political coalition perspective. *Research Policy*, 43(2), 278–283. **<https://doi.org/10.1016/j.respol.2013.10.008>**
- Heyes, G., Sharmina, M., Mendoza, J.M.F., Gallego-Schmid, A., & Azapagic, A. (2018). Developing and implementing circular economy business models in service-oriented technology companies. *Journal of Cleaner Production*, 177, 621–632. **<https://doi.org/10.1016/j.jclepro.2017.12.168>**
- Hina, M., Chauhan, Ch., Kaur, P., Kraus, S., & Dhir, A. (2022). Drivers and barriers of circular economy business models: Where we are now, and where we are heading. *Journal of Cleaner Production*, 333, 130049.
- Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation & Recycling*, 127, 221–232.
- Le Tellier, M., Berrah, L., Stutz, B., Audy, J.-F., & Barnabé, S. (2019). Towards sustainable business parks: A literature review and a systemic model. *Journal of Cleaner Production*, 216, 129–138.
<https://doi.org/10.1016/j.jclepro.2019.01.145>
- Luzzini, D., Brandon-Jones, E., Brandon-Jones, A., & Spina, G. (2015). From sustainability commitment to performance: The role of intra- and inter-firm collaborative capabilities in the upstream supply chain. *International Journal of Production Economics*, 165, 51–63. **<https://doi.org/10.1016/j.ijpe.2015.03.004>**
- Mellor, S., Hao, L., & Zhang, D. (2014). Additive manufacturing: A framework for implementation. *International Journal of Production Economics*, 149, 194–201. **<https://doi.org/10.1016/j.ijpe.2013.07.008>**
- Piowar-Sulej, K. (2021). Human resources development as an element of sustainable HRM – with the focus on production engineers. *Journal of Cleaner Production*, 278.
<https://doi.org/10.1016/j.jclepro.2020.124008>
- Potting, J., Hekkert M., Worrell E., & Hanemaaijer A. (2017). Circular economy: Measuring innovation in the product chain. <https://www.pbl.nl/sites/default/files/downloads/pbl-2016-circular-economy-measuring-innovation-in-product-chains-2544.pdf>
- Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular economy, *Journal of Cleaner Production*, 179, 605–615.
- Próchniak, J. (2025). Sustainable organizations – the state of research based on bibliometric analysis. *Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie*, 216, 455–473.
- Rizos, V., Tuokko, K., & Behrens, A. (2017). The circular economy: A review of definitions, processes and impacts. *CEPS Papers 12440*. Centre for European Policy Studies.
- Santa-Maria, T., Vermeulen, W.J.V., & Baumgartner, R.J. (2022). How do incumbent firms innovate their business models for the circular economy? Identifying micro-foundations of dynamic capabilities. *Business Strategy and the Environment*, 31(4), 1308–1333. **<https://doi.org/10.1002/bse.2956>**

- Shevchenko, T., Saidani, M., Ranjbari, M., Kronenberg, J., Danko, Y., & Laitala, K. (2023). Consumer behavior in the circular economy: Developing a product-centric framework. *Journal of Cleaner Production*, 384, 135568. <https://doi.org/10.1016/J.JCLEPRO.2022.135568>
- Stål, H.I., & Corvellec, H. (2018). A decoupling perspective on circular business model implementation: Illustrations from Swedish apparel. *Journal of Cleaner Production*, 171, 630–643. <https://doi.org/10.1016/j.jclepro.2017.09.249>
- Tecchio, P., McAlister, C., Mathieux, F., & Ardente, F. (2017). In search of standards to support circularity in product policies: A systematic approach. *Journal of Cleaner Production*, 168, 1533–1546. <https://doi.org/10.1016/j.jclepro.2017.05.198>
- Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S., & Valkokari, P. (2019). Unlocking circular business: A framework of barriers and drivers. *Journal of Cleaner Production*, 212, 90–98. <https://doi.org/10.1016/j.jclepro.2018.11.202>
- UNEP. (2011). *Decoupling natural resource use and environmental impacts from economic growth*. <https://www.resourcepanel.org/reports/decoupling-natural-resource-use-and-environmental-impacts-economic-growth>
- Viciunaite, V., & Alfnes, F. (2020). Informing sustainable business models with a consumer preference perspective. *Journal of Cleaner Production*, 242. <https://doi.org/10.1016/j.jclepro.2019.118417>
- Weissbrod, I., & Bocken, N.M.P. (2017). Developing sustainable business experimentation capability – a case study. *Journal of Cleaner Production*, 142, 2663–2676. <https://doi.org/10.1016/j.jclepro.2016.11.009>
- Witjes, S., & Lozano, R. (2016). Towards a more Circular Economy: Proposing a framework linking sustainable public procurement and sustainable business models. *Resources, Conservation and Recycling*, 112, 37–44.
- Zhao, X., Yi, C., Zhan, Y., & Guo, M. (2022). Business environment distance and innovation performance of EMNEs: The mediating effect of R&D internationalization. *Journal of Innovation and Knowledge*, 7(4). <https://doi.org/10.1016/j.jik.2022.100241>