

5

ASSESSMENT APPROACHES AND METHODS FOR A CIRCULAR ECONOMY

*Andrea Raggi, Hinrika Droege, Katelin Opferkuch,
Erik Roos Lindgreen, Anna M. Walker, Sandra Caeiro,
Tomás B. Ramos and Roberta Salomone*

5.1 Introduction

Both private and public sector organisations play a key role in the global uptake of the circular economy (CE). Businesses from many sectors are experimenting with CE business models, and one reason for this growing interest is probably connected to the concept's promise of various financial benefits through innovation (Ellen MacArthur Foundation, 2013). Beyond such financial returns, research has framed a wider set of advantages of CE activities for companies based on three domains of sustainable development, or the 'triple bottom line', namely planet, people, profit or prosperity (PPP). These include lowering environmental impacts and realising social improvements and the previously mentioned economic benefits, such as cost savings and the development of new markets (Laubscher and Marinelli, 2014; Korhonen et al., 2018). According to this frame, the potential of CE strategies lies in reducing negative sustainability impacts without jeopardising growth and prosperity (Ferasso et al., 2020).

However, the actual sustainability implications of the CE have mostly been assumed rather than carefully assessed (Blum et al., 2020; Harris et al., 2021). Indeed, it is crucial to assess to what extent CE strategies actually contribute to solving global crises, such as climate change, biodiversity loss and economic inequality, while also taking into account potential effects at the regional and local level, such as acidification, eutrophication, ecosystem toxicity and local employment. Likewise, it is essential to improve the understanding of how to assess the potential impacts of the CE. However, doing so is at present beyond the scope of the current impact measurement and reporting methodologies.

To evidence this promised reduction in sustainability impacts, research points to an increasing need for CE indicators and other assessment methods for business. Such

approaches can help organisations to evaluate their progress in the implementation of CE practices and the actual realisation of the expected environmental, social and economic benefits (Kristensen and Mosgaard, 2020). Getting data on such impacts is quite crucial, since for many CE strategies it is unclear whether, or to what extent, they actually lead to more sustainable outcomes across all the dimensions and aspects of sustainability (Kravchenko et al., 2019). Well-intended CE strategies might actually lead to increased impacts and/or burden shifting (Lonca et al., 2018; Corona et al., 2019; Walzberg et al., 2021). This chapter responds to this important gap in understanding by analysing the needs and challenges for private and public sector organisations seeking to assess the circularity and sustainability of their activities.

A key requirement for companies to engage with assessing their sustainability impacts is the availability of the right methods and tools for the purpose. Indeed, as regards the metrics for CE assessment, there are multiple approaches and indicators to choose from, with a large number of review articles inventorying such CE assessment approaches for businesses (e.g. Corona et al., 2019; Kristensen and Mosgaard, 2020). Many of the existing assessment approaches are inventoried and categorised, mainly focusing on their connection to different sustainability dimensions and specific CE strategies. Research has found frequent inclusion of the environmental and economic domains, with less attention being given to social aspects (Oliveira et al., 2021).

Overall, existing assessment approaches are extremely diverse. This might be caused by the complex nature – and limited understanding – of the relationship between the CE and sustainability (Geissdoerfer et al., 2017; Schroeder et al., 2019). There seems to be a lack of consensus on whether the CE and sustainability assessment are different or the same and whether one forms part of the other (Vinante et al., 2021; Walzberg et al., 2021). Hence, the need to bring order to the vast multitude of approaches and indicators available and to delve deeper into the relationships between circularity and sustainability and the related assessment processes, which were identified as objectives of this research.

Notably, companies and other organisations do not exist in isolation but are part of networks (sometimes formally constituted, others less so). CE practices mostly take place within a network of companies (Batista et al., 2018), thus going beyond single firms. While both private sector and academic literature is emerging on how to assess the circularity of a company (Elia et al., 2017; World Business Council for Sustainable Development, 2018; Vinante et al., 2021) and its impact on sustainability (Kravchenko et al., 2019; Kristensen and Mosgaard, 2020), limited literature has looked at the inter-firm level. Hence, the objective to create an overview of sustainability assessment approaches in circular inter-firm networks and to identify criteria of sound sustainability assessment in a CE context, while exploring their application in academia and practice. Additionally, the research sought to analyse the potential synergies between, as well as complementary features of, the CE and sustainability assessment approaches applicable to geographical contexts.

A further area considered by the research was the need to develop communications for CE practices. CE assessment metrics, in fact, could be used to

transparently and reliably communicate to various stakeholders through sustainability reporting the circularity and sustainability progress in companies (Ditlev-Simonsen and Midttun, 2010; Lock and Seele, 2016; EC, 2021). If, in general, the range of reporting approaches available is quite wide (Thijssens et al., 2016), there is an extensive discussion on their ability to contribute to transparent and quality non-financial disclosures (Melloni et al., 2017; Cortesi and Vena, 2019; de Villiers and Sharma, 2020). More specifically, a lack of clarity and a need for further investigation emerged on how circularity should be communicated in sustainability reports and on what the benefits and challenges related to CE reporting are, also in light of the evolving relevant regulation. Therefore, there is a growing need for guiding principles for the inclusion of CE-related information in sustainability reports. From this arose the objective of examining the frameworks suggested in the literature and the existing approaches in order to guide companies in CE sustainability reporting.

Both private and public sector organisations are considered key actors in the transition towards a CE (Kirchherr et al., 2017; Parchomenko et al., 2019). Public sector organisations are defined by the Organisation for Economic Co-operation and Development (OECD, 2019) as any organisation under government control that develops public goods or services. Their political nature distinguishes them from the market-driven private sector (Domingues et al., 2017). Public sector organisations are often characterised as bureaucracies with non-competitive (impersonal) hierarchies, rule-based management, functional speciality, division of labour and focused missions (Weber, 2008). Authors highlight that the different characteristics between private and public sector organisations need to be acknowledged in the development, implementation and execution of CE assessment approaches (e.g. Kristensen and Mosgaard, 2020).

The public sector contributes significantly to the socio-economic system, for example as a regulator and policymaker, a role model or a significant consumer and purchasing power. Many governments have developed and implemented CE strategies and activities already (Klein et al., 2020). These activities can serve as a role model to other public sector organisations, non-governmental organisations, the private sector, as well as citizens (Domingues et al., 2017). Public sector organisations can impact sustainability, especially in areas such as procurement, internal operations (e.g. material consumption) and their ownership of many buildings, among others (Brammer and Walker, 2011). From an economic viewpoint, in the European Union (EU), for example, public sector expenditure accounts for 51.5% of gross domestic product (Eurostat, 2021).

To further exploit the potential of the CE in the public sector, it is appropriate for public organisations to implement a CE assessment in their processes (Klein et al., 2020). Numerous public sector organisations have declared their support for CE performance evaluation; nevertheless, its implementation does not appear to be widespread (Ghisellini et al., 2016). Therefore, a further objective of this project was to analyse which factors hinder the implementation of CE assessments

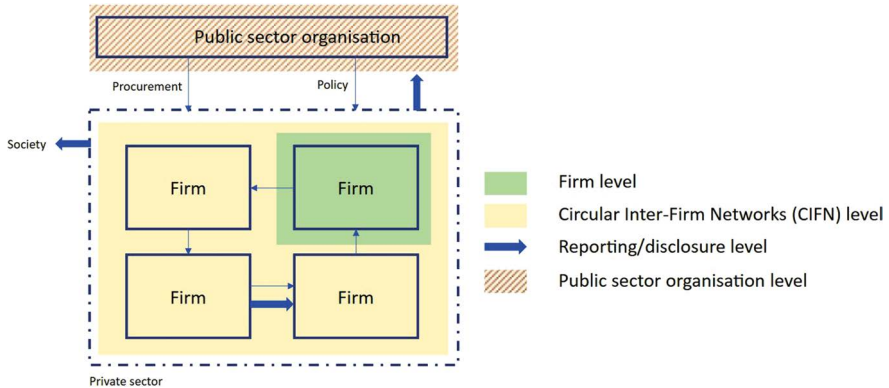


FIGURE 5.1 Different analysis levels of CE assessment applied in this chapter

in public sector organisations and to identify how to overcome these challenges, as well as to provide public organisations with a conceptual framework for assessing and reporting CE performance. Starting from the above-mentioned gaps and objectives, Cresting's research investigated the topic of assessing the sustainability of the CE by understanding the main related methodological issues for both the private and public sectors. The results of the project work packages contain lessons on the tools, methods and indicators useful for measuring both the extent and effects of a CE towards sustainability, at different sectoral contexts and scales. Throughout the research, a dual perspective including theoretical contributions and end-user point of views (i.e. companies, practitioners and public sector organisations) was considered.

The levels of analysis are summarised in Figure 5.1, in order of their appearance in the chapter: the firm level, the circular inter-firm networks (CIFN) level, the reporting and disclosure level and the level of public sector organisations. The dotted line indicates the boundaries of the private sector. The direction of reporting and disclosure takes place from the private sector to society and public sector organisations, while firms also communicate CE metrics between themselves. Measurement-related interactions between public sector organisations are summarised as procurement and policy interactions: this is explained in more detail later in the chapter.

The next section starts by highlighting the main aims for businesses to assess circularity; then, the outcomes of a systematic analysis of key experiences of sustainability assessment for the CE are presented and briefly discussed, identifying the implemented methods and tools for different industry sectors, company dimensions, sustainability perspectives (environmental, economic, social), and key waste streams. In section 5.3 the urgent topic of strengthening inter-firm connections by applying both CE and sustainability assessment is presented. Section 5.4 is centred around the findings related to the use of assessment approaches for facilitating

the inclusion of relevant data within sustainability disclosures and external communication. In [section 5.5](#), while summarising the results of the analysis of CE performance assessment in public organisations and the development of a specific framework, connection to the previous business-centred parts is made. The chapter continues with an overview of key learnings on the use of CE assessment within both the private and public sectors ([section 5.6](#)) as well as listing opportunities for future research ([section 5.7](#)). Finally, the chapter ends with some concluding remarks.

5.2 CE assessment goals and approaches for businesses

CE assessment benefits for businesses can generally be grouped into two categories: (1) internal improvements and insights and (2) external communication and collaboration ([Roos Lindgreen et al., 2022](#)). The first category includes e.g. improving and optimising internal CE strategies, providing insights into broader sustainability performance, enabling a learning process and cultural change among the employees of the company, contributing to the development of a company strategy and vision, and allowing for comparability and identifying market opportunities. In the second category, external benefits are diverse as well, and include the use of the assessment results in marketing and improving the reputation of a company, communication and reporting to stakeholders and clients, providing evidence of CE activities to increase overall transparency, and identifying opportunities for collaboration.

5.2.1 Navigating the diversity of CE metrics

To create some structure to the large number of available assessment approaches, four general categories relevant to businesses were identified ([Table 5.1](#)). The first comprises life cycle-based methods. These enable quantifying impacts across all phases of a product's or system's life cycle, from the extraction of raw materials to its disposal ([Finkbeiner et al., 2010](#)). This group also includes material flow analysis (MFA)-based methods, which establish an overview of resource and energy flows across the life cycle of a system, and footprint tools, such as the carbon footprint and the water footprint, which can be considered a sort of simplified Life Cycle Assessment (LCA) ([Brunner and Rechberger, 2016](#); WBCSD and WRI, 2004). The second category comprises several available sustainability reporting frameworks, such as Global Reporting Initiative (GRI) standards. These reporting frameworks aim to create a common language and format for organisations to report on their sustainability impacts ([Global Reporting Initiative, 2018](#)). Next up is the group of single indicators: these are quantitative and qualitative indicators that present circularity as single thematic or sectoral CE key variables which are mainly oriented around metrics such as recycling rates or virgin or secondary resource use ([Kristensen and Mosgaard, 2020](#)). Finally, there is a

TABLE 5.1 Categories of the assessment approaches reviewed

<i>Category</i>	<i>Assessment approach</i>	<i>References</i>
Life cycle-based/ footprint	Carbon footprint	WBCSD and WRI, 2004
	Ecological footprint	Wackernagel and Beyers, 2019
	Product environmental footprint	EC, 2013
	Environmental life cycle assessment	ISO, 2006a, 2006b
	Life cycle costing	Hunkeler et al., 2008
	Material flow analysis	Brunner and Rechberger, 2016
	Social life cycle assessment	UNEP, 2020
	Water footprint	Hoekstra et al., 2011
Reporting framework	Environmental accounting	Bebbington et al., 2021
	GRI standards	GRI, 2016
Single indicators	Material Circularity Indicator (by Ellen MacArthur Foundation)	Ellen MacArthur Foundation and Granta, 2015
	Material durability	Figge et al., 2018
	Recycled content	Kristensen and Mosgaard, 2020
	Recycling rate	Kristensen and Mosgaard, 2020
	Time for disassembly	Vanegas et al., 2018
	Volume of non-renewable resources not extracted	Kristensen and Mosgaard, 2020
	Volume of virgin material production prevented	Kristensen and Mosgaard, 2020
	Volume of waste diverted from landfill	Kristensen and Mosgaard, 2020
Tailor-made indicators	Tailor-made circularity indicators based on a life cycle approach	N/A
	Tailor-made circularity indicators based on direct impact	N/A
	Tailor-made sustainability indicators based on direct impact	N/A
	Tailor-made sustainability indicators based on a life cycle approach	N/A

Source: Based on Roos Lindgreen et al. (2022)

category of tailor-made indicators, which could be based on a life cycle approach or direct (i.e. scope 1) impact, which makes it possible to tailor the CE or sustainability assessment more closely to a company's specific context (Kravchenko et al., 2020).

5.2.2 Sustainability assessments as guide to circularity for business

As a result of the large number and diversity of assessment approaches, businesses might struggle to select the one(s) most relevant to their context. In addition, many of the CE assessment approaches found in the (grey) literature are usually solely based on resource use metrics, making them unsuitable to assess the full sustainability performance of circular systems (Corona et al., 2019; Walker et al., 2021). For both reasons, several authors propose to concentrate on using existing sustainability assessment approaches to assess the impact of CE strategies. For instance, Kristensen and Mosgaard (2020) acknowledge that LCA and other methodologies, such as MFA, Life Cycle Costing (LCC), and Corporate Social Responsibility (CSR), are likely to be applicable to CE. Work by Corona et al. (2019) finds LCA to be the most used framework to assess circular strategies and highlights the importance of avoiding burden shifting from reduced material consumption to increased environmental, economic or social impacts. Overall, LCA can be described as a suitable and effective method to measure the environmental impacts of CE strategies for businesses (Roos Lindgreen et al., 2021). It provides decision-makers with a tool to prioritise actions towards developing low-impact strategies. For the other dimensions of sustainable development, related existing methods such as LCC and Social Life Cycle Assessment (S-LCA) could provide an appropriate pointer for assessing CE activities (Niero and Rivera, 2018; Moraga et al., 2019; Kristensen and Mosgaard, 2020). Global standardisation organisations such as ISO and the British Standard Institute (BSI) also promote their use in CE assessment (BSI, 2017; ISO/TC 323, 2020).

A complication of existing life cycle-based methods is that generally they are considered to be challenging to use, due to their time-intensive nature, complexity and cost. There certainly exists tension between the accuracy and completeness of assessment and its feasibility for companies. Does the complex nature of more 'complete' methods warrant the use of relatively simple, resource efficiency-centred CE metrics? Such metrics might be less financially demanding, while also requiring fewer input data. However, the results that follow from such approaches could potentially lead to the implementation of strategies that do not deliver the sustainability impacts promised by CE.

While it is acknowledged that resource efficiency-based metrics could be of use in specific decision-making situations, for CE to be a valuable concept, current ecological and social crises demand that its outcomes should be sustainable (Walker et al., 2021). For this reason, the value of assessing impacts of CE strategies before their introduction becomes evident (Roos Lindgreen et al., 2022). The challenging

nature of the approaches remains, but businesses are rapidly developing knowledge about the use of such tools. In addition, research focuses on the accessibility of life cycle-based methods and tools, not only through their simplification, but primarily through investigating experiences of businesses with such tools by means of a shared learning process between academia and the private sector (Das et al., 2021).

These lessons as summarised above have been integrated in the design of the new Strategic Circular Economy Impact Assessment (SCEIA) framework, which provides guidance for companies to assess the sustainability impacts of their CE strategies. The framework has five objectives: (1) to enable holistic (multidimensional) assessment; (2) to prevent burden shifting to other parts of the supply chain or product life cycle (life cycle perspective); (3) to provide flexibility in terms of scale and sustainability maturity; (4) to build on existing assessment tools; and (5) to assist in strategic decision-making processes. A more detailed description of the framework is provided in [Chapter 4](#) in this volume.

While much literature on the design of CE assessment approaches exists, less is known about the topic of the assessment process and the aforementioned topic of shared learning. This includes conducting research into company needs and capabilities for assessment, which could then provide the blueprint to design assessment approaches that match business realities. Relevant questions are, for example, whether and how CE assessment implies the involvement of a wider set of stakeholders in setting measurement targets through e.g. materiality assessment, how the assessment results could be used for strategic decision-making, or, more generally, how much time and resources it is recommended should be allocated to assessment activities in different sectors. Answers to these questions are expected to be able to increase the level of uptake of CE assessment approaches, providing increased evidence to the CE transition.

After establishing such ‘process level insights’, a next step would be to learn more from businesses that have just begun their ‘assessment journey’: how can they be stimulated to better understand the impact of their operations, without the risk of overcomplication following the large number of indicators and tools available? Businesses are not always sure where to start with CE assessment, and by focusing on assessment as a trajectory, or a process, starting small and slowly expanding, companies could be tempted to assess their impacts, convincing them that not dozens – if not more – environmental, social and economic indicators should be used in the decision-making process at once. A formalised description of such an ‘assessment trajectory’ could provide such companies and organisations more generally with concrete assistance.

5.3 CE practices and inter-firm networks

When dealing with inter-firm networks and the CE, a semantic issue should be first addressed: what actually constitutes the inter-firm or so-called meso level? While some scholars ([Ghisellini et al., 2016](#); [Kirchherr et al., 2017](#); [Panchal et al.,](#)

2021) have a more limited perspective at the meso level, claiming that it includes only cases of industrial symbiosis or eco-industrial parks, other scholars (Masi et al., 2017; Chertow, 2000; Oliveira et al., 2021) have a wider understanding of the term. In their view, it also includes supply chains throughout product life cycles, which can be both closed and open looped (Farooque et al., 2019). The latter conceptualisation is the one used throughout this chapter, and, to avoid confusion, the term inter-firm will be used. The different actors collaborating on CE practices can be seen as acting in CIFNs, rather than linear supply chains. Indeed, the supply chain management literature advocates for a network perspective of supply chains, providing a superior understanding of the dynamics within them (Carter et al., 2015). A feature that distinguishes the CIFN from a traditional supply chain network is that the former goes beyond the consumer and includes actors throughout the whole life cycle of a product.

5.3.1 *Assessing sustainability in inter-firm networks*

The question arises how sustainability can be assessed in such CIFNs. Rather than conceptualising new assessment approaches, Walker et al. (2021) show in their literature review that the open and closed loops in supply chains, which CE practices entail, are found in both the fields of industrial ecology and circular supply chain management. After identifying the sustainability assessment approaches that have passed academic rigour, the insights into the actual assessment practices of companies active with CE practices in Italy and the Netherlands were collected through 43 interviews. While the academic assessment approaches were both quantitative and qualitative, most of the approaches applied in practice were qualitative. One exception to this are the life cycle thinking (LCT) methodologies, such as LCA and carbon footprint, which were found to be frequently employed despite their quantitative nature. The companies using them were mostly larger companies and smaller specialised firms, thus explaining the availability of technical know-how (Roos Lindgreen et al., 2022). Additionally, and instead of relying on quantitative assessment approaches, practitioners underscored the importance of relationships when initiating CE practices and assessing them. The relevance of supplier selection criteria and audits to manage performance was stressed, in connection with the frequent exchange of best practices and mutual trust. The latter was seen as an essential starting point both for initiating CE practices and for evaluating them jointly. It was also found that the connection between collaboration and assessment was reciprocal (meaning that more collaboration facilitated the assessment process), as was described by Alghababsheh and Galliar (2020).

To evaluate whether the approaches applied in practice and proposed by academia are suitable for sustainability assessment in CIFNs, it was essential to set some criteria for sound sustainability assessment. Therefore, the four criteria presented by Muñoz-Torres et al. (2018) were adapted by Walker et al. (2022), namely (1) balance of the different sustainability dimensions aligned with the United Nations Sustainable Development Goals (SDGs); (2) consideration of the intergenerational

nature of sustainability; (3) stakeholder involvement; and (4) LCT. Regarding the first criterion, it was found that the LCT methodologies adopted most frequently addressed the environmental dimension, rather than balancing the sustainability dimensions. Regarding the limited inclusion of the social dimension, Walker et al. (2021) underscored in their paper that the social assessment approaches are diverse, inherently context-dependent and mandate stakeholder inclusion (Kühnen and Hahn, 2018). The most prominent LCT-based social assessment methodology in academia, the S-LCA (Finkbeiner et al., 2010), is less commonly applied in both the literature and in practice, compared to environmental LCA and LCC, for example. Of the 43 companies that were interviewed, less than half conducted some type of social assessment; the main barriers were a lack of expertise and missing standards. Although the S-LCA, for example, is partially standardised, it was not seen as implementable because of limited data availability and low perceived importance of CE practices' social impacts regarding CSR or risk management strategy, two areas generally informed by social assessment (Rosenbaum et al., 2015; Kühnen and Hahn, 2019). In contrast, those social assessment approaches applied were mostly qualitative and were evaluated through discussion with partners.

The second criterion of addressing the intergenerational nature of sustainability was the least fulfilled both in the literature and among the interviewed companies. It also emerged that the third criterion, stakeholder engagement, was already a best practice for most of the interviewed companies, while in the literature on LCT methodologies this was documented only sporadically. For companies aiming to conduct more quantitative assessments, it was proposed to work with a set of social indicators based on a normative consensus like the SDGs, which is then complemented with more context-based and strategic indicators legitimised through stakeholder inclusion (Gasparatos and Scolobig, 2012; Kühnen and Hahn, 2018). At this point it is essential to underline that the balance between having a normative core for the assessment, legitimised through global consensus, and using context-specific indicators, determined with stakeholders, will persist and is essential to yield meaningful results (Kühnen and Hahn, 2018). While this holds for sustainability assessment in general, it is especially relevant for the social dimension, due to the high context-related variation of values and norms. Indeed, this creates a certain trade-off between standardisation and contextualisation (Roos Lindgreen et al., 2022), which requires discernment on the part of assessment practitioners, rather than a one-approach-fits-all solution.

Finally, the LCT criterion was also broadly applied in practice by the interviewed companies, although sometimes practitioners did not involve actors throughout the whole life cycle but only in the next tiers of the supply chain.

5.3.2 *Socio-material lens for assessment contextualisation*

While LCT-based methods have evolved to become the most adopted approaches in the context of CIFNs, it is essential to understand that they need to be embedded into companies, inter-firm networks (e.g. through life cycle management; see

Zinck et al., 2018) and their local contexts. One of the options is to use the epistemological lens of Actor Network Theory (ANT) to model end-of-life scenarios of a LCA and to contextualise its results. In this way, the assessment is viewed in its role as a calculative device and can be seen as performative, i.e. a tool to advocate for the implementation of one CE solution over the other, for example (Niero et al., 2021). Conducting more LCT-based assessments supported by sociological analyses is essential in a sustainable development context, because the results can direct companies towards potential levers of action (Baumann and Lindkvist, 2022). Besides the need to embed the LCA into a certain context, it is essential to understand the limitations of this calculative device, given it can only provide a partial (limited set of impact categories) and unidimensional (focusing on environment) picture of a system's sustainability (Gasparatos and Scolobig, 2012; Niero et al., 2021). In addition, LCAs are being used and interpreted by other actors such as the companies commissioning the LCAs for decision-making and external communication (Pryshlakivsky and Searcy, 2021) and should thus not be viewed as a neutral methodology. In a similar vein, it is an assessment approach that mirrors the worldview of LCA practitioners through their modelling choices (Gasparatos, 2010). While a certain degree of subjectivity is unavoidable, and according to Freidberg (2018) even desirable, LCA practitioners should be transparent about these values. This is especially relevant given the status that LCA has acquired as a best practice assessment methodology in the CE context, which is bound to increase its application substantially (ISO, 2020; Roos Lindgreen, 2022).

5.4 CE assessment within sustainability disclosure and external communication

As already mentioned, multiple assessment approaches for the CE have been proposed and reviewed both by academics (e.g. Saidani et al., 2019; Kristensen and Mosgaard, 2020), as well as by private initiatives (e.g. Ellen MacArthur Foundation, 2020; WBCSD, 2022). However, these approaches are generally designed to produce results/data for internal use, offering companies the opportunity to utilise assessment results for internal improvement and CE strategy optimisation. As regards external communication, given the scarcity of indications in the literature on CE data to be disclosed externally, as well as on the connections between CE assessment and corporate sustainability reporting, companies have to decide independently how and what to report in terms of circularity (Opferkuch et al., 2021, 2022). This, as Pauliuk (2018) suggests, could lead to companies reporting indicators for CE which best suit their narrative and thus open themselves up to claims of greenwashing. However, the recently accepted draft European Sustainability Reporting Standards, specifically the standard Resource Use and Circular Economy, will now guide companies to disclosing comparable CE data within their mandatory corporate sustainability reports (EFRAG, 2022). To comply with these reporting requirements, CE assessments will provide companies with sufficient and

relevant CE data to increase the transparency of their business activities and reduce potential claims of greenwashing (Opferkuch et al., 2022). Additionally, the use of CE assessment results can assist companies with the identification of relevant CE-specific risks and opportunities, as is required by their investors and external stakeholders. Overall, CE assessments can gather data relevant for inclusion within corporate disclosures; thus, the assessments themselves can help to facilitate and improve existing corporate sustainability reporting processes.

5.4.1 The need for businesses to report their progress towards circularity

There are numerous reasons why companies should include CE content (including the results of any CE assessments) within their corporate sustainability reports. At a European level, the context of CE disclosure is rapidly moving from voluntary to mandatory disclosure. Following the publication of the EU's Green Deal (EC, 2020), which cemented the CE as a priority approach to address a number of environmental issues, the CE has been included as a key environmental objective within relevant sustainable finance regulations, namely the Corporate Sustainability Reporting Directive (CSRD) (EC, 2021) and the EU Taxonomy Regulation (EC, 2020). What this means is that in the coming years there will be an increasing demand for (1) CE data within corporate sustainability reports and (2) the number of investments made to companies engaging with and reporting CE data. Companies that are already voluntarily conducting CE assessments and communicating this type of data will be at a clear advantage compared to those that will only do so when it becomes mandatory. In addition to this evolving climate of CE disclosure, early evidence suggests that companies are experiencing a number of benefits when externally communicating their CE activities (Opferkuch et al., 2023).

Using semi-structured interviews, a sample of 43 companies engaged with the CE and operating in either Italy or the Netherlands were asked what benefits they experienced when they externally communicated their CE activities. Generally, companies had recorded a number of benefits. First, the CE is a powerful storytelling tool. Companies explained that framing the descriptions of their business activities using a life cycle approach enabled them to develop informative narratives which explain the life cycle of the materials being used and the products they produce. This in turn, helps consumers to understand exactly how the company's products are being made and what the company's values are. Second, companies described the CE as an important tool to promote sustainability education. A major challenge for companies intending to externally communicate CE data was a perceived low market awareness and consumer acceptance of 'circular products' (Opferkuch et al., 2023). These results show the difficulties companies have in selecting what CE content (both qualitative and quantitative) to externally communicate when their audience does not understand the advantages of CE strategies compared with existing linear strategies. Third, by externally communicating CE activities and the results of CE assessments, companies felt that they were

improving their own reputations and enabling eligibility for CE-specific financial incentives. Following on from the publication of the EU Taxonomy (EC, 2020) a number of financial institutions and governmental organisations have developed a variety of financial instruments related to the CE, e.g. private and public equity funds, venture capital, as well as CE-specific adaptations to current bank lending, insurance and project financing procedures (Ellen MacArthur Foundation, 2020). Therefore, companies that are conducting CE assessments and disclosing the results can potentially receive necessary investments in order to continue and advance their CE implementation.

5.4.2 *Disclosing CE assessments in the private sector*

Looking forward, there are several factors that companies should keep in mind when selecting data from their CE assessments to be included within their corporate sustainability reports. Early evidence of a CE within corporate sustainability reports indicates that companies most often qualitatively describe their CE activities with an implicit connection to sustainability aspects and often unquantified indicators (Stewart and Niero, 2018; Opferkuch et al., 2022). Therefore, as proposed in Opferkuch et al. (2023), companies must find a balance between qualitative and quantitative CE data, tangible and intangible CE content, and short- and long-term CE visions. Through a content analysis of the sustainability reports of 94 sustainably ranked European companies, numerous shortcomings of current CE disclosure practices were identified (Opferkuch et al., 2022). Most often, companies were found to be reporting targets for the implementation of a CE that address higher-ranking CE strategies (as presented in Potting et al., 2017) such as targets which aim to eliminate and/or replace non-renewable resources within packaging. However, companies were rarely found to also report appropriate indicators which measure their progress towards achieving these targets. Most frequently, companies are reporting CE indicators which measure references to the linear economy, e.g. indicators showing the volume of waste being sent to landfill. Therefore, it is recommended that companies utilise the 10R-hierarchy, originally proposed by Potting et al. (2017) to develop targets and indicators for individual CE strategies, with the aim of disclosing higher-ranking strategies (where applicable).

Finally, companies should pay close attention to the various ongoing developments in regulations and policies relevant to corporate sustainability reporting and communication, namely the CSRD (EC, 2021), the EU Taxonomy Regulation (EC, 2021, 2020) and the recent Green Claims Directive (GCD) (EC, 2023). In particular, the latter development which aims to reduce instances of greenwashing within both product and organisational level environmental claims, including those concerned with CE attributes. Within the GCD, the EC will require companies to meet a list of predetermined criteria before externally communicating any sustainability claims. These criteria focus on factors such as substantiation, scientific rigour and comparability, to name but a few (EC, 2023). This regulation will undoubtedly influence the

choice of assessment approaches companies can use to collect, measure and verify the data needed for environmental claims in order to comply with this regulation. Although these regulations are imposed at a European level, they will lay the foundations for integrating a CE, and other sustainability issues, within national-level sustainable finance regulations in countries around the world. For example, the integration of a CE as a key material disclosure topic can be seen in countries such as South Africa, through the ‘National Green Finance Taxonomy’ (National Treasury of the Republic of South Africa, 2021) and the People’s Republic of China, within the ‘Green Bond Endorsed Project Catalogue’ (People’s Bank of China et al., 2021).

5.5 CE assessment in the public sector

To be able to design and prioritise circular policies and solutions that can contribute to sustainable development based on actual evidence, public sector organisations are starting to implement CE assessment initiatives and the topic is gaining attention in the literature (Corona et al., 2019; Droege et al., 2021a). The public sector assesses CE activities at different levels. At the macro level it assesses the progress and impact of CE policies. At the meso level, assessment initiatives emerge in circular supply chain management and circular public procurement (Xu et al., 2022). At the micro level, internal CE strategies and practices are assessed (Droege et al., 2021a). Due to the lack of a shared understanding and a standardised framework, a variety of CE measurement approaches exist in the public sector too, and the literature and practice are only starting to gain a deeper understanding of CE assessment.

5.5.1 Assessing the impact of CE regulations and policies

CE regulations and policies intend to address the multifaceted issue of resource availability concerns and sustainable development at the macro level. The complexity of sustainability and circularity issues carries the risk of leading to CE policies that are not effective or even desirable. Measuring the impact of regulations and policies is a first step to make outcomes and potential repercussions transparent and to ensure that strategies and activities follow the intentions of the policymaker/regulator.

There is a significant body of literature on CE policies and policy assessment in China and Europe (e.g. Geng et al., 2012, McDowall et al., 2017). China was one of the first countries to release an indicator framework to track the progress of its ‘Circular Economy Promotion Law’ (Geng et al., 2012). The Chinese government introduced a target responsibility system which ties individual performance of civil servants against targets derived for the five-year-plan. In addition, the Chinese government assesses several CE pilot programmes to measure and compare progress of the different pilots (McDowall et al., 2017). Articles analysing CE assessment implementation in China have been subject to multiple publications (e.g. Geng et al. 2012, 2013).

In Europe, indicators are used to inform the policy debate and targets are set for the EU member states (McDowall et al., 2017). The first CE Action Plan drawn up in 2015 (EC, 2015) refers to existing indicator sets such as the Resource Efficiency Scoreboard and the Raw Materials Scoreboard (McDowall et al., 2017). Later, the EU released its own assessment frameworks and outputs such as ‘EU Circular Economy Indicators’ or the ‘impact assessment of circular economy policies on the labour markets’ (Eurostat, 2019). These CE assessments in use are facing criticism in the literature because they fail to grasp the complexity of the multifaceted CE concept; some of them lack specific goals and benchmarks and are not transparent in their methodology (e.g. Geng et al., 2012; MacDowell et al., 2017). Researchers have also highlighted that the assessment of environmental and economic topics, particularly those that are the focus of the private sector, is challenging (e.g. Pauliuk, 2018; Roos Lindgreen et al., 2021). However, the assessment of CE policies often excludes the social dimension, which, as already mentioned, is even more complex and often is more subjective than the environmental and economic aspects.

5.5.2 Assessing circular public procurement

Public procurement is a fast-growing research field in the context of the CE. Procurement can help organisations and governments to achieve CE-related objectives connected to buying goods and services (Alhola et al., 2019). The United Nations Environment Programme (UNEP) states that

Circular procurement occurs when the buyer purchases products or services that follow the principles of the circular economy, supporting the assessment of designing, making, selling, reusing and recycling products to determine how to get the maximum value from them, both in use and at the end of their life

(UNEP, 2021)

Collaboration and transparency are key principles in public procurement activities as multiple parties are involved in the procurement procedures. Thus, CE assessments can play a central role by providing a standardised language to all parties involved leading to a more successful CE partnership (Ghisellini et al., 2020), while the lack of transparency and information is considered a key barrier to CE implementation (Kirchherr et al., 2018; Droege et al., 2021b). In a systematic review of the public procurement literature, Xu et al. (2022) found that a variety of assessment methodologies are adopted. LCA and eco-labels are widely implemented, and, for example, the EU procurement Directive 2014/24/EU is built upon it (Alhola et al., 2019). There are also procurement guidelines for emissions, packaging, environmental management systems and legal sourcing provided by public sector organisations at the supra-national, national, regional and local level (Kristensen et al., 2021).

5.5.3 Assessing CE in internal operations

Existing CE assessments for organisations focus on the private sector and little progress has been made towards CE assessments addressing public sector organisations. [Droege et al. \(2021c\)](#) co-developed a CE assessment framework for public sector organisations. In a participatory case study with Portuguese public sector organisations, they developed a CE assessment framework that covers the following components: (i) a system definition; (ii) a definition of CE assessment elements; (iii) CE assessment targets; and (iv) CE indicators. The system definition included public procurement, resources, processes and operations, as well as employee-related activities as important areas for CE assessment in public sector organisations. These areas were broken down further into 35 CE elements which were then detailed by allocating CE principles, a target as well as an indicator to assess the CE progress of each element.

The authors showed that public sector organisations encounter difficulties when considering non-sector-specific frameworks, as they include indicators that are not relevant for CE assessment of a service-based organisation and/or require very complex assessment methods that are not feasible to be executed by most public sector professionals ([Droege et al., 2021c](#)). It also highlights the importance of stakeholder involvement to get sector specific insights, incorporate user-friendliness and the requirement for continuous development of CE assessments ([Droege et al., 2021c](#)). Thus, the developed framework gives these organisations specific guidance on how to assess their specific CE progress.

5.6 Key learnings for CE assessment in both the private and public sectors

CE assessments need to be tailored to their context. What ‘CE performance’ is and how it should be addressed differs across sectors and organisations. However, cross-sector learning is very important to understand the experiences and innovative ideas which the public and private sectors can exchange with each other ([Xu et al., 2022](#)).

First, as circularity is a complex multifaceted issue, it is valuable to include experts and stakeholders in the development and execution of CE assessments. For example, depending on the thematic focus of the public sector organisation, it might lack technical and specialised staff with expert knowledge of the CE. Thus, including experts and stakeholders can bridge this knowledge gap. While this challenge might not apply to big private corporations or more technical organisations, small and medium-sized enterprises might encounter similar difficulties as they potentially also lack trained staff and the financial resources to implement complex assessments ([Droege et al., 2023](#)).

In addition, CE assessment in the private and public sectors still faces implementation challenges that need to be overcome. Bridging the findings from

the academic and grey literature with insights from practitioners can help to develop assessment approaches with low barriers for implementation. It can support the reduction of complexity and increase user-centricity, which improves user experience of CE assessments as the intended audience is directly addressed (Droege et al., 2023). Increased attention on shared learning between businesses, the public sector and academia will further improve the general understanding of needs and capabilities for assessment. Through such collaborations, assessment approaches that match business realities can be realised (Roos Lindgreen et al., 2022).

Currently, CE assessment is not yet widespread and research identified multiple challenges that prevent implementation. In the public sector, Droege et al. (2021b) identified challenges across four main factors (cultural, structural, financial and technical) that are interrelated and partly drive each other. The most pressing barriers for CE assessment implementation in the public sector are cultural factors, a lack of public and political pressure and a resistance to change. Cultural challenges drive structural ones such as a lack of leadership commitment, the voluntary nature and lack of governance for CE assessment. Technical and financial challenges, contrary to previous findings of the literature, are not prioritised and are seen as a result of the cultural and structural challenges.

For the private sector, barriers to CE assessment can be divided into internal and external barriers (Roos Lindgreen et al., 2022). The former include factors such as small company size, unclear use of CE assessments and the necessary acquisition of new skills by a business's employees. The latter contains barriers such as a lack of definition of what a CE means, complexity of the supply chain under assessment and a lack of standardisation of CE measurement.

5.7 Future research avenues

In line with these learnings, several suggestions for future research can be proposed. On the one hand, future research should focus on further adapting assessment approaches to a variety of different contexts, while on the other hand it should create knowledge to support companies in CIFNs and public sector organisations to actually implement these approaches.

It is recommended that the academic sector increases its focus on building knowledge that supports organisations on their pathway towards sustainability, acknowledging that assessing circularity in itself does not necessarily lead to insights into an organisation's sustainability impacts. This knowledge creation – and awareness – will strengthen the assessment capabilities of organisations to design assessment approaches that match company capabilities, while limiting the introduction of new methods to reduce so-called assessment fatigue. The design and application of assessment methods should be centred around both core as well as tailor-made indicators, thereby facilitating the comparability of performance and flexibility for context-specific aspects.

Overall, many organisations have already started to assess their circularity and sustainability impacts. Illuminating such best practices and sharing their lessons among organisations can demonstrate the efficacy of CE assessment and reporting practices, while also highlighting common pitfalls. Exchanging such information can facilitate the uptake of assessment methods, promoting the strategic change in organisations necessary to combat current sustainability challenges.

It is strongly recommended to incorporate both the environmental as well as social dimensions of sustainability when assessing CE impacts. At a methodological level, in comparison to environmental LCA, it is expected that S-LCA is inherently more socially embedded due to the integral value discussions that need to take place during the assessment (Kühnen and Hahn, 2018). Yet, given that several CE practices are novel, future research should explore their social implications in the sectors where these circular innovations are most prevalent. Moreover, scholars should aim to also include the ‘use phase’ of the product or service, which is mostly omitted from the social assessment scope (UNEP, 2020). Special attention should be attributed to the fact that organisations must not become more circular at the expense of adverse social impacts, given the relative simplicity of circularity assessments. This key insight is in contrast with the recent GCD, which pertains only to product and organisational claims of environmental performance, excluding any considerations of social sustainability impacts (EC, 2023). This provides an opportunity for academia to collect evidence which can advocate for the development of the necessary social-specific criteria within the GCD, not only to reduce instances of greenwashing within social-related claims but to actually encourage firms to communicate substantiated claims of social sustainability.

As the CE is being increasingly integrated within European and international sustainable finance policies (EC, 2020), studies should investigate the implications of CE implementation on existing risk identification and management processes. In particular, these implications should be connected to streams of research on sustainability trade-offs and due diligence processes. This will help to provide clarity on the assumption that circular practices are always sustainable.

Another potential research strand could focus on the role of strategic partners for implementing assessment methods in CIFNs, including partners within the network and external knowledge partners, to better understand the process of organisational learning.

Finally, the role of LCT-based assessment approaches itself can be more thoroughly analysed from a sociological perspective. Several scholars (e.g. Baitz et al., 2013; Freidberg, 2018; Niero et al., 2021; Pryshlakivsky and Searcy, 2021) have started to view the assessments as more than mere tools, and in fact as calculative devices with the power to convince other actors of the evidence-based superiority of a potential strategy. LCT assessment approaches have rightly been called the best methodologies available to evaluate sustainability aspects in a CE context. Yet to ensure their continued effectiveness and validity, it is crucial to also pay attention to how they are applied and talked about by practitioners.

5.8 Conclusions

The path towards circular processes and systems has recently taken on an increasingly important role, both for private sector companies and public organisations, and is often equated with a path towards sustainability. However, it has been highlighted that circular practices might not translate into improvements in all aspects of the various dimensions of sustainability (economic, social, environmental and institutional/governance). Hence, there is a need for adopting ad hoc assessments of the sustainability of each specific circular system before promoting its diffusion.

Therefore, alongside the approaches for measuring circularity as such, often based on technical indicators of efficiency of use and recovery of materials, it is necessary to adopt sustainability assessment methods that are based on the LCT, such as LCA and related methods. These are recognised as adopting holistic and multi-criteria approaches that allow users to avoid problem shifting from one aspect of sustainability to another, from one type of impact to another, and from one phase of the life cycle of a product or process to another.

These reliable and accurate methods are consolidated and are also well suited to the evaluation of circular systems in the context of inter-firm networks, as also revealed through a survey conducted among a sample of Italian and Dutch companies at the cutting edge of the implementation of circular practices. From this survey, it also emerged that social assessment is less widespread because of a lack of expertise and standards.

The adoption of LCT assessment approaches is also facilitated by the existence of relationships of mutual trust and collaboration between organisations in a supply chain or circular network. Although, on the one hand, these methods generally meet the various criteria identified for sound sustainability assessment, on the other hand they are particularly resource-requiring, and therefore are not always within the reach of any organisation. Precisely to encourage companies to adopt evaluation approaches for their CE strategies, a specific holistic and multidimensional SCEIA framework was developed (see [Chapter 4](#) in this volume).

LCT assessment should be embedded in local contexts by supporting them with sociological analyses, e.g. using the ANT to model end-of-life scenarios. Furthermore, LCT-based methods should be acknowledged as calculation devices in decision-making processes. It is essential to be transparent about their limitations, including the fact that they consider a predefined, albeit relatively broad, range of impact categories and the fact that they present elements of subjectivity linked to the modelling choices of practitioners.

Most of the proposed circularity assessment approaches are oriented towards internal uses in organisations, such as strategic improvement. Regarding the external communication of these results, the connection between CE assessment and corporate sustainability reporting is less studied. Recently there has been an evolving climate of CE disclosure due to increasing regulation in this area, especially at the European level. Furthermore, early evidence suggests that companies are experiencing a number of benefits when externally communicating their CE activities.

However, companies disclosing their CE activities in sustainability reports most often describe them qualitatively and do not make clear connections with sustainability. In other words, CE is often only implicitly linked to sustainability aspects, revealing an opportunity for reporting trends to improve. In addition, there is a need to educate consumers about the advantages and importance of the CE within an organisation's products and operations.

Alongside the private sector, the assessment of CE activities is also becoming increasingly popular in the public sector, where it can take place at the macro, meso and micro level. Specifically, as regards the micro level, unlike what happens in private companies, there are still too few tools to support public organisations. To overcome this gap, a specific and easy-to-implement evaluation framework has been developed by the Cresting project through a participatory approach. That framework, which considers various components, including the definition of the evaluation system and elements, the identification of CE targets and related indicators, can support public administration organisations on their journey towards circularity. However, even in this area, there is still a need to verify the sustainability of the circular solutions adopted, as well as the need to understand the relationship between CE assessment and sustainability assessment. Additionally, involving stakeholders to obtain a sector-specific perspective of CE assessment and addressing their views, knowledge and needs will contribute to a user-friendly and acceptable assessment. This collaborative involvement should be a fundamental pillar of the assessment initiatives.

Whatever the reference sector, circular systems are complex and highly context-dependent systems, which involve different actors and organisations. Furthermore, their relationship to sustainability aspects is not always obvious and clearly defined. We therefore need suitable approaches and methods to capture such complexity while assessing circularity and its impacts on sustainability. Those methods should, on the one hand, guarantee reliability and accuracy; however, on the other hand, they may require technical skills, human and financial resources, as well as an adequate cultural attitude, that are not always present in organisations.

It is therefore desirable to develop synergies, through collaboration among stakeholders, to demonstrate the effectiveness of these assessment and reporting practices, promoting their understanding, as well as for the development of simplified tools, while maintaining an adequate degree of reliability.

References

- Alghababsheh, M. and Gallear, D. (2020) Socially sustainable supply chain management and suppliers' social performance: The role of social capital. *Journal of Business Ethics*. <https://doi.org/10.1007/s10551-020-04525-1>
- Alhola, K., Ryding, S.O., Salmenperä, H. and Busch, N.J. (2019) Exploiting the potential of public procurement: opportunities for circular economy. *Journal of Industrial Ecology*, 23(1), 96–109. <https://doi.org/10.1111/jiec.12770>
- Baitz, M., Albrecht, S., Brauner, E., Broadbent, C., Castellan, G., Conrath, P., Fava, J., Finkbeiner, M., Fischer, M., Fullana i Palmer, P., Krinke, S., Leroy, C., Loebel, O.,

- McKeown, P., Mersiowsky, I., Möginger, B., Pfaadt, M., Rebitzer, G., Rother, E., ... Tikana, L. (2013) LCA's theory and practice: Like ebony and ivory living in perfect harmony? *The International Journal of Life Cycle Assessment*, 18(1). <https://doi.org/10.1007/s11367-012-0476-x>
- Batista, L., Bourlakis, M., Liu, Y., Smart, P. and Sohal, A. (2018) Supply chain operations for a circular economy. *Production Planning & Control*, 29(6), 419–424. <https://doi.org/10.1080/09537287.2018.1449267>
- Baumann, H. and Lindkvist, M. (2022) A sociomaterial conceptualization of flows in industrial ecology. *Journal of Industrial Ecology*, 26(2), 655–666. <https://doi.org/10.1111/jiec.13212>
- Bebbington, J., Larrinaga, C., O'Dwyer, B. and Thomson, I. (2021) *Routledge Handbook of Environmental Accounting*, Routledge.
- Blum, N., Haupt, M. and Bening, C.R. (2020) Why 'Circular' doesn't always mean 'Sustainable'. *Resources, Conservation and Recycling*, 162, 105042. <https://doi.org/10.1016/j.resconrec.2020.105042>
- Brammer, S. and Walker, H. (2011) Sustainable procurement in the public sector: An international comparative study. *International Journal of Operations & Production Management*, 31, 452–476.
- Brunner, P.H. and Rechberger, H. (2016) *Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers* (2nd edn), CRC Press.
- BSI (2017) BS 8001:2017. *Framework for Implementing the Principles of the Circular Economy in Organizations: Guide*. London: The British Standards Institution.
- Carter, C.R., Meschnig, G. and Kaufmann, L. (2015) Moving to the next level: Why our discipline needs more multilevel theorization. *Journal of Supply Chain Management*, 51(4). <https://doi.org/10.1111/jscm.12083>
- Chertow, M.R. (2000) Industrial symbiosis: Literature and taxonomy. *Annual Review of Energy and the Environment*, 25(1). <https://doi.org/10.1146/annurev.energy.25.1.313>
- Corona, B., Shen, L., Reike, D., Carreón, J.R. and Worrell, E. (2019) Towards sustainable development through the circular economy: A review and critical assessment on current circularity metrics. *Resources, Conservation & Recycling*, 151(May), 104498. <https://doi.org/10.1016/j.resconrec.2019.104498>
- Cortesi, A. and Vena, L. (2019) Disclosure quality under integrated reporting: A value relevance approach. *Journal of Cleaner Production*, 220, 745–755. <https://doi.org/10.1016/j.jclepro.2019.02.155>
- Das, A., Konietzko, J. and Bocken, N. (2021) How do companies measure and forecast environmental impacts when experimenting with circular business models? *Sustainable Production and Consumption*, 29, 273–285. <https://doi.org/10.1016/j.spc.2021.10.009>
- de Villiers, C. and Sharma, U. (2020) A critical reflection on the future of financial, intellectual capital, sustainability and integrated reporting. *Critical Perspectives on Accounting*, 70, 101999. <https://doi.org/10.1016/J.CPA.2017.05.003>
- Ditlev-Simonsen, C.D. and Midttun, A. (2010) What motivates managers to pursue corporate responsibility? *Corporate Social Responsibility and Environmental Management*, 38(18), 25–38. <https://doi.org/10.1002/csr.237>
- Domingues, A.R., Lozano, R., Ceulemans, K. and Ramos, T.B. (2017) Sustainability reporting in public sector organisations: Exploring the relation between the reporting process and organisational change management for sustainability. *Journal of Environmental Management*, 192, 292–301. <http://dx.doi.org/10.1016/j.jenvman.2017.01.074>
- Droege, H., Raggi, A. and Ramos, T.B. (2021a) A systematic review of CE assessment approaches for public sector organisations. In V. Mauerhofer (ed.), *Governance, Law and Sustainability*, London: Routledge, pp. 203–221. <https://doi.org/10.4324/9781003158837-17>
- Droege, H., Raggi, A. and Ramos, T.B. (2021b) Overcoming current challenges for circular economy assessment implementation in public sector organisations. *Sustainability* (Switzerland), 13(3), 1182. <https://doi.org/10.3390/su13031182>

- Droege, H., Raggi, A. and Ramos, T.B. (2021c) Co-development of a framework for circular economy assessment in organisations: Learnings from the public sector. *Corporate Social Responsibility and Environmental Management*, 28, 1715–1729. <https://doi.org/10.1002/csr.2140>
- Droege, H., Kirchherr J., Raggi, A. and Ramos T.B. (2023) Towards a circular disruption: On the pivotal role of CE policy entrepreneurs. *Business Strategy & the Environment*, 32(3), 1142–1158. <https://doi.org/10.1002/bse.309>
- EFRAG (2022) (Draft) *European Sustainability Reporting Standard E5 - Resource Use and Circular Economy*. <https://www.efrag.org/Assets/Download?assetUrl=%2Fsites%2Fwebpublishing%2Fsiteassets%2F12%2520Draft%2520ESRS%2520E5%2520Resource%2520use%2520and%2520circular%2520economy.pdf&AspxAutoDetectCookieSupport=1>
- Elia, V., Gnani, M.G. and Tornese, F. (2017) Measuring circular economy strategies through index methods: A critical analysis. *Journal of Cleaner Production*, 142, 2741–2751. <https://doi.org/10.1016/j.jclepro.2016.10.196>
- Ellen MacArthur Foundation (2013) *Towards the Circular Economy*, vol. 1: *An Economic and Business Rationale for an Accelerated Transition*, p. 96. <http://www.ellenmacarthurfoundation.org/publications>.
- Ellen MacArthur Foundation (2020) *Financing the Circular Economy*. <https://www.ellenmacarthurfoundation.org/assets/downloads/Financing-the-circular-economy.pdf>
- Ellen MacArthur Foundation and Granta (2015) *Circularity Indicators: Project Overview*. Ellen MacArthur Foundation. <https://emf.thirdlight.com/link/yybss1obhtdv-ub419h/@/preview/1?o> (accessed 7 July 2024)
- European Commission (EC) (2013) 2013/179/EU: Commission recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. *Official Journal of the European Union*, L 124(32013H0179). <http://data.europa.eu/eli/reco/2013/179/oj/eng>
- European Commission (EC) (2015) Closing the loop: An EU Action Plan for the Circular Economy. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0614> (accessed 20 July 2020)
- European Commission (EC) (2021) Proposal for a Directive of the European Parliament and of the Council amending Directive 2013/34/EU, Directive 2004/109/EC, Directive 2006/43/EC and Regulation (EU) No 537/2014, as regards corporate sustainability reporting (Issue COM(2021) 189 final). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021PC0189&from=EN>
- European Commission (EC) (2023) Proposal for a Directive on substantiation and communication of explicit environmental claims (Green Claims Directive) (COM/2023/166 final). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A0166%3AFIN>
- European Parliament and the Council (2020) Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088. *Official Journal of the European Union*, L 198 (32020R0852). <https://eur-lex.europa.eu/eli/reg/2020/852/oj>
- Eurostat (2019) Circular Economy Indicators. <https://ec.europa.eu/eurostat/web/circular-economy/overview> (accessed 2 July 2020)
- Eurostat (2021) Eurostat Government Expenditure by Function. [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_expenditure_by_function_%E2%80%93_COFOG#:~:text=In%202021%2C%20total%20government%20expenditure,gross%20domestic%20product%20\(GDP\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_expenditure_by_function_%E2%80%93_COFOG#:~:text=In%202021%2C%20total%20government%20expenditure,gross%20domestic%20product%20(GDP).). (accessed 7 October 2023)
- Farooque, M., Zhang, A., Thürer, M., Qu, T. and Huisingh, D. (2019) Circular supply chain management: A definition and structured literature review. *Journal of Cleaner Production*, 228, 882–900. <https://doi.org/10.1016/j.jclepro.2019.04.303>

- Ferasso, M., Beliaeva, T., Kraus, S., Clauss, T. and Ribeiro-Soriano, D. (2020) Circular economy business models: The state of research and avenues ahead. *Business Strategy and the Environment*, 29(8), 3006–3024. <https://doi.org/10.1002/bse.2554>
- Figge, F., Thorpe, A.S., Givry, P., Canning, L. and Franklin-Johnson, E. (2018) Longevity and circularity as indicators of eco-efficient resource use in the circular economy. *Ecological Economics*, 150, 297–306. <https://doi.org/10.1016/j.ecolecon.2018.04.030>
- Finkbeiner, M., Schau, E.M., Lehmann, A. and Traverso, M. (2010) Towards life cycle sustainability assessment. *Sustainability*, 2(10), 3309–3322. <https://doi.org/10.3390/su2103309>
- Freidberg, S. (2018). From behind the curtain: Talking about values in LCA. *The International Journal of Life Cycle Assessment*, 23(7). <https://doi.org/10.1007/s11367-015-0879-6>
- Gasparatos, A. (2010) Embedded value systems in sustainability assessment tools and their implications. *Journal of Environmental Management*, 91(8). <https://doi.org/10.1016/j.jenvman.2010.03.014>
- Gasparatos, A. and Scolobig, A. (2012) Choosing the most appropriate sustainability assessment tool. *Ecological Economics*, 80, 1–7. <https://doi.org/10.1016/j.ecolecon.2012.05.005>
- Geissdoerfer, M., Savaget, P., Bocken, N.M.P. and Hultink, E.J. (2017) The Circular Economy: A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
- Geng, Y., Fu, J., Sarkis, J. and Xue, B. (2012) Towards a national circular economy indicator system in China: An evaluation and critical analysis. *Journal of Cleaner Production*, 23, 216–224. <https://doi.org/10.1016/j.jclepro.2011.07.005>
- Geng, Y., Sarkis, J. and Ulgiati, S. (2013) Measuring China’s Circular Economy. *Science* 339, 1526–1527. DOI:10.1126/science.1227059
- Ghisellini, P., Cialani, C. and Ulgiati, S. (2016) A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114, 11–32. <https://doi.org/10.1016/j.jclepro.2015.09.007>
- Global Reporting Initiative (2018) Empowering small and medium enterprises: Recommendations for policy makers to enable sustainability corporate reporting for SMEs. <https://www.globalreporting.org/>
- Harris, S., Martin, M. and Diener, D. (2021) Circularity for circularity’s sake? Scoping review of assessment methods for environmental performance in the circular economy. *Sustainable Production and Consumption*, 26, 172–186. <https://doi.org/10.1016/j.spc.2020.09.018>
- Hoekstra, A.Y., Aldaya, M.M., Chapagain, A.K. and Mekonnen, M.M. (2011) *The Water Footprint Assessment Manual* (2nd edn). Earthscan.
- Hunkeler, D., Lichtenvort, K. and Rebitzer, G. (2008) *Environmental Life Cycle Costing*. CRC Press.
- ISO (2006a) ISO 14040:2006. Environmental management – Life cycle assessment – Principles and framework. <https://www.iso.org/standard/37456.html> (accessed 7 June 2021).
- ISO (2006b) ISO 14044:2006. Environmental management – Life cycle assessment – Requirements and guidelines. <https://www.iso.org/standard/38498.html> (accessed 7 June 2021).
- ISO (2020) ISO/TC 323 – Circular economy. <https://www.iso.org/cms/render/live/en/sites/isoorg/contents/data/committee/72/03/7203984.html>
- Kirchherr, J., Reike, D. and Hekkert, M. (2017) Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127(April), 221–232. <https://doi.org/10.1016/j.resconrec.2017.09.005>
- Klein, N., Ramos, T.B. and Deutz, P. (2020) Circular economy practices and strategies in public sector organizations: An integrative review. *Sustainability*, 12(10), 4181. <https://doi.org/10.3390/su12104181>

- Korhonen, J., Nuur, C., Feldmann, A. and Birkie, S.E. (2018) Circular economy as an essentially contested concept. *Journal of Cleaner Production*, 175, 544–552. <https://doi.org/10.1016/j.jclepro.2017.12.111>
- Kravchenko, M., Pigosso, D.C.A. and McAloone, T.C. (2019) Towards the ex-ante sustainability screening of circular economy initiatives in manufacturing companies: Consolidation of leading sustainability-related performance indicators. *Journal of Cleaner Production*, 241, 118318. <https://doi.org/10.1016/j.jclepro.2019.118318>
- Kravchenko, M., Pigosso, D.C.A. and McAloone, T.C. (2020) A procedure to support systematic selection of leading indicators for sustainability performance measurement of circular economy initiatives. *Sustainability*, 12(3), 951. <https://doi.org/10.3390/su12030951>
- Kristensen, H.S. and Mosgaard, M.A. (2020) A review of micro level indicators for a circular economy – moving away from the three dimensions of sustainability? *Journal of Cleaner Production*, 243, 118531. <https://doi.org/10.1016/j.jclepro.2019.118531>
- Kristensen, H. S., Mosgaard, M. A. and Remmen, A. (2021) Circular public procurement practices in Danish municipalities. *Journal of Cleaner Production*, 281, 124962. <https://doi.org/10.1016/j.jclepro.2020.124962>
- Kühnen, M. and Hahn, R. (2018) Systemic social performance measurement: Systematic literature review and explanations on the academic status quo from a product life-cycle perspective. *Journal of Cleaner Production*, 205, 690–705. <https://doi.org/10.1016/j.jclepro.2018.08.201>
- Kühnen, M. and Hahn, R. (2019) From SLCA to positive sustainability performance measurement: A two-tier Delphi study. *Journal of Industrial Ecology*, 23(3). <https://doi.org/10.1111/jieec.12762>
- Laubscher, M. and Marinelli, T. (2014) Integration of circular economy in business: Going green. *Care Innovation* (November), 1–6.
- Lock, I. and Seele, P. (2016) The credibility of CSR (corporate social responsibility) reports in Europe: Evidence from a quantitative content analysis in 11 countries. *Journal of Cleaner Production*, 122, 186–200. <https://doi.org/10.1016/j.jclepro.2016.02.060>
- Lonca, G., Muggèo, R., Imbeault-Tétreault, H., Bernard, S. and Margni, M. (2018) Does material circularity rhyme with environmental efficiency? Case studies on used tires. *Journal of Cleaner Production*, 183, 424–435. <https://doi.org/10.1016/j.jclepro.2018.02.108>
- Masi, D., Day, S. and Godsell, J. (2017) Supply chain configurations in the circular economy: A systematic literature review. *Sustainability*, 9(9). <https://doi.org/10.3390/su9091602>
- McDowall, W., Geng, Y., Huang, B., Bartekov, E., Bleischwitz, R., Türkeli, S., Kemp, R. and Doménech, T. (2017) Circular economy policies in China and Europe. *Journal of Industrial Ecology*, 21(3), 651–661. <https://doi.org/10.1111/jieec.12597>
- Melloni, G., Caglio, A. and Perego, P. (2017) Saying more with less? Disclosure conciseness, completeness and balance in integrated reports. *Journal of Accounting and Public Policy*, 36(3), 220–238. <https://doi.org/10.1016/j.jaccpubpol.2017.03.001>
- Moraga, G., Huysveld, S., Mathieux, F., Blengini, G. A., Alaerts, L., Van Acker, K., de Meester, S. and Dewulf, J. (2019) Circular economy indicators: What do they measure? Resources, Conservation and Recycling, 146, 452–461. <https://doi.org/10.1016/j.resconrec.2019.03.045>
- Muñoz-Torres, M.J., Fernández-Izquierdo, M.Á., Rivera-Lirio, J.M., Ferrero-Ferrero, I., Escrig-Olmedo, E., Gisbert-Navarro, J.V. and Marullo, M.C. (2018) An assessment tool to integrate sustainability principles into the global supply chain. *Sustainability*, 10(2). <https://doi.org/10.3390/su10020535>
- National Treasury of the Republic of South Africa (2021) Draft: Green Finance Taxonomy of South Africa (June).
- Niero, M., Jensen, C.L., Fratini, C.F., Dorland, J., Jørgensen, M.S. and Georg, S. (2021) Is life cycle assessment enough to address unintended side effects from Circular Economy initiatives? *Journal of Industrial Ecology*, 25(5), 1111–1120. <https://doi.org/10.1111/jieec.13134>

- Niero, M., and Rivera, X. C. S. (2018) The role of life cycle sustainability assessment in the implementation of circular economy principles in organizations. *Procedia CIRP*, 69, 793–798. <https://doi.org/10.1016/j.procir.2017.11.022>
- Oliveira, C.T. de, Eduardo, T., Dantas, T. and Soares, S.R. (2021) Nano and micro level circular economy indicators: Assisting decision-makers in circularity assessments. *Sustainable Production and Consumption*, 26, 455–468. <https://doi.org/10.1016/j.spc.2020.11.024>
- Oliveira, M., Miguel, M., van Langen, S.K., Ncube, A., Zucaro, A., Fiorentino, G., Passaro, R., Santagata, R., Coleman, N., Lowe, B.H., Ulgiati, S. and Genovese, A. (2021) Circular economy and the transition to a sustainable society: Integrated assessment methods for a new paradigm. *Circular Economy and Sustainability*, 1, 99–113. <https://doi.org/10.1007/s43615-021-00019-y>
- Opferkuch, K., Caeiro, S., Salomone, R. and Ramos, T.B. (2021) Circular economy in corporate sustainability reporting: A review of organisational approaches. *Business Strategy and the Environment*, 30(8), 4015–4036. <https://doi.org/10.1002/bse.2854>
- Opferkuch, K., Caeiro, S., Salomone, R. and Ramos, T.B. (2022) Circular economy disclosure in corporate sustainability reports: The case of European companies in sustainability rankings. *Sustainable Production and Consumption*, 32, 436–456. <https://doi.org/10.1016/j.spc.2022.05.003>
- Opferkuch K., Walker, A.M., Roos Lindgreen, E., Caeiro, S., Salomone, R. and Ramos, T.B. (2023) Towards a framework for corporate disclosure of circular economy: Company perspectives and recommendations. *Corporate Social Responsibility and Environmental Management*, 30(5), 2457–2474.
- Organisation for Economic Co-operation and Development (OECD) (2019) Government at a glance. OECD Statistics. <https://stats.oecd.org/Index.aspx?QueryId=94403> (accessed 26 February 2020)
- Panchal, R., Singh, A. and Diwan, H. (2021) Does circular economy performance lead to sustainable development?: A systematic literature review. *Journal of Environmental Management*, 293, 112811. <https://doi.org/10.1016/j.jenvman.2021.112811>
- Parchomenko, A., Nelen, D., Gillabel, J. and Rechberger, H. (2019) Measuring the circular economy: A Multiple Correspondence Analysis of 63 metrics. *Journal of Cleaner Production*, 210, 200–216. <https://doi.org/10.1016/j.jclepro.2018.10.357>
- Pauliuk, S. (2018) Critical appraisal of the circular economy standard BS 8001:2017 and a dashboard of quantitative system indicators for its implementation in organizations. *Resources, Conservation and Recycling*, 129, 81–92. <https://doi.org/10.1016/j.resconrec.2017.10.019>
- People's Bank of China, National Development and Reform Commission, and China Securities Regulatory Commission (2021) Notice on Issuing the Green Bond Endorsed Projects Catalogue (2021 Edition). 96, 1–64. <https://www.climatebonds.net/files/files/the-Green-Bond-Endorsed-Project-Catalogue-2021-Edition-110521.pdf>
- Potting, J., Hekkert, M., Worrell, E. and Hanemaaijer, A. (2017) Circular economy: Measuring innovation in the product chain. PBL Netherlands Environmental Assessment Agency, 42.
- Pryshlakivsky, J. and Searcy, C. (2021) Life Cycle Assessment as a decision-making tool: Practitioner and managerial considerations. *Journal of Cleaner Production*, 309, 127344. <https://doi.org/10.1016/j.jclepro.2021.127344>
- Roos Lindgreen, E., Salomone, R. and Reyes, T. (2020) A critical review of academic approaches, methods and tools to assess circular economy at the micro level. *Sustainability (Switzerland)*, 12(12), 4973. <https://doi.org/10.3390/su12124973>
- Roos Lindgreen, E., Salomone, R. and Reyes, T. (2021) Assessing Circular Economy at the company level: Proposal of an ex-ante evaluation framework. International Sustainable Development Research Society Conference, July, 13–15.

- Roos Lindgreen, E., Opferkuch, K., Walker, A.M., Salomone, R., Reyes, T., Raggi, A., Simboli, A., Vermeulen, W.J.V. and Caeiro, S. (2022) Exploring assessment practices of companies actively engaged with circular economy. *Business Strategy and the Environment*, 31(4), 1414–1438. <https://doi.org/10.1002/bse.2962>
- Rosenbaum, E., Vasta, A. and Dewulf, J. (2015) Who and why: The reason for conducting a social impact assessment – Business, Policy and NGO perspectives on S-LCA. In S. Sala, A. Vasta, L. Mancini, J. Dewulf and E. Rosenbaum (eds), *Social Life Cycle Assessment: State of the Art and Challenges for Supporting Product Policies*. Joint Research Centre, Institute for Environment and Sustainability, pp. 14–26. <https://core.ac.uk/reader/91286680>
- Saidani, M., Yannou, B., Leroy, Y., Cluzel, F. and Kendall, A. (2019) A taxonomy of circular economy indicators. *Journal of Cleaner Production*, 207, 542–559. <https://doi.org/10.1016/j.jclepro.2018.10.014>
- Schroeder, P., Anggraeni, K., and Weber, U. (2019) The relevance of circular economy practices to the sustainable development goals. *Journal of Industrial Ecology*, 23(1), 77–95. <https://doi.org/10.1111/jiec.12732>
- Stewart, R. and Niero, M. (2018) Circular economy in corporate sustainability strategies: A review of corporate sustainability reports in the fast-moving consumer goods sector. *Business Strategy and the Environment*, 27(7), 1005–1022. <https://doi.org/10.1002/bse.2048>
- Thijssens, T., Bollen, L. and Hassink, H. (2016) Managing sustainability reporting: Many ways to publish exemplary reports. *Journal of Cleaner Production*, 136, 86–101. <https://doi.org/10.1016/j.jclepro.2016.01.098>
- United Nations Environment Programme (UNEP) (2020) Guidelines for social life cycle assessment of products and organisations 2020. <https://www.lifecycleinitiative.org/library/guidelines-for-social-life-cycle-assessment-of-products-and-organisations-2020/>
- Vanegas, P., Peeters, J.R., Cattrysse, D., Tecchio, P., Ardente, F., Mathieux, F., Dewulf, W. and Duflo, J.R. (2018) Ease of disassembly of products to support circular economy strategies. *Resources, Conservation & Recycling*, 135, 323–334. <https://doi.org/10.1016/j.resconrec.2017.06.022>
- Vinante, C., Sacco, P., Orzes, G. and Borgianni, Y. (2021) Circular economy metrics: Literature review and company-level classification framework. *Journal of Cleaner Production*, 288, 125090. <https://doi.org/10.1016/j.jclepro.2020.125090>
- Wackernagel, M. and Beyers, B. (2019) *Ecological Footprint: Managing Our Biocapacity Budget*. New Society Publishers. <https://newsociety.com/products/9780865719118>
- Walker, A.M., Vermeulen, W.J.V., Simboli, A. and Raggi, A. (2021) Sustainability assessment in circular inter-firm networks: An integrated framework of industrial ecology and circular supply chain management approaches. *Journal of Cleaner Production*, 286, 125457. <https://doi.org/10.1016/j.jclepro.2020.125457>
- Walker, A.M., Opferkuch, K., Roos Lindgreen, E., Simboli, A., Vermeulen, W.J.V. and Raggi, A. (2022) Assessing sustainability across circular inter-firm networks: Insights from academia and practice. In M. Wojnarowska, M. Ćwiklicki and C. Ingrao (eds), *Sustainable Products in the Circular Economy: Impact on Business and Society*. Routledge, pp. 154–171. <https://doi.org/10.4324/9781003179788-10>
- Walzberg, J., Lonca, G., Hanes, R.J. and Eberle, A.L. (2021) Do we need a new sustainability assessment method for the circular economy? A critical literature review. *Frontiers in Sustainability*, 1, 1–20. <https://doi.org/10.3389/frsus.2020.620047>
- World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) (2004) *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (rev. edn). World Resources Institute and World Business Council for Sustainable Development. https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf (Accessed 7 July 2024)

- World Business Council for Sustainable Development (WBCSD) (2018) *Circular Metrics - Landscape Analysis*. <https://www.wbcsd.org/Programs/Circular-Economy/Metrics-Measurement/Resources/Landscape-analysis>
- World Business Council for Sustainable Development (WBCSD) (2019) *Reporting Matters*. <https://www.wbcsd.org/resources/reporting-matters-2019/> (Accessed 7 July 2024)
- Weber, M. (2008) *Economy and Society: An Outline of Interpretive Sociology*, vol. 2. Wiley, pp. 24–37.
- Xu, L., Jia, F., Yan, F. and Chen, L. (2022) Circular procurement: A systematic literature review. *Journal of Cleaner Production*, 365, 132845. <https://doi.org/10.1016/j.jclepro.2022.132845>
- Zinck, S., Ayed, A.-C., Niero, M., Head, M., Wellmer, F.-W., Scholz, R.W. and Morel, S. (2018) Life cycle management approaches to support circular economy. In E. Benetto, K. Gericke and M. Guiton (eds), *Designing Sustainable Technologies, Products and Policies: From Science to Innovation*. Springer International Publishing, pp. 3–9. https://doi.org/10.1007/978-3-319-66981-6_1