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Towards radical circular economy futures: addressing social relations of production

Abstract:

The mainstream narrative associated with the transition to a circular economy is one linked to eco-modernism: paradigmatic change is depicted as an apolitical and technical matter that is fully compatible with growth-led and market-based capitalist logic. As a result of the dominance of this viewpoint, the socio-political foundations of the transition to the circular economy have largely gone unquestioned. This is particularly pronounced regarding how variations in the social relations of production could shape the transition to alternative and more radical futures. This paper aims to address this knowledge gap by incorporating social relations of production into the analysis of circular economy futures. In doing so, a set of nine future circular scenarios is developed by drawing on a typology of five conceptual dimensions that include ownership of the means of production and access to the resulting goods. The typology and the circular scenarios are then validated by a three-part Delphi-like approach. It is argued that the proposed set of scenarios allows a more nuanced understanding of circular economy futures than previous contributions as they provide further insights about key actors and forces of change that could drive the transition to a sustainable society beyond neoliberal capitalism.

Keywords: Circular economy; Foresight; Scenario planning; Sustainable development; Sustainability transitions.

Abbreviations: Autarkic Fortress Circularity, AFC; Circular economy, CE; Convivial Eco-Socialism Circularity, CEC; Free-market Insufficiency Circularity, FIC; Information and communication technology, ICT; Landlord Fortress Circularity, LFC; Multinational Enterprise-led Modernist Circularity, MMC; Open-access Peer-to-peer Circularity, OP2C; Platform Peer-to-peer Circularity, PP2PC; Scenario Exploration System, SES; State-led Modernist Circularity, SMC; Welfare State Modernist Circularity, WSMC.

1. Introduction

The general understanding of a circular economy (CE) is that it involves a shift towards a sustainable and waste-free production and consumption paradigm (Lazarevic & Valve, 2017). Within this mainstream view, whilst the principal features of a CE are contested with several different interpretations (Kirchherr *et al.*, 2017; Korhonen *et al.*, 2018), broadly, the transformations required tend to be depicted as both a voluntarist and technical matter: the necessary change is expected to be addressed by the implementation of innovative eco-efficient technologies and incremental modifications in people´s behaviour as consumers, within the same growth-led market-based economic system (Hobson & Lynch, 2016; Corvellec *et al.*, 2021).

However, given that the idea of a transition towards a CE is profoundly influencing the development strategies that will be pursued in the coming decades in many regions of the world, including the European Union, there is a need to go beyond this limited conception of circularity and investigate the underlying socio-political requirements, implications and consequences of what could be a far-reaching economic paradigm change. To date, this requirement has largely been overlooked (Llorente-González & Vence, 2020; Genovese & Pansera, 2021; Lowe & Genovese, 2022), with only a few studies beginning to engage with this issue, either by exploring a set of plausible circular future scenarios (Bauwens *et al.*, 2020), developing alternative future images of sustainability/circularity for a specific territory (Svenfelt *et al.*, 2019; Fauré *et al.*, 2019; Marjamaa & Mäkelä, 2022) or conceptualising future institutional configurations (Frenken, 2017).

Whilst these first conceptual exercises undoubtedly provide valuable insights on the expected shape of possible future circular scenarios, they nonetheless still largely build upon broad trends within the current market capitalist economy; deeper insights, in particular regarding the potential role for the social relations of production in shaping the transition to alternative futures, have not yet been fully considered (Lowe & Genovese, 2022). As a result, existing images of the future do not clearly portray the ecological and social contradictions inherent within the capitalist growth imperative. Indeed, the fundamental social transformations (and conflicts) that might be required to deliver more radical sufficiency-based futures remain unaddressed.

Therefore, this paper has been developed with the aim of contributing to the emergent discussion on future visions of CE by exploring some of these fundamental socio-political transformations, together with the actors and institutions that conduct the resulting forces of change. More specifically, in what follows, this work has three aims:

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1. To develop a new typology (or framework), consisting of multiple conceptual dimensions (or axes), that together seek to capture key socio-political transformations associated with different hypothetical configurations of the CE, including transformations in the social relations of production.
2. To operationalise this typology by deriving a set of alternative circular futures (henceforth "futures," "configurations" or "scenarios" are used interchangeably). As will be discussed, the set of futures are not meant to be comprehensive, mutually exclusive or normative: they represent plausible, internally coherent but extreme cases along the continuums offered by the five axes.
3. To validate the typology and uncover the *plausibility* and *preferability* of the scenarios identified using a three-part Delphi-like approach drawing on up to 21 multidisciplinary CE experts and including: (a) a structured conversation, (b) an anonymous controlled survey and, (c) an interactive workshop.

The final set of scenarios extends previous work by revealing the actors and forces of change involved in the process of an *active transition* to circularity and one that could move the discussion on from the 'end of history' narrative that dominates the existing CE literature. The paper also highlights the performative potential that scenarios represent: this gives the scenarios developed here relevance beyond simply technical considerations that are too often the sole focus of CE literature, to include the fundamental structural questions that society *as a whole* must grapple with as a prerequisite. Nonetheless, the scenarios also illustrate that there is potential for the CE to be corrupted and fail in its goal of achieving positive change.

The paper is organised as follows. Section 2 presents the literature on future studies, with a particular emphasis on future CE scenarios. Section 3 details the methodology employed to derive the five conceptual axes that articulate the set of alternative circular futures, how the narratives for these futures were constructed, and the Delphi-like approach that is used to validate the typology and futures. The futures are then described in Section 4. In Section 5, the feedback from CE experts emerging from the Delphi-like approach is presented. Finally, Section 6 discusses the scenarios developed and the feedback from CE experts. Section 7 concludes, provides avenues for future research, and limitations.

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2. Background

2.1. Future studies

Future studies are gaining increasing prominence in the academic literature (Beckert, 2016; Urry, 2016; Bell, 2017; Andersson, 2018; Beckert & Bronk, 2018). This growing attention is rooted in the increasing concern about ever more frequent environmental crises (Buell, 2009; Walker, 2017; Hickey-Moody *et al.*, 2021). The focus on imagined futures has developed from many fields, including history (Andersson, 2018), anthropology (Appadurai, 1996; Hastrup, 2013; Bryant & Knight, 2019) and sociology (Adam & Groves, 2011; Urry, 2016; Tutton, 2017), among others. The main aim of these studies is to understand how the future can be imagined, constructed, and transformed in a way that shapes present societal action (Oomen *et al.*, 2021). Therefore, this field does not seek to predict the future but to facilitate the formulation, implementation, and re-envisioning of socially desired futures (Dator, 2019). Indeed, images of the future are socially performative, as they shape social practices and the performance of reality, and therefore have the ability to influence future outcomes (Mangnus *et al.*, 2021; Oomen *et al.*, 2021).

One of the most frequent methods of imagining the future is the construction of scenarios (Börjeson *et al.*, 2006; Lord *et al.*, 2016). Huss (1988) defines the scenarios as narratives that describe a consistent set of factors, which depict alternative sets of plausible future conditions. This approach addresses the weaknesses of extrapolative forecasts by including qualitative variables, predicting turning points, and connecting traditional forecasting with decision-making, with the aim of predicting potential future events and supporting the planning and the decision-making process (Huss, 1988; Schoemaker, 1993; Lempert & Groves, 2010; Kok *et al.*, 2011; Vervoort *et al.*, 2014).

One of the main characteristics of the use of scenarios in future studies is their focus on the interrelationships between technological developments and political, social and cultural changes (Bell, 2017). This reflects the fact that scenario narratives tend to adopt a more politically active approach and have the potential to open up the construction of social imaginaries to a wider public, involving stakeholders and reshaping public priorities and the long-term visions embedded within public policy (Mangnus *et al.*, 2021; Oomen *et al.*, 2021).

2.2. Future studies and their relevance to circular economy

There is currently scant literature devoted to the conceptualisation and theorisation of the future in the field of circular economy and neighbouring disciplines such as ecological economics and industrial ecology (Goodwin, 1994; Jansson, 2013; Bartolini & Sarracino, 2018; Belmonte-Ureña *et al.*, 2021). This is despite the fact that imagining new models of development to create harmony between humankind and

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the natural environment (of which humankind is part) is crucial to the basic principles of these fields of knowledge (Jansson, 2013). The existing literature focuses mainly on describing the unsustainable nature of the 'business-as-usual' future scenario (Hagens, 2020) and the potential of new ideas such as the CE, green growth, degrowth, and sufficiency (Belmonte-Ureña *et al.*, 2021; Jungell-Michelsson & Heikkurinen, 2022).

Although it has been more than a decade since the start of the discussion around the CE and its implications, only a few studies have tried to frame the variety of future scenarios that could arise from the implementation of CE initiatives, or, tried to understand how circular imaginaries can influence institutional discourses and their propagation (e.g., Rodríguez *et al.*, 2019; Bauwens *et al.*, 2020; Hermann *et al.*, 2022; Lowe & Genovese, 2022; Luoma *et al.*, 2022). However, several of these focus on the microeconomic level of transition towards the CE and very few discuss the fundamental reforms that could enable the CE transition (Bauwens *et al.*, 2020).

Among the literature that discusses future scenarios for the transition towards the CE, a few contributions stand out and lead the discourse: Bauwens *et al.* (2020), Calisto Friant *et al.* (2020, 2021), Fauré *et al.* (2019), and Svenfelt *et al.* (2019). While valuable insights can be found in all of these approaches, the study conducted by Bauwens *et al.* (2020) offers a particularly fertile ground for conceptual discussion, as it introduces a classification framework based on theoretical dimensions or axes that are employed to derive alternative extreme cases of future scenarios. The selected dimensions are *governance* and *nature of technologies deployed*, leading to a square two-by-two matrix containing four alternative CE futures, namely: planned circularity (combining centralised governance and a preference for low-tech innovations); circular modernism (resulting from a centralised governance approach, and the prevalence of high-tech innovations); bottom-up sufficiency (exhibiting decentralised governance mechanisms and convivial low-tech innovations); and peer-to-peer circularity (based on decentralised governance within a scenario of thriving high-tech innovations) (Bauwens *et al.*, 2020).

While the two dimensions selected by Bauwens *et al.* (2020) can indeed play a decisive role and the futures described are analytically interesting, some relevant factors are overlooked in this approach. As pointed out by Lowe and Genovese (2022), this framework does not shed light on the role played by the *relations of production* in shaping alternative futures. As such, Bauwens *et al.*'s (2020) classification assumes the current market capitalist economic structure as an immutable status quo within which a transition to a CE should happen. Thus, the futures depicted seem to buy into the "end of history" narrative (Fukuyama, 1992): whatever circular future we might have, it will be within the boundaries of a capitalist "liberal-democracy."

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Consequently, the framework proposed by Bauwens *et al.* (2020) leads to some debatable results. For instance, it does not offer a clear conceptual criterion to discriminate between high-tech CE scenarios in which decisions are centralised by multinational and large businesses, from those that are led by the state. Instead, all cases in which central state planning is determinant are considered to be based solely on coercion while no relevant role is given to high-tech innovation, thus making it difficult for the authors to assign a case as significant as China to one of the scenarios. The "planned circularity" scenario depicted by Bauwens *et al.* (2020) seems to better correspond to what Calisto Friant *et al.* (2020) described as a "fortress circularity" narrative or discourse, characterised by a top-down imposition of resource efficiency, using a framing of scarcity to promote resource and population controls. Although departing from similar ideas, the notion of a "fortress circularity" future has two main conceptual advantages over that of a "planned circularity". First, it does not need to rely on the debatable assumption that high-tech innovations would not also be a priority within a centrally planned version of circularity. Secondly, the notion of "fortress circularity" explicitly acknowledges the fact that top-down authoritarian governance can be carried out both by the state and by the action of large corporations (something especially evident in the global south) (Calisto Friant *et al.*, 2020).

Another shortcoming of the classification by Bauwens et al (2020) is the lack of a clear conceptual distinction that allows differentiation between a future characterised by a citizen-based sharing economy from what has been described as a "platform capitalism" (Frenken, 2017; Lowe & Genovese, 2022), i.e. a future in which digital innovations are co-opted and controlled by large multinational firms. Although the authors recognise this issue, it is not clear how a collaborative alternative to the platform scenario can be conceptually derived without incorporating into the analysis the logical requirement of a complete transformation in the social relations of production, involving radical changes in the ownership of knowledge and the means of production. In the same vein, the scenario referred to as "bottom-up sufficiency" lacks a historical and practical sense of the transformations required in the relations of production and this is therefore overlooked in the theoretical framework. The proposals from Fauré *et al.* (2019) and Svenfelt *et al.* (2019), albeit not specifically developed with CE in mind, but referring to "sustainable" futures in general, seem to adopt a more general view that remedies some of these conceptual limitations. Indeed, these classification frameworks, while recognising the roles of governance and technology, do include additional dimensions. Notably, these additional dimensions include ownership and property rights (collective vs individual), and the organisation/scale of production systems (large-scale industrial operations vs small-scale localised production) also plays a prominent role.

Given the relevance of the Bauwens *et al.* (2020) framework, and its limitations, this source became the starting point of a structured literature review process, which is described in the following section. The aim of this process was to explore and define relevant dimensions for inclusion in our typology, in order

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to operationalise a set of CE futures and guide the participatory exercise conducted through a Delphi-like approach.

3. Methodology

This section introduces the components of the methodology in the order in which they occurred. As such, the development of the typology is described first, followed by the procedure used to construct each scenario, and then the Delphi-like expert consultation process used to validate both the typology and scenarios. Figure 1 provides a visual overview of the methodology adopted, showing how each of these three steps ultimately fed into the construction of the scenarios and narratives that will be presented in Section 4.

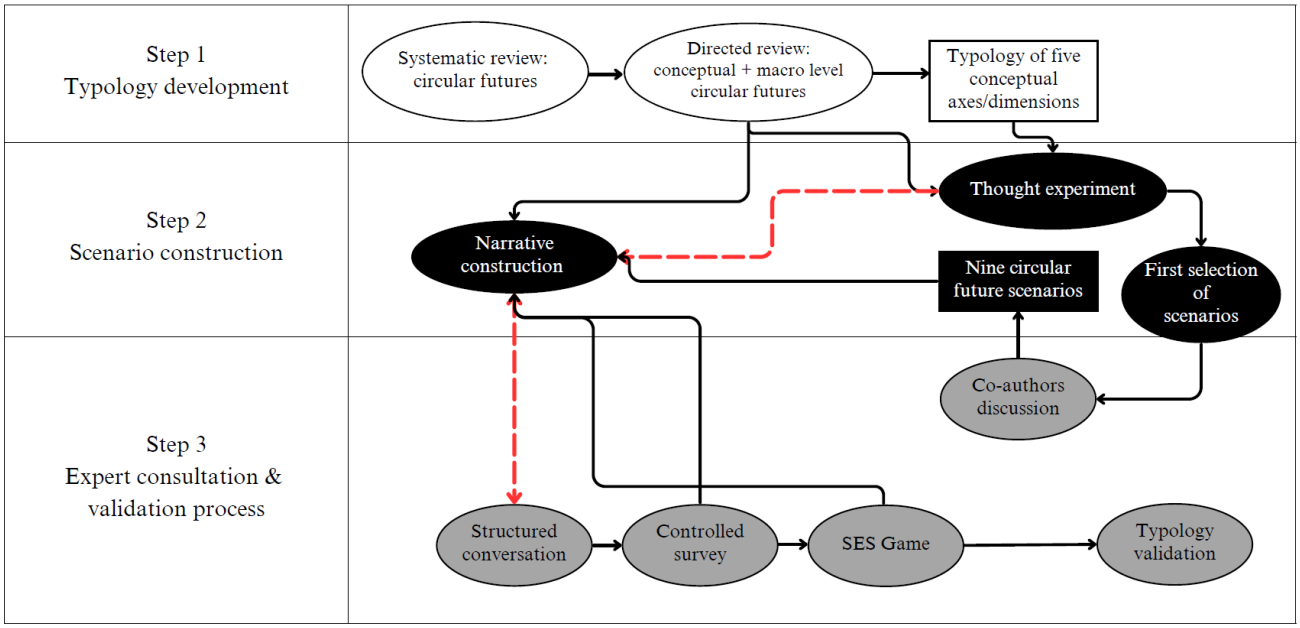

Figure 1. Overview of methodology employed to construct and validate the typology and circular future scenarios (and associated narratives). Note: oval shapes represent processes; rectangles represent outputs. White shapes are typology development; black shapes are scenario construction; grey shapes refer to the Delphi-like validation exercise (n.b. co-author discussion was part of Step 2 but also formed part of the validation process). Solid lines represent one-way interactions; dotted lines indicate feedback loops.

3.1. Step one: Typology development

A comprehensive literature review was conducted using the Scopus database, together with the keywords "Circular Economy" and "Future* AND/OR Scenario*". More than 1400 abstracts were reviewed, and from this, 40 peer-reviewed papers were identified that were relevant to the subject, as they focused on the conceptual analysis of future circular scenarios (and did not merely contain the words "future" or "scenarios" in other contexts) (Appendix 1). The initial aim was to understand several features of these studies, including overall goals, timeframe, economic and geographical scope, focus of the

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204 scenarios (exploratory, predictive, experimental, normative), methodology, conceptual axes used to build
205 the scenarios, and finally, the future scenarios identified.

206 The majority of the literature reviewed focused on specific economic sectors or strategic materials
207 to which circular strategies were to be applied. For example, Dong et al (2020) explored how China's
208 copper demand could be met in the upcoming century by considering a new policy called "Green Fence,"
209 and introduced scenarios and analysis using a quantitative predictive method. In the same vein, Istrate *et*
210 *al.* (2021) focused on energy recovery from municipal solid waste in Spain and introduced possible
211 scenarios that could arise by 2030. Although these types of studies provide interesting insights into the
212 empirical applications of the future scenarios methodology, priority was given to those works exploring
213 circular futures conceptually *and* at the macroeconomic level.

214 With this in mind, to build the typology that we go on now to discuss, the work of four authors
215 was most relevant: Svenfelt *et al.* (2019), Bauwens *et al.* (2020), Calisto Friant *et al.* (2020) and Fauré *et al.*
216 (2019). Based on these sources, the following relevant axes were identified with the aim of going on to
217 differentiate hypothetical futures and building the narratives associated with these:

218 1. Nature of innovation and technology (ranging from convivial technologies to large-scale
219 industrial technologies);
220 2. Governance (ranging from very decentralised to very centralised);
221 3. Organisation/scale of production (ranging from very large global scale to very small local
222 scale);

223 However, in line with Lowe and Genovese (2022), two additional conceptual axes were also considered:

224 4. Access to final goods and services (ranging from universal or inclusive to access based on
225 competitive markets);
226 5. Ownership/control of means of production (ranging from predominantly collective to
227 predominantly private).

228 Axes one and two correspond closely to those proposed by Bauwens *et al.* (2020)[1]. The main
229 difference in the axes presented here is that, in the dimension regarding the nature of the innovations
230 deployed, the focus is less on the level of technological complexity than on the convivial or industrial

[1] Bauwens *et al.* (2020, p.5) utilised the following definitions: (1) High-tech innovations - "...advanced and complex technologies characterized by high R&D intensity and high knowledge transfer costs" (2) Low-tech innovations - Those "...designed to be as simple as possible, characterized by low R&D investment and low knowledge transfer costs" (3) Centralised governance - A configuration of institutions resulting in "...concentration of political and economic power and responsibilities into the hand of national governments and large corporations" (4) Decentralised governance - That in which there is an "...expansion of local political and economic autonomy through the transfer of powers and responsibilities away from large national political and administrative bodies and large corporations."

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231 character of the technologies. We refer to convivial technologies as those socio-technical innovations that
232 comply with the following five main characteristics (see Genovese and Pansera, 2021): *relatedness*
233 (promotion of human relationships); *accessibility* (free and open-access); *adaptability* (independent usage);
234 *bio-interaction* (useful to ecological cycles); and *appropriateness* (contextual and dependent on local
235 knowledge).

236 Axis three seeks to reflect the essential difference between a CE characterised by the further
237 extension of economies of scale and global value chains, on the one hand, and a CE based on the principle
238 of proximity and the development of local capacities (Gallaud & Laperche, 2016), on the other.

239 The fourth and fifth axes incorporate two conceptual dimensions concerning *ownership of the means*
240 *of production* and access to the resulting products. These key socio-economic dimensions have different
241 implications for how the output of the productive process is socially distributed and on the underlying
242 configuration of the relations of production. The fourth axis, *access to final goods*, captures the degree of
243 universality or inclusivity in consumption patterns. The highest degree of inclusivity may occur either
244 through extended civil association in consumer cooperatives or through generalised state ownership and
245 provision of goods. In addition, however, inclusivity is also increasingly facilitated by the diffusion of
246 technologies that enable the collectivisation of both knowledge and the means of production. The
247 opposite case entails the predominance of individual private ownership of consumer goods, which implies
248 that the market is the prevailing mechanism for the distribution of social output. European welfare states
249 of the 1950-1970s can be seen as an intermediate case between market and community-mediated access,
250 whereas the Washington Consensus model of minimal state (Chang, 2002; Mazzucato, 2013) could be
251 considered an example of predominant market access.

252 The fifth axis refers to the *ownership and control over the means of production*, and ranges from being
253 predominantly collective to individual/private. By means of production, we understand all the raw
254 materials, instruments, machines, technologies and knowledge applied in the productive process (Marx,
255 1973). Private ownership and control of the means of production is, together with extended
256 commodification of labour, one of the main features of the capitalist mode of production (Marx, 1992).
257 The associated relations of production are those of exploitation based on the power imbalance between
258 the owners of the means of production and the wage labour force. Therefore, the fifth axis can be
259 interpreted as a measure of the balance of power between those in control of the means of production
260 and those whose livelihoods depend primarily on their own labour[2]. At one extreme, production is mainly

[2] This category also includes self-employed workers, especially when: 1) their subsistence depends on a limited number of clients (which in practice corresponds to an informal employment relationship) and/or, 2) a significant share of their income is dedicated to securing access to their basic working tools (rent and utilities, internet connection, software licences, virtual storage space, training courses, etc.).

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undertaken in order to obtain profits, which are largely captured by private companies. At the other, the means of production are collectively owned and managed either by worker cooperatives or under centralised state control, and therefore the main driver of the productive process is not profit but the satisfaction of social material needs.

3.2. Step two: Scenario construction

Following the approach used to develop the typology described, and in line with the methodology applied by Bauwens *et al* (2020), a thought experiment was conducted to build a set of scenario narratives (see also Svenfelt *et al*, 2019) based on the five selected conceptual axes. Initially, four *general* types of scenarios were identified: *modernist*, *peer-to-peer*, *fortress* and *post-growth circularity*.

Taking these categories as a point of departure and applying the five proposed conceptual dimensions, the co-author group took an enumerative approach and initially developed 12 specific scenarios from a total of 32 possible configurations (assuming a binary value for the five dimensions). Indeed, whilst recognising that each dimension can clearly be used to characterise a continuum of different configurations, the focus was placed on the extreme cases along each of these dimensions, whilst also aiming to build internally coherent scenarios.[3] For example, market-based scenarios combining private ownership with small/local scale of production were discarded, since it is expected that their inherent dynamic will lead to the concentration of production, tending in the long run to a "large-scale" scenario. Taking these factors into consideration, after the first round of discussion the number of scenarios was reduced to nine.

The second step of the scenario construction phase consisted of developing coherent narratives for each of the nine scenarios, presenting the expected overarching economic, social and environmental outcomes, with a focus on the underlying socio-political relations. Two of the co-authors led the drafting of these scenarios with a view to providing depictions that were sufficiently vivid to provoke discussion during the expert consultation process. Prior to this, though, each scenario was also critically assessed and validated by the other members of the co-author group.

3.3. Step 3: Expert consultation process

The typology used to delineate CE futures and the nine resulting circular future scenarios that were constructed (introduced in Section 4) were reviewed and refined using a three-round consultation process with CE experts. These CE experts were drawn from members of the EU Horizon 2020 ReTraCE

[3] There are 32 possible scenarios assuming a binary value for the five dimensions.

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(*Realising the Transition to the Circular Economy*) project that included academic and industry-based practitioners, and supplemented with further practitioners and policymakers who were external to the project. Experts were carefully selected based on their up-to-date core knowledge of the CE[4], but care was also taken to ensure representation on the basis of knowledge fields, countries and gender. For a full description see Appendix 2.

Figure 2 presents a detailed depiction of the three-stage expert consultation process. In the first round, a structured conversation was performed, in the context of a webinar consisting of a public presentation and discussion of the proposed conceptual axes and resulting scenarios. Second, an anonymous controlled survey was conducted amongst members of the group of experts consisting of both open-ended questions and closed-ended questions based on a four-point Likert scale (Appendix 3). The feedback obtained during the first two rounds was used to select two scenarios (those respectively considered as most plausible and most preferable/desirable) to further develop the respective narratives and test them by means of a *Scenario Exploration System* (SES) interactive 'game' (the third and round of the consultation process) (Bontoux *et al.*, 2016).

The SES is a simulation tool that allows the exploration of paths towards future scenarios. The performance of the game engages experts in simulation, where they play the role of key stakeholders such as established businesses, policymakers, civil society organisations, respected public figures, research organisations, or public voices such as in the media. The SES game was developed by the Joint Research Centre of the European Commission and can be modified and adapted to explore different sets of scenarios (European Commission, 2022). Indeed, the SES game allowed the players to experiment with different scenarios from key positions by using roleplaying as a technique to provide insights into the development of such scenarios (Bishop *et al.*, 2007). The SES was played by three separate groups of experts in two rounds, and it involved a total of 21 individuals who were selected from academia, business, non-governmental organisations, and policymaking (Appendix 2).

This 'Delphi-like' procedure was used to gather experts' opinions on whether the scenarios were plausible and/or preferable, to inquire about the relevance of the conceptual axes, and to further elaborate the qualitative details of the resulting scenarios (for example, in terms of drivers, barriers, and expected environmental, economic, and social outcomes). The procedure was iterative in the sense that feedback in each round of consultations fed into the development of the following round and into the narratives of

[4] Experts needed to be actively 'practicing' in this field by which was meant either actively engaged in substantial research on the CE as evidenced by, for example, publications in relevant scientific peer-reviewed journals (if an academic), or, working directly in the field of the CE (if a policymaker or practitioner). In other words, academics, practitioners and policymakers for whom the CE was a peripheral area of interest were excluded.

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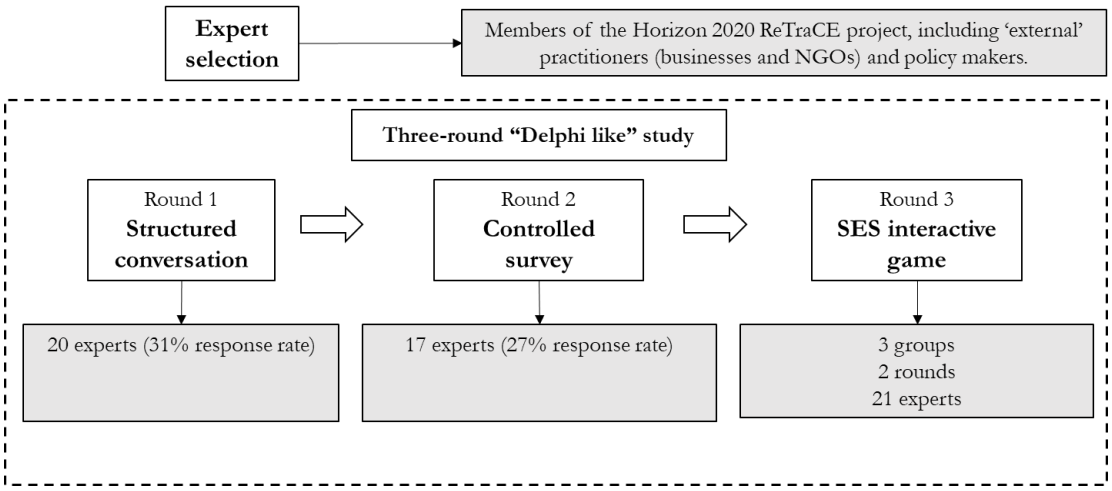
319 the different scenarios, ultimately leading to the different CE-based scenarios presented in the next section.
320 (Prieto-Sandoval *et al.*, 2018; de Jesus *et al.*, 2019).



321
322 **Figure 2.** Depiction of three-stage Delphi-like expert consultation process. Note: See Figure 1 for how this three-
323 stage process fits within the wider methodology. See Appendix 2 for details of the experts consulted in rounds 1
324 and 3 (Round 2 was an anonymous survey).

325 ## 4. Description of future CE scenarios

326 The final narrative for each of the nine scenarios (Table 2), including expert feedback following
327 the Delphi-like approach, is presented below.

328 Table 2. Mapped CE futures, conceptual axes and precedents

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329

	Conceptual axes					Precedent Scenarios
	1	2	3	4	5	
	Nature of innovations	Political/ productive governance	Scale of production	Access to final goods and services	Ownership of the means of production	
MNE-led Modernist Circularity (MMC)	High-tech	Centralised	Large	Market-based	Private	Circular modernism (Bauwens et al. 2020); Technocentric circular economy (Calisto Friant et al. 2020)
Welfare State Modernist Circularity (WSMC)	High-tech	Centralised	Large	Universal/inclusive	Private	Circular economy in the welfare state (Svenfelt et al. 2019); Reformist circular society (Calisto Friant et al. 2020)
State-led Modernist Circularity (SMC)	High-tech	Centralised	Large	Universal/inclusive	Collective	
Open-access P2P Circularity (OP2C)	High-tech	Decentralised	Large	Universal/inclusive	Collective	Peer-to-peer circularity (Bauwens et al. 2020)
Platform P2P Circularity (PP2PC)	High-tech	Decentralised	Large	Market based	Private	Peer-to-peer circularity (Bauwens et al. 2020)
Autarkic Fortress Circularity (AFC)	Low-tech	Centralised	Large	Universal/inclusive	Collective	Planned circularity (Bauwens et al. 2020)
Landlord Fortress Circularity (LFC)	Low-tech	Centralised	Large	Market based	Private	Fortress circular economy (Calisto Friant et al. 2020)
Convivial Eco-socialism Circularity (CEC)	Low-tech	Decentralised	Small	Universal/inclusive	Collective	Transformational circular society (Calisto Friant et al. 2020); Bottom-up sufficiency (Bauwens et al. 2020); Local self-sufficiency (Svenfelt et al. 2019)
Free-market Insufficiency Circularity (FIC)	Low-tech	Decentralised	Small	Market based	Private	

330
331

332 *4.1. Modernist circularity scenarios*

333 Circular modernist scenarios are those which are shaped by the presence of centralised governance
334 and the pre-eminence of high-tech innovations, as outlined by Bauwens *et al.* (2020). These future circular
335 scenarios are based on an eco-modernist techno-centric narrative, which argues that nature can be
336 protected by developing technology that is capable of effectively decoupling economic activity from
337 resource use and environmental impact.

338 These scenarios are traditionally depicted in the literature as being led exclusively by private
339 business initiative, with the public sector playing a secondary role as a mere facilitator, either through soft
340 regulation or 'corrective' taxing. The key role of the public sector as a political promoter and main investor
341 of material resources in technological innovation (Mazzucato, 2013) is therefore often overlooked.
342 However, more nuanced scenarios emerge when considering alternative arrangements with respect to

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ownership and control of key social resources and means of production, which are embodied in different configurations regarding the role of the state and private business in leading the transition to a circular economy.

4.1.1. Multinational Enterprise-led Modernist Circularity Scenario

The Multinational Enterprise-led Modernist Circularity (MMC) scenario is one in which the transition to a CE is mainly derived from the actions and decisions of a few large companies that operate at the global level. As such, they profit from economies of scale, innovations in logistics and ICT, wage, tax and regulatory differences among countries, and preferential access to international financial markets. These large multinational companies understand circularity mainly as a business opportunity and a way of securing their profits in a context of resource scarcity, by being able to retain key materials within the global value chains under their control for as long as possible.

In this scenario, multinational companies are able to influence the policy sphere to shape the CE strategies and regulation towards a version of the CE that does not conflict with the way they envision their business activity and preserves their profit-driven and growth-led paradigm. Therefore, the role of national governments is limited to managing externalities by setting basic legal standards and underpinning the transition through fiscal policies to deter the traditional linear economic sectors, many of which are already in crisis. Whilst public procurement may also be a relevant element in the overall demand for circular-based goods and services, these goods and services are nevertheless mainly provided by large private oligopolistic companies.

Citizens are largely responsible for recycling and preventing waste arising from the products that they purchase, while they have a small influence on the design and the reusability or repairability of the products available in the market. Although democratic institutions are formally in place, the strong interference of business lobbies in political decision-making results in low levels of citizen representation and involvement; as such, this model of circularity maintains key similarities with the vision of circularity developed in the European Union, where efforts to promote CE through directives are often mediated by oligopolistic economic structures and lobbying actions (Pinyol Alberich and Hartley, 2023). Moreover, the increasing economic dependence places local governments in a situation of relative weakness vis-à-vis transnational corporations, thus undermining the principle of national sovereignty.

4.1.2. Welfare State Modernist Circularity Scenario

The Welfare State Modernist Circularity (WSMC) scenario has many elements in common with the "CE in the welfare state" case proposed by Svenfelt *et al.* (2019). Although large corporations still

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dominate the transition, the state has a more involved role not only in directing public investments to CE-related innovation but also in ensuring the provision of public goods and supporting collaborative ways of consumption. Therefore, public procurement is a relevant part of the overall demand for circular-based goods and services, which are nevertheless mainly provided by large private companies.

Consequently, the state actively seeks to make private firms' goals compatible with the reduction of the environmental impact of the overall economy (Fauré *et al.*, 2019; Svenfelt *et al.*, 2019), and to organise redistribution mechanisms to ensure certain minimal conditions of social equality. The state also takes the initiative to enable the development of high-tech innovation and is responsible for coordinating and shaping economic activity through legislation and taxation to enforce environmental protection. In this sense, this scenario emphasises the key role of the public sector as a political promoter and main investor of material resources in technological innovation (Mazzucato, 2013), and also as mediator/administrator of the inherent tension between the atomistic interests of maximising private initiative and the common interest in terms of social equality and justice.

The WSMC model is characterised by a national scale of production. The means of production are privately owned, although in a context of cooperation with the state, new forms of hybrid ownership can emerge that combine public and private elements to maximise societal welfare and enable high-tech innovations while minimising environmental impact.

4.1.3. State-led Modernist Circularity Scenario

The State-led Modernist Circularity (SMC) scenario is a model of circularity where the state is the main actor that assumes the responsibility to drive the transition towards the CE while promoting high levels of technological development. This model of circularity maintains key similarities with the vision of circularity developed in China, where state-owned companies and state agencies directly dictate measures to transition towards a CE (Mathews & Tan, 2016; Fan & Fang, 2020). The state also acts as a key enabler of innovation by developing eco-industrial parks that allow centralised and large-scale production and innovation (Mathews & Tan, 2016).

The means of production in this model of circularity are largely owned by the state that controls the strategic sectors of the economy. However, this ownership is not absolute, as the state may allow the participation of private business owners in the economy as well. The SMC can enable new dynamics in the access to final goods; while for some goods consumption is market-based, provision of strategic goods is under the control of the state to guarantee accessibility and social distribution. The SMC model of circularity is shaped by a scale of production that is at least national, as production is planned primarily to

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satisfy the internal demand for goods and services. However, public firms may also compete at the global level to obtain financial gains, take advantage of economies of scale and secure strategic markets and/or resources.

There are two stark examples of state-led schemes that depict what could be expected in a transition towards the CE under the SMC scenario. The first one dates back to the era when the USSR designed a national scheme for recycling waste (Fedotkina *et al.*, 2019). The focus was put on five materials: glass, textiles, tyres, wastepaper, and polymeric materials. The Soviet Union-led program emphasised standardisation in product design and unification in production and put forth centralised initiatives for waste collection and material processing to ensure the widespread use of secondary materials. As a result, in the 1980s, the recycling rate for paper and glass bottles stood at 30% and 45% respectively and households and companies were actively involved in the collection of recyclable waste (Fedotkina *et al.*, 2019). In addition, in 1986, a new provision was introduced by the government that holds the producer responsible for developing new technologies and facilities for reusing or recycling products after their end-of-life period (Fedotkina *et al.*, 2019). The second example is China, as mentioned before, and its current approach to the transition towards the CE as a national sustainable development strategy. The main aim of China's CE strategy is to tackle environmental degradation and resource scarcity (Su *et al.*, 2013), however, it also covers several aspects of sustainable development at the national level including resource and waste management, energy efficiency and conservation, land management and soil protection, and water management. For monitoring progress, a framework of indicators has been developed by the Chinese National Development and Reform Commission (NDRC), which is the body responsible for the regulation and implementation of CE initiatives across the country, mainly through the establishment of eco-industrial parks (Mathews & Tan, 2011). More than a decade after the introduction of the law proclaiming the CE as a goal in China's strategic economic and social development plan in 2008, the government actively monitors progress and refines the program periodically according to developments at the regional scale.

In summary, the SMC is shaped by the leading role of the state in organising the production and consumption systems. With these actions, the state seeks to enable economic development in the short and long term and to ensure certain levels of social welfare while also achieving acceptable levels of environmental protection. The overarching power of a highly centralised state can also lead to major negative implications, such as a lack of public participation in decision-making or the vulnerability of citizens to the state, which can especially affect marginalised groups such as ethnic minorities, dissidents, or the LGTBI+ community.

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4.2. Peer-to-peer circularity scenarios

Peer-to-peer future scenarios involve a transition to CE based on technological innovations that enable a high level of decentralisation of both political governance and productive systems (Bauwens *et al.*, 2020), through developments that increase interconnectivity, digitalisation, automatisation, de-localisation and traceability. In this case, the ownership of the means of production and access to the resulting products is highly dependent on the type of access to certain key knowledge and digital developments, which can be in private hands that limit access to obtain a profit or maybe open-source and thus enhance collaboration in their use and development.

4.2.1. Open-access Peer-to-peer Circularity scenario

The Open-access Peer-to-peer Circularity (OP2PC) scenario depicts a future in which generalised technical innovations in digitalisation and distributed production, together with socio-political developments in terms of collectivisation of both knowledge and the means of production, allow for a 180º shift from *consumption* to *prosumption*. Accordingly, there is a shift from market-based access to final goods to universal/inclusive access.

This scenario may also combine political decentralisation and digital collaborative open-source technologies with a "general economic downscaling" (Calisto Friant *et al.*, 2020), leading to sufficiency-based community-owned local productive systems. Collective ownership of the means of production materially supports both general citizen political involvement and economic inclusion and allows for the development of sufficiency-driven rather than profit-driven productive activities. Therefore, it prioritises that local social needs are met within the shorter loops of the value-retention hierarchy of CE (Reike *et al.*, 2018; Calisto Friant *et al.*, 2020).

It should be noted that, as the main technologies still rely on economies of scale and there are no macro-level mechanisms to coordinate efforts towards an overall reduction in resource consumption, this future scenario may lead to rebound effects (Zink and Geyer, 2017) due to the enhanced access to consumption goods (through platforms) and the 'massification' of productive tools (such as 3D printers).

4.2.2. Platform Peer-to-peer Circularity scenario

The Platform Peer-to-peer Circularity (PP2PC) scenario is related to what has been described in the literature as *platform capitalism* (Frenken, 2017; Lowe & Genovese, 2022). It differs from the open access peer-to-peer circularity future in that the main technical innovations in digitalisation that may enable the creation of a collaborative sharing economy are instead co-opted by large private corporations (Martin, 2016; Bauwens *et al.*, 2020). As the ownership of the means of production remains under the control of

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private companies that operate in a "winner-take-all" type of market (Bauwens *et al.*, 2020), platform monopoly creation becomes the norm.

This economic trend is further aggravated by the high level of political decentralisation, as there are no political governance mechanisms that could operate on behalf of workers/consumers as a collective. As Bauwens *et al.* (2020 p.8) themselves pointed out, this could lead to "social issues, such as increased labour market flexibility and an erosion of workers' rights (...) as well as a commodification of aspects of life that were previously beyond the reach of the market".

4.3. Fortress circularity scenarios

Fortress circularity scenarios are characterised by a high level of political centralisation together with the primacy of non-technological innovations and therefore share some features with what has been depicted by Bauwens *et al.* (2020) as a "planned circularity" scenario. However, the authoritarian nature of the decision-making process, and the primacy of coercive mechanisms over technological innovation, make it closer to what Calisto Friant *et al.*, (2020) described as a "fortress circularity". It is thus acknowledged that an authoritarian centralised governance could be enforced both by the state and by the action of large monopolistic/oligopolistic corporations. Taking these factors into consideration, and applying the proposed analytical axes, two further scenarios have been outlined: autarkic fortress circularity and landlord fortress circularity.

4.3.1. Autarkic Fortress Circularity Scenario

At first glance, the Autarkic Fortress Circularity (AFC) scenario can be related to what Bauwens *et al.* (2020, p.6) labelled broadly as a "planned circularity," in which the transition is "centrally piloted by the government via strong coercive measures," rather than based on technological innovation. Nevertheless, in addition to the extended use of strict command-and-control regulations, the "fortress" character of this CE strategy lies in the fact that it is not driven by real concern about reversing environmental damage, but responds to the notion of prevailing (or at least of not being relegated) in what is perceived as a context of fierce global competition for scarce key resources (Calisto Friant *et al.*, 2020). The focus is therefore put on low-tech innovations in the higher material loops (Bauwens *et al.*, 2020), population control, rationing and top-down resource efficiency (Calisto Friant *et al.*, 2020). Income distribution and social justice may be addressed by centralised governance, although only strictly within national borders (and regardless of the impact on income distribution and social justice in other territories). Tariffs might be imposed in order to favour domestic production resulting from the large-scale implementation of CE measures, in order to make this competitive with imported goods characterised by superior technical performance.

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In this scenario, the transition towards the CE is led by a primary governing body through top-down initiatives and schemes. As a result of this process, communities are expected to experience a reduction in individual freedom of choice. Also, from the technological point of view, no substantial investment is required either for R&D activities or capital investment. In this case, the cost of knowledge transfer would be expected to be low.

This scenario is also close to the approach that has been described as "authoritarian environmentalism" (Bauwens et al, 2020), in which political decision-making is considered to be more effective when directed by a group of experts rather than relying on a democratic process. It has been argued that the risk of shifting towards this type of authoritarian structure can result from an unwillingness to envisage radical democratic alternatives to the current model of liberal democracy (Faber, 2018).

4.3.2. Landlord Fortress Circularity Scenario

The Landlord Fortress Circularity (LFC) scenario is shaped by the action of a few large multinational companies that have successfully co-opted strategic resources to produce key elements for the economy, such as electronic goods, batteries, or motorised vehicles. These large corporations maintain the ownership of the means of production, access to which is mediated via market mechanisms. Consumers do not buy but lease, in a system where big companies are responsible for maintaining, repairing, and refurbishing their products to keep them operational, while establishing oligopolistic structures to create and protect their revenue streams (Lloveras et al., 2024). Therefore, profit is secured by companies not through the production of new goods but by controlling the price of leasing these strategic products; as such, this scenario might exhibit lower levels of technological sophistication. Under this model of circularity, large firms become owners not only of the means of production but of the goods produced, establishing social relationships with consumers that have several similarities to that of landlords and tenants.

The LFC model of circularity is therefore primarily shaped by the co-option by oligopolies of strategic materials and products necessary to develop essential economic activities. While the transition of the consumption systems from a buyer to lender paradigm maintains the value of resources within the economy and effectively decreases the generation of waste, the control of key products by a few companies can lead to an outcome where the market reproduces the same failures as the real estate market. For example, key products may become inaccessible due to activities such as speculation and unfair pricing. These failures can be accentuated as ownership is centralised in a few hands and even buying some strategic products may become a new option for financial speculation, driving prices up as well as inequality. Although material recovery is expected to be very high under this paradigm, and even economic growth

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and environmental decoupling may be perceived as 'attainable' goals, other elements such as social welfare and equality may dramatically decrease.

4.4. Post-growth circularity scenarios

The post-growth type of scenarios have been depicted as a combination of low-tech convivial innovations and decentralised political governance, leading to a general downscaling of production and a return to local and community-based productive systems centred on the principle of *sufficiency* (Bauwens *et al.*, 2020; Calisto Friant *et al.*, 2020). This radical transformation is theorised as the result of bottom-up initiatives stemming from direct civil political involvement. However, it remains unclear how this process of widespread democratisation would be materially sustained without a substantial change in the current prevailing relations of production. Therefore, two alternative scenarios are explored, one of them based on a complete socialisation of the resources and means of production, and the other linked to the effects of a further commodification of the social relations of production.

4.4.1. Convivial Eco-socialism Circularity scenario

The Convivial Eco-socialism Circularity (CEC) scenario retains many of the main features that were derived in the "bottom-up scenario" depicted by Bauwens *et al.* (2020), the local self-sufficiency described by Svenfelt et al., (2019), and the "transformational circular society" proposed by Calisto Friant *et al.* (2020). The main difference resides in the acknowledgement that a shift in the productive paradigm from market-based profit-seeking to community-based self-sufficiency inevitably requires a radical change in the underlying relations of production.

An example of this type of bottom-up sufficiency would be that inspired by the negotiated coordination model proposed by Devine (2002). The CEC scenario would require that community-based decision-making is also materially supported by the collective ownership of the means of production (e.g. through worker cooperatives) and that it allows for universal/inclusive access to the social output (e.g. through consumer cooperatives). Therefore, it is the result of a consensual decision that may only be achieved once individuals relate to each other in a condition of mutual equality, without any material dependency ties such as those existing between owners and non-owners (either of means of production, real estate, financial capital, knowledge, etc.). This also implies breaking the ties of dependency between human groups, such as those produced through debt and exploitative contracts that imply the loss of sovereignty by people over their natural resources.

Although high-tech innovations in digitalisation and distributed production may be relevant in this scenario, it is mainly sustained in a revalorisation of local/indigenous knowledge, channelled through

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562 community-based productive initiatives. Therefore, key innovations are not technical but organisational,
563 involving the cooperation of all society members and the shift towards alternative economic objectives.
564 Rather than pursuing monetary profit and social status derived from consumption, individuals seek to live
565 what are seen as more meaningful lives by collaborating with their immediate community in the
566 construction of welfare and sufficiency.

567 *4.4.2. Free-market insufficiency circularity scenario*

568 The Free-market insufficiency circularity scenario (FIC) describes a case in which a degrowth
569 process is not the result of a democratic or consensual decision, as in the case of the CEC scenario, but
570 the undesired outcome of a failed capitalist development path. In the Free-market Insufficiency Circularity
571 scenario, circular practices have emerged as a forced survival strategy in the face of acute scarcity, either
572 due to resource insufficiency or extreme inequality in wealth distribution.

573 This is the type of circularity that can be expected, for example, in territories in which colonial ties
574 have not been broken in practice and continue in the form of unequal economic relations (neo-
575 colonialism). As both resources and means of production are concentrated in the hands of transnational
576 capitals and/or local subsidiary elites, the prevalence of rent-seeking and extractive activities gradually
577 drains indigenous capital (both natural and artificial). Broken community ties and the absence of
578 mechanisms for social integration are both causes and effects of the economic relation of dominance and
579 exploitation, leading to chronic poverty, recession and insufficiency.

580 This scenario could be thought of as the peripheral counterpart to the eco-modernist or fortress
581 circularity scenarios in 'core' countries; through the process of unequal exchange, high-income countries
582 in the global North must necessarily feed on low-income countries in the global south (e.g. appropriating
583 materials to ensure political and economic control over the transition to "clean" energies).

584 5. Insights from multidisciplinary CE experts – validating the typology and 585 scenarios

586 This section presents the feedback from multidisciplinary CE experts that was used to validate the
587 typology and nine circular scenarios. Emphasis is placed on some of the alternative currents of thought
588 that were expressed to give the reader an insight into the breadth of ideas that ultimately fed into the final
589 scenarios presented in Section 4. [5]

[5] Please note where necessary to enhance readability, the circular futures will be referred to by their full names rather than acronyms.

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590 *5.1. Structured conversation*

591 Participants agreed that the proposed analytical axes were relevant and resulted in a comprehensive
592 set of scenarios, although some respondents pointed out that the number of scenarios was too large and
593 could be reduced. In particular, several experts pointed to the existence of fundamental similarities
594 between the different types of market-led scenarios and suggested they could be merged. This was
595 especially the case with the MNE-led Modernist Circularity, Platform P2P Circularity, and Landlord
596 Fortress Circularity scenarios. These scenarios were also often singled out as portraying the most plausible
597 continuity of the current state of affairs, which was mostly seen as an undesirable outcome both in
598 environmental and social terms. However, some experts also raised concerns about the environmental
599 feasibility of these scenarios and suggested that a scenario that unquestionably maintains the economic
600 growth imperative cannot achieve sustainability and circularity and prevent worsening climate change.

601 In contrast, neither of the two centralized state-led scenarios (State-led Modernist Circularity and
602 Autarkic Fortress Circularity) were seen as redundant and prompted quite different reactions. While the
603 State-led Modernist Circularity was generally viewed as an environmentally and socially desirable scenario
604 (although some raised concerns about freedom of speech and legitimacy), Autarkic Fortress Circularity
605 was deemed by most respondents as socially undesirable and only partially desirable from an
606 environmental perspective. Moreover, Autarkic Fortress Circularity was considered in general as an
607 implausible dystopian scenario (which many referred to as "eco-fascism"), whilst State-led Modernist
608 Circularity was most frequently seen as a positive environment for the promotion of innovation, industrial
609 symbiosis, collaboration, and social equality. Although State-led Modernist Circularity was generally
610 viewed as more plausible than the Autarkic Fortress Circularity, it was at the same time considered less
611 likely than MNE-led Modernist Circularity and Welfare State Modernist Circularity scenarios, especially in
612 Western market-based economies, as it would require a major political and cultural change.

613 The Convivial Eco-Socialism Circularity scenario was considered the most desirable from an
614 environmental and social perspective, as it combined the most radical political, cultural and economic
615 changes towards an egalitarian and sustainable society. It was also deemed as one of the most unlikely
616 scenarios, as it directly challenges the interests of large corporations and political and economic elites.
617 Therefore, this scenario was perceived by the participants as highly unfeasible due to the opposition of
618 those who were seen as the most powerful and influential actors in society. The Convivial Eco-Socialism
619 Circularity scenario also generated doubts as it demands a radical change in the economy that would
620 require a very high level of societal collaboration and trust, which was seen as very difficult to achieve
621 from the current point of departure. This scenario involves many changes in mainstream lifestyle that were
622 seen as positive, especially in redefining the social role of work. Additionally, the Convivial Eco-socialism

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Circularity scenario implies the need for major changes in mainstream lifestyles in wealthier economies that can be perceived as undesirable, both in those countries, and in the global south, such as a reduction of intercontinental trade and consumption of foreign products.

Finally, some experts suggested that the proposed scenarios may involve different implications and outcomes depending on the geographical scale of analysis (global, national, regional, etc). In this respect, it was also pointed out that the Free-market Insufficiency Circularity, which was rated as one of the less desirable scenarios, could be interpreted as the peripheral counterpart of the accumulation of wealth in the most affluent economies.

5.2. Anonymous survey

Figure 3 presents the results from the closed-ended survey questions; illustrative responses from each of the open-ended questions are provided in the supplementary information.

Largely reinforcing the messages from the prior debate, in the survey, the Convivial Eco-socialism Circularity scenario was again judged to be the most desirable from an environmental, social, and economic standpoint. Conversely, the least desirable scenarios were Free-market Insufficiency Circularity from an environmental perspective ("de-growth will happen after we ruined our climate for human habitation"), Landlord Fortress Circularity from a social perspective (**"**extremely uneven distribution of wealth, rise in corruption and individualism") and Autarkic Fortress Circularity from an individual consumer perspective ("a *Soviet-quality* economy").

In terms of plausibility, whilst the Convivial Eco-Socialism Circularity was seen as most desirable, once more it was not seen as particularly plausible, scoring only slightly higher than the least plausible scenario (Autarkic Fortress Circularity). One respondent described the Convivial Eco-socialism Circularity as follows:

> *"This scenario represents a totally different discourse from the one that our society has embarked [on]. The level and nature of reforms that would be required are quite significant and private companies would be the main obstacle towards realising this."*

Plausibility was judged to be highest for MNE-led Modernist Circularity, the consensus toward which is summed up by the epithets "business as usual circularity," and "a reductionist view of the circular economy." Indeed, one respondent described the MNE-led Modernist Circularity scenario as follows:

> *"The ideological, cultural, and institutional shift needed to incorporate its ideas is not far from what we have currently. [Realising]… the scenario does not seem particularly challenging especially when compared with more radical ideas. However, its technocratic nature means it will likely fail to achieve the goals of the CE."*

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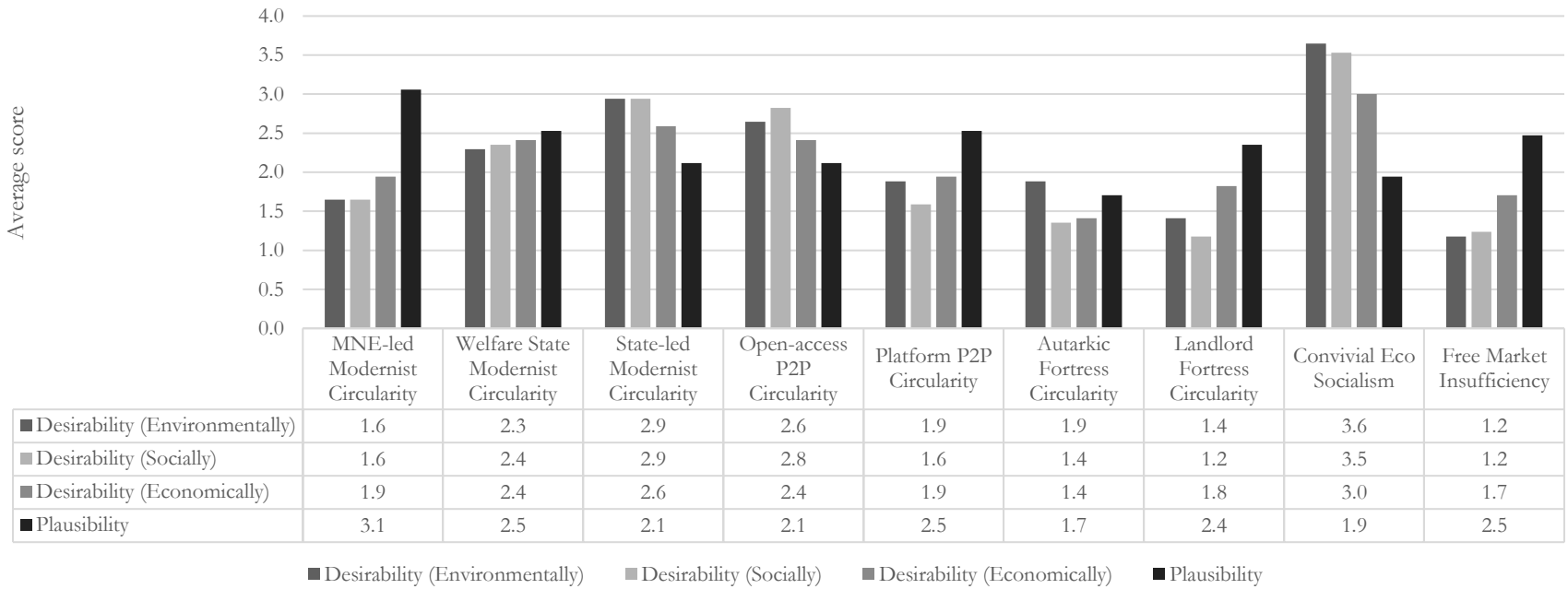

	MNE-led Modernist Circularity	Welfare State Modernist Circularity	State-led Modernist Circularity	Open-access P2P Circularity	Platform P2P Circularity	Autarkic Fortress Circularity	Landlord Fortress Circularity	Convivial Eco Socialism	Free Market Insufficiency
Desirability (Environmentally)	1.6	2.3	2.9	2.6	1.9	1.9	1.4	3.6	1.2
Desirability (Socially)	1.6	2.4	2.9	2.8	1.6	1.4	1.2	3.5	1.2
Desirability (Economically)	1.9	2.4	2.6	2.4	1.9	1.4	1.8	3.0	1.7
Plausibility	3.1	2.5	2.1	2.1	2.5	1.7	2.4	1.9	2.5

Figure 3. Survey results by circular future (closed-ended questions; average scores on a 4-point Likert scale)

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662 *5.3. SES interactive game*

663 After all the scenarios were defined and reviewed through the experts' consultation process, one
664 scenario was selected as the most feasible and another as the most preferable/desirable. We combined the
665 MNE-led Modernist Circularity and Landlord Fortress Circularity scenarios, as both were seen as being
666 built on similar premises (in terms of their oligopolistic nature) and complementary to each other. Also,
667 both were perceived as plausible by the experts. The participants, after roleplaying this combined scenario,
668 acknowledged that it was somewhat realistic, as many of the trends were perceived as already taking place
669 in the present socio-economic context. However, some participants raised concerns about the
670 environmental outcomes of this scenario and suggested that a scenario that unquestionably maintains the
671 economic growth imperative cannot achieve sustainability and prevent worsening climate change.

672 The reflections on this scenario led to a debate among the participants on the rising social tensions
673 emerging from the perceived disparities in the distribution of wealth and the lack of broad-based social
674 welfare. The rising inequality of this scenario raised significant opposition among many stakeholders. In
675 this sense, some participants complained about the impossibility of modifying the predetermined long-
676 term negative environmental trends through actions of resistance against the prevailing logic of the
677 scenario. These concerns pointed to the necessity of incorporating into the SES some additional dynamic
678 factors, such as the effect that stakeholder resistance and collaboration in the first phases of the game may
679 have on the longer-term trends.

680 The most preferred scenario, Convivial Eco-socialism Circularity, portrays a vision of the future
681 shaped by low-tech and a reconfiguration of the economy where the satisfaction of societal needs through
682 cooperation becomes the main priority. This scenario was perceived by the participants as highly unfeasible
683 due to the opposition of the most powerful actors in society; doubts related to the radical changes required
684 in both social relations of productions and lifestyles.

685 ## 6. Discussion

686 The section begins by discussing how the nine scenarios presented here address debateable results
687 and conceptual issues in the existing literature outlined in Section 2, before going on to consider the
688 relevance of these scenarios more generally.

689 *6.1. Extending existing literature*

690 The set of nine scenarios presented here significantly advances the current literature aimed at the
691 prefiguration of CE futures. While some previous studies, including the four sources that were most

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692 relevant in the development of this work (Fauré *et al.*, 2019; Svenfelt *et al.*, 2019; Bauwens *et al.*, 2020,
693 Calisto Friant *et al.*, 2020), propose alternative futures that, in some cases, are incompatible with capitalism,
694 by not focusing on the underlying capitalist relations of production these studies lack a conceptual basis
695 to identify the fundamental characteristic of those futures that represent a radical shift from free-market
696 economic systems (Lowe and Genovese, 2022). For example, previous studies were unable to provide a
697 solid conceptual foundation to successfully incorporate future trajectories divergent from the liberal
698 capitalist market system, such as the *sui generis* political and socio-economic system pursued by China. The
699 usual misconception of identifying the Western capitalist economic system with the socio-political values
700 of *de facto* democracy prevents us from acknowledging both the authoritarian components underlying the
701 social relations within market liberalism, and the capacity of centralised political power configurations to
702 deliver socio-economic prosperity and resource efficiency through State-led systemic innovation.

703 Previous studies were also not able to establish a clear conceptual differentiation between
704 contradictory future outcomes stemming from the same initial configuration of the chosen variables. The
705 lack of consideration of the concentration and centralisation dynamic of market structures under private
706 ownership of the means of production (Schumpeter, 1942; Baran & Sweezy, 1966; Shaikh, 1991;
707 Brancaccio *et al.*, 2018) impedes a clear understanding of the specific conditions under which certain
708 'desired' scenarios may 'degenerate' into 'dystopian' projections of the current *status quo*. This is the case,
709 for instance, with the dichotomy between the high-tech collaborative and decentralised Peer-to-Peer (P2P)
710 scenarios and the oligopolistic P2P 'platform capitalist' futures. Moreover, none of the previous
711 approaches addressed the fundamental question of whether it is actually possible to conceive the most
712 radical post-growth scenarios without assuming an equally radical transformation in the social relations of
713 production (and thus in the core institutions associated with the capitalist mode of production: *private*
714 *property* and *labour market*).

715 In addition, the set of nine scenarios proposed also sought to provide a coherent response to
716 several conceptual issues. First, as three types of eco-modernist scenarios (combining high-tech
717 innovations and a "top-down" approach to governance) were clearly distinguished, namely market-led
718 (MNE-led Modernist Circularity), state-led (State-led Modernist Circularity) and welfare state-based
719 (Welfare State Modernist Circularity), it was possible to envisage different future trajectories responding
720 to alternative roles of the state in the economy and the innovation process (Mazzucato, 2013). Therefore,
721 the set of nine scenarios offers a clear criterion to understand how future modernist circular societies may
722 diverge if current global trends are maintained. As a result, the future development of CE would be
723 expected to be found closer to the MNE-led Modernist Circularity in the so-called 'liberal market

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724 economies[6] (such as Australia, the UK and the US), somewhere between MNE-led Modernist Circularity
725 and Welfare State Modernist Circularity in the 'coordinated market economies' (such as France, Germany,
726 Japan and the Scandinavian countries), and between the Welfare State Modernist Circularity and the State-
727 led Modernist Circularity in the so-called 'socialist market economies' (i.e. China).

728 Second, the proposed framework acknowledges that a planned "top-down" transition towards
729 circularity can be led not only by the state but also by large private corporations (or both) and that each of
730 these variants of CE futures may rely primarily on high or low-tech innovations. The three modernist-type
731 scenarios are examples of the former case (top-down + high-tech) while the two fortress-type scenarios
732 introduced (state-led Autarkic Fortress Circularity and firm-led Landlord Fortress Circularity) should be
733 understood as examples of the latter (top-down + low-tech). Since these five scenarios are built upon
734 "top-down" initiative and control, all five futures may be considered to some extent as alternatives to an
735 authoritarian approach to circularity (and not only those led primarily by the state). The differences
736 identified lie mainly in the channels through which power is exerted and the mechanisms by which the
737 benefits and losses of the paradigm change are socially distributed.

738 Third, the inclusion of the social relations of production also allowed us to envisage different
739 future developments for circular societies based on P2P technological innovations that promote political
740 and economic decentralisation. A clear distinction has been made between the case in which the ownership
741 and control over the key technologies and knowledge are held collectively (Open-access P2P Circularity)
742 from that in which they are in private hands (Platform P2P Circularity). In the first case, decentralised
743 collective decision-making is materially supported by common control over the means of production,
744 effectively resulting in equitable power relations (at least between those capable of understanding, using,
745 and developing the key technologies). In the second scenario, the winner-take-all logic of the markets
746 involved together with private ownership of the key technologies leads to "platform capitalism" (Frenken,
747 2017; Lowe & Genovese, 2022). Apparent collaboration in consumption conceals an unequal power
748 relation in which high-tech oligopolies control every link of the key value chains, including the
749 consumption phase, and can define prices and employment conditions virtually without any counterpart
750 on behalf of workers/consumers, leading to deterioration of workers' rights (Bauwens *et al.*, 2020), income
751 inequality and fragmentation of the social fabric.

752 Fourth, a similar conclusion can be extracted from the study of those scenarios that combine a
753 generalised downscaling of production with a focus on low-tech innovations (Convivial Eco-socialism
754 Circularity, Free-market Insufficiency Circularity). In particular, it was stressed that a democratic

[6] According to the classification by Hall and Soskice (2001).

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755 community-based bottom-up sufficiency scenario (Convivial Eco-socialism Circularity) would require
756 collective ownership of the means of production (e.g., through worker cooperatives) and
757 universal/inclusive access to the social output (e.g., through consumer cooperatives), in order to guarantee
758 that in practice individuals relate to each other on mutual terms of equality. If production and consumption
759 in small integrated local communities remain mediated through private ownership of the basic means of
760 livelihood, unequal relations of material dependence will continue to be reproduced among their members
761 (landlords/tenants, employers/employees, suppliers/customers, etc.), undermining the process of
762 democratic community-based decision-making. At the other extreme, the Free-market Insufficiency
763 Circularity scenario can be understood as a call for attention to the romanticised vision that some
764 promoters of the CE have of local communities that are forced by extreme deprivation to resort to
765 practices labelled as 'circular'. In these cases, reduced consumption and intensive use of the available local
766 resources do not stem from a community-based decision to shift towards "living with less" but are the
767 result of unequal social relations based on the ownership of land and critical resources by local and foreign
768 economic elites.[7]

769 Overall, the nine scenarios developed here map onto the three narratives identified by Leipold *et*
770 *al.* (2022) —optimist, reformist, and sceptical—that underpin assessments of the CE. For example, MNE-
771 led Modernist Circularity might be described as an optimistic scenario given its reliance on green growth;
772 Free Market Insufficiency, which arises due to a forced survival strategy, is clearly sceptical, and the state-
773 led modernist scenario could be understood as reformist given the role of the state as a key enabler of
774 innovation. However, the scenarios depicted here build on these undercurrents in existing work and
775 translate them into broader based visions of the future.

776 *6.2. Relevance of circular scenarios*

777 The reference to romanticised visions though brings us to what overarching function these circular
778 futures ultimately serve: what relevance do they have? Whilst it is clear from the expert feedback that the
779 most likely future scenario – at least in the UK of 2022 where the study was conducted – is MNE-led
780 Modernist Circularity, it is also clear that Convivial Eco-socialism Circularity was the most preferable
781 future amongst the experts consulted even though it was considered unlikely to transpire. Whilst scenarios
782 presented here are not meant to be normative or aspirational, nonetheless, if we are to surmount the *status*
783 *quo*, society needs to dare to examine the type of future that we want to inhabit for ourselves and future

[7] A clear example of this can be found in the many informal recycling and recovery economies that emerged in developing countries, as response to the profound social crises that followed the processes of privatisation, economic deregulation and consequent external plunder and indebtedness that took place and/or intensified after the implementation of the Washington Consensus policies (Oteng-Ababio, 2012; Cosacov & Perelman, 2015; Paiva & Banfi, 2016).

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784 generations. The future scenarios presented here tap into this desire and give us licence and inspiration to
785 examine the kind of CE that we want to build - the kind of society that we wish to construct and the
786 fundamental principles, structures and institutions that this will be founded on. As such, the futures
787 hopefully help to shift the boundaries of consciousness regarding what is feasible and what we should be
788 striving for, and therefore help re-evaluate dominant reductionist narratives, where they stem from, how
789 they are perpetuated, and the power dynamics behind them.

790 In more formal terms, future scenarios such as Convivial Eco-socialism Circularity hold the
791 potential for *performative* impact that can challenge the *ontic* nature of conceptions of the CE that cling to
792 growth-led and market-based economic systems as the default conduit of human progress (Hale *et al.*,
793 2019). In so doing, they also allow a space for *science* (divorced from politics) to help define what is *plausible*
794 and not just the received wisdom of what political systems will tolerate. For example, we know, most
795 pertinently, that absolute decoupling (i.e. rising economic growth accompanied by *reductions* in material and
796 energy flows) at a regional or global scale has little empirical support (Hickel and Kallis, 2020; Vogel and
797 Hickel, 2023). Nonetheless, and despite the implausibility of this notion, decoupling clearly underpins
798 leading climate mitigation scenarios and the work of leading international organisations and national
799 governments (Hickel *et al.*, 2021). As such, the preponderance of this techno-optimistic perspective may
800 explain why the CE experts consulted here viewed the MNE-led Modernist Circularity as the most
801 plausible (i.e. likely) circular future (even if it was not seen as most preferable in environmental, social and
802 economic terms)[8]. The scenarios presented here, and particularly those focused on post-growth, allow us
803 to begin to challenge these accepted realities based on a notion of science and technology that is in keeping
804 with planetary boundaries (Rockström *et al.*, 2009).

805 Nonetheless, discussions emerging from the SES game relating to the *most desirable* scenario
806 (*Convivial Eco-socialism Circularity*) also focused on the difficulty of realising such a future. In accordance
807 with recent work (Hasselbalch *et al.*, 2023), it was pointed out that the transition towards this scenario
808 would imply *revolutionary reforms* that would also need a clear theory of transformation and political
809 organisation. In addition, participants highlighted the need for a post-growth *theory of the state* (D'Alisa and
810 Kallis, 2020), capable of articulating a dialectical process between civil and political society also embodying,
811 in a Gramscian sense, a hegemonic battle for a new common sense leading to new institutions capable of
812 overcoming current growth-oriented values.

813 As regards, the implications of the different scenarios for practitioners, these are extensive –
814 ranging, for example, from internalising environmental externalities and promoting technology such as

[8] With the exception of the two post-growth futures, all of the scenarios rely on continued economic growth to varying degrees.

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carbon-capture and storage, to harvesting local/indigenous knowledge and promoting collective ownership of the means of production; from promoting higher R-imperatives (i.e. reducing unnecessary production, repairing and reusing products to postpone the end of life) as opposed to less ambitious measures focused on simple recycling targets. However, given that our typology and the nine scenarios that emerged from it capture key socio-political transformations, they have relevance (and performative potential) beyond just practical considerations, which have been the primary focus of literature in the field.[9] Indeed, the typology and scenarios focus instead on the fundamental structural questions that society and *as a whole* must grapple with in choosing its future direction: how do we assemble ourselves and our productive relations and 'transact' with one another; what do we understand by the 'social contract' between society and its members; what are our rights as humans; what are our social norms and values; what do we mean by 'justice,' 'identity,' 'community,' amongst others. If scenarios such as those articulated can indicate a "true North" in the words of Bauwens *et al.* (2020), then the possible direction of travel needs to be relevant beyond just narrow business circles and the interests that these represent and be able to begin to conjure with these bigger existential questions. This is a prerequisite before the CE descends – as it so often does – into purely technical and engineering considerations. This paper provides the first conceptual step in this direction for the policymakers of tomorrow. In this vein, our study could support emerging efforts to propose versions of the CE that incorporate more inclusive, democratic and ecocentric pathways to circularity, such as "social CE" (Social Circular Economy, 2017), "circular humansphere" (Schröder et al., 2020), "permacircular economy" (Arnsperger C. & Bourg D, 2017), "social CE" Clube and Tennant, 2023), and "circular society" (Jaeger-Erben et al., 2021).

7. Conclusion

This paper has sought to develop and validate a nine-scenario set of hypothetical future configurations of the CE that extends the current literature by focusing on the socio-political foundations of circularity. To achieve this, a typology consisting of five conceptual dimensions was defined that between them look to capture key socio-political transformations that could influence different plausible configurations of the CE, including transformations in the social relations of production. In so doing, we have sought to extend and refine the square two-by-two matrix developed by Bauwens *et al.* (2020) to ensure that it includes the key actors, institutions and forces of change that might constitute and drive a societal transition beyond neoliberal capitalism and the 'end of history' narrative that abounds in the existing literature. Indeed, we also reflected on the performative impact that future studies can have in envisioning alternatives to the most plausible scenario identified by the CE experts consulted (MNE-led

[9] This includes the four sources that were most relevant in the development of this work (Fauré *et al.*, 2019; Svenfelt *et al.*, 2019; Bauwens *et al.*, 2020, Calisto Friant *et al.*, 2020).

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Modernist Circularity), and in enabling more radical alternatives that were considered most preferable (Convivial Eco-socialism Circularity).

There are several limitations associated with our findings though, which suggest avenues for future research. First, like Bauwens *et al.* (2020) before us, our paper is qualitative by design and therefore does not detail the effects of the nine scenarios. Nonetheless, these scenarios could provide the foundation for subsequent quantitative investigation and modelling of these effects. Second, while it was considered a priority that both the group of co-authors and the experts consulted should be as multidisciplinary and diverse as possible, it is acknowledged that the selection of axes, scenarios and the validation process is nevertheless influenced by their particular range of ideas, opinions and knowledge, as is usually the case in Delphi-based research design. Nonetheless, the very focus of this paper was on giving prominence to theoretically relevant ideas that have become under-represented – such as the role of social relations of production – and ignored by the mainstream CE discourse. As such, any limitations associated with the positionality of the experts is counterbalanced *to some degree* by the salience given to new ideas outside the predominant CE narrative. Third, although we have presented a broader range of circular economy futures than Bauwens et al. (2020), there are undoubtedly additional scenarios that could be imagined. This is especially true as the circular economy is adopted in various geographical contexts and historical phases. Moreover, we have chosen to highlight extreme scenarios that are not mutually exclusive. Also, while this paper has aimed to characterise hypothetical scenarios, future research might focus on the transitional dynamics required to reach each of the scenarios portrayed, and also deepen the discussion of the role of different societal actors in each of the configurations depicted.

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Category	Number of individuals represented	Gender	Country	Years of relevant experience
Non-profit CE network	1	Female (1)	South Africa (1)	Between 5 and 10 (1)
Non-governmental organisations	2	Female (2)	Belgium (2)	Between 5 and 10 (2)
Private sector organisations	4	Male (2), Female (2)	Greece (2), UK (1), Italy (1)	More than 10 (2) Between 5 and 10 (2)
University sector				
Engineering	2	Male (2)	Italy (2)	More than 10 (2)
Environmental science	2	Male (1), Female (1)	Italy (2)	More than 10 (1) Between 5 and 10 (1)
Economics	3	Male (2), Female (1)	Spain (2), Sweden (1)	More than 10 (3)
Management	7	Male (5), Female (2)	UK (3), Germany (2), Spain (2)	More than 10 (4) Between 5 and 10 (2) Between 1 and 5 (1)

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APPENDIX 3

Number	Question text
1	In what field do you work?
2	What country are you from?
3	What is your field of expertise?
4	How desirable do you see this scenario? [Environmentally] [1,2]
5	How desirable do you see this scenario? [Socially] [1,2]
6	How desirable do you see this scenario? [Economically] [1,2]
7	What are the main social changes that you imagine in this scenario? [1]
8	How plausible do you see this scenario? [1,2]
9	What would be the main barriers and enablers to materialize this scenario? [1]
10	Other comments or remarks [1]
11	Is there any scenario that you consider missing or that should be deleted or merged with other?
12	Do you have other comments or remarks over this set of scenarios?
13	Would you be interested to participate in a next round of feedback related to the assessment of these scenarios?

[1] Asked for each of the nine future scenarios identified by the typology. [2] Ratings based on a four-point Likert scale.

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