European Journal of Futures Research

RESEARCH ARTICLE Open Access

Circular futures under institutional diversity: which organisations and circular practice forms thrive, where and why

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Abstract

Circular futures research has extensively mapped competing imaginaries, but often leaves the institutional conditions for plausibility and scaling insufficiently specified. This article shows how institutional diversity shapes circular futures. Using Jessop's strategic–relational approach, we conceptualise the circular transition as a selection environment and develop eight scenarios that combine three axes (centralisation, growth orientation, and redistributive capacity), operationalised through six institutional dimensions. Through structured coding and pattern analysis, we derive propositions about which organisational archetypes (corporations, SMEs, commons/co-operatives, public sector) become central and how practice families (reduce, reuse, repair, remanufacture, recycle) manifest (e.g. OEM-authorised versus public–community repair). The article makes three contributions: (1) a replicable procedure for building plausible scenarios; (2) five propositions for testing organisational centres and practice variants; and (3) an explanation of why identical instruments (e.g. right to repair, modular eco-design) perform differently across contexts, advancing debates on circular futures and providing guidance for using futures research to design institutionally grounded circular economy policies.

Keywords Futures research, Circular futures, Scenario planning, Circular economy, Organisations, Institutions

Introduction

The circular economy (CE) is becoming increasingly prominent as organisations seek to adapt to and manage the uneven ecological crises currently facing societies [1]. However, implementing CE principles is neither straightforward nor uniform. Rather than serving as a technical blueprint that can be universally applied, CE develops within specific institutional contexts – such as existing norms and cultural frameworks – that favour certain practices and constrain others [2, 3]. Organisational decisions about reducing, reusing, repairing, remanufacturing, or recycling are therefore shaped by institutional arrangements, policy mixes, and prevailing social expectations [4]. Consequently, what is recognised as circular, who is authorised to act, and how value is captured are better understood as institutionally selected rather than technologically predetermined [5].

Building on this understanding, a growing body of literature explores alternative circular futures beyond business as usual. Comparative typologies and scenario analyses map divergent visions, ranging from eco-modernist circularity to convivial and community-led variants [6–8]. Related research examines how ownership

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and value theories shape circular models [9] and investigates policy imaginaries and instruments in specific regions [10]. Collectively, this scholarship approaches CE as a space of competing visions, institutional designs, and organisational forms, broadening circularity beyond a single pathway. This has opened the door to circular futures research, setting the stage for a systematic analysis of how institutional arrangements, actors, circular practices, and the governance architectures that connect them shape each other.

Against this backdrop, research on circular futures has mostly examined how diverse socio-technical imaginaries influence the transition to a CE. By contrast, the roles of institutional configurations and power relations in steering these transitions have received less attention. As a result, studies often overlook institutional diversity and treat the institutional context as a static backdrop rather than a relational arena in which societal actors – including academia, business, public administration, and civil society organisations – co-produce the direction of change. This can result in rigid mappings between a given future and a single dominant circular practice, overlooking the fact that all circular practices recur across scenarios but in different forms, with varying governance, ownership and access rules, patterns of value capture, and degrees of environmental additionality. In sum, institutional diversity permeates the specific forms that circular practices take. Accordingly, there is a clear need to move from broad imaginaries to a more comprehensive assessment of how organisational archetypes interact with institutional contexts, and how this interaction shapes which circular practices thrive and what forms they take. Responding to this need, in this paper we examine how different institutional configurations shape access to value capture within circular economy transitions. In doing so, we contribute to debates on governance architectures, agency, and questions of justice and allocation, while advancing circular futures and sustainability transition research.

In this study, we explicitly frame CE transitions as political processes and model the institutional context along three macro axes: (i) centralisation of authority, (ii) growth orientation, and (iii) redistributive capacity. Drawing on Jessop's strategic–relational approach to the state, we construct eight theoretically grounded scenarios, each specified across six institutional dimensions. We then analyse (a) which organisational archetypes (corporations, SMEs, commons/co-operatives, and public-sector organisations) come to the fore in each institutional configuration, and (b) which forms of each circular practice (reduce, reuse, repair, remanufacture, recycle) gain legitimacy and are likely to thrive – distinguishing, for example, open/collaborative from proprietary/closed arrangements. Our three-step design—(i) specify institutions and build the scenarios, (ii) code organisational archetypes and circular practices in each scenario, and (iii) assess the data with quantitative and qualitative methods – enables systematic cross-scenario comparison. It allows us to move from state-led technocracy to pluralist and market-led arrangements, and to community polycentrism under post-growth. It also generates testable propositions about how organisational archetypes and institutional contexts jointly shape circular practices and their environmental and social outcomes, and theorises how institutional architectures select particular organisational centres and circular practice variants in the governance of CE transitions.

In particular, two analytical research questions structure our analysis:

- RQ1: Under which institutional configurations (operationalised through Jessop's six dimensions) can we expect different organisational archetypes (corporations, SMEs, commons-based organisations, public sector) to become central in circular transitions?
- RQ2: How do alternative institutional mixes – and the organisational centrality they privilege – shape the variants within each circular practice family (reduce, reuse, repair, remanufacture, recycle)?

By addressing these research questions, the paper makes three contributions to organisation-environment scholarship. First, it offers a transparent, replicable, scenario-based procedure for building institutionally plausible configurations using Jessop's six dimensions, based on structured expert elicitation and pattern analysis. Second, it develops five propositions for empirical testing on the selection of organisational centres and circular practice variants. Third, it explains why seemingly identical instruments (e.g. right to repair, modular eco-design) often transfer poorly across contexts, offering guidance for designing institutionally grounded CE policies and a comparative research agenda.

The remainder of this paper is organised as follows. Section 2 provides a critical review of the relevant literature linking CE and institutional theory, with particular focus on circular futures. Section 3 describes the scenario planning methodology and analytical procedures. Section 4 presents the comparative results for RQ1 and RQ2. Section 5 discusses the broader implications for institutional work and policy design. Section 6 offers concluding remarks and suggests avenues for future research.

Theoretical background

Politicising circular imaginaries

The CE has often been promoted as an apolitical, win–win strategy that promises to protect the environment while benefiting businesses, people, and governments [11, 12]. Since the 2010s, policy initiatives such as the European Commission's Circular Economy Action Plan have presented it as a techno-economic model centred on resource efficiency, innovation, and competitiveness, supporting corporate commitments and green investment [13],European [14].

An increasing number of scholars question this neutrality [15]. The CE has been interpreted as an eco-modernist project focused on technological fixes and solutionism [16], and as insufficiently attentive to gender, labour, and environmental justice [17, 18]. Savini [19] argues that it can reproduce inequalities and become a site of private accumulation by dominant actors, extending the reach of capital under the banner of sustainability while marginalising alternative ways of organising production and consumption, and avoiding questions about what is produced, for whom, and why [2].

Against this background, critical and post-growth scholars reframe the CE as a political economy rather than a purely technological project [20]. A growing field of circular futures studies explores alternative imaginaries and pathways, differentiated by governance arrangements (centralised or decentralised), the role of technology (high- or low-tech, prospects for decoupling), and assumptions about growth (continued growth or degrowth) [6, 7]. This scholarship politicises anticipatory imaginaries and raises questions about who has the authority and capacity to steer circular transitions under different socio-ecological conditions.

Typologies such as Circular Modernism or Technocentric CE, Bottom-up Sufficiency, and Reformist or Transformational Circular Society map these alternatives [6, 21]. Circular modernist variants rely on central coordination and high-tech solutions delivered by states and multinationals, based on contested promises of decoupling and facing rebound effects [22, 23]. Sufficiency-oriented variants emphasise low-tech approaches, reduced throughput, and democratic governance within planetary limits, but require deep social change. Reformist variants strengthen the role of the state through regulation, taxation, bans, and welfare support to prioritise functional and ecological outcomes, although their viability depends on political consent [5]. These typologies are useful signposts, yet they remain largely descriptive: they tell us little about the specific institutional conditions under which configurations gain legitimacy and scale, who is authorised to act, and how ownership and access to circular practices are defined. They therefore open, but do not yet fully answer, core earth system governance questions about architectures, agency, justice, and allocation in circular economy transitions.

Institutions and circular practices

In parallel, a second research stream examines how institutional environments shape organisational behaviour, focusing on the rules, policies, norms, and structures that govern CE implementation. Organisational behaviour is shaped by coercive pressures from laws and regulations, normative pressures from professional and societal expectations, and mimetic pressures from imitation of perceived best practices, which produce isomorphism [24]. Together, these pressures help explain why organisations adopt circular or sustainable practices to maintain legitimacy within their institutional fields (see, e.g., [25–27]).

Institutional analysis is now well established within CE scholarship, particularly within what may be described as the circular modernist paradigm. Multinational enterprises (MNEs) are seen as pivotal because they coordinate resource-intensive global supply networks and control key markets for secondary products and materials [28]. Early studies highlighted strong institutional pressures as central drivers of circular and sustainable transitions, with coercive regulation playing a key role in steering firms towards cleaner production (see, e.g., [29, 30]). Subsequent work shows that legislation alone rarely produces systemic transformation [17, 25]. Effective change typically arises from interacting combinations of coercive, normative, and mimetic pressures [31], and firms respond to normative and reputational expectations by adopting certifications and voluntary standards [32] or by publicising CE commitments to enhance legitimacy.

CE adoption frequently relies on inter-organisational collaboration, including meta-organisational structures and orchestration mechanisms that establish shared standards, coordinate resource flows, and foster co-experimentation across sectors [33, 34]. In global value chains, institutional pressures extend beyond individual firms: supply chains function as arenas where expectations and standards diffuse among actors [35], and powerful firms can amplify pressures by enforcing environmental or circular requirements on suppliers [36]. Supply chain integration – through joint planning, information exchange, and relational trust – supports such alignment and helps ensure that circular objectives are shared across partners [31], even where regulatory institutions are weak. Taken together, these dynamics can be seen as emerging governance architectures for circular transitions, in which authority, responsibility, and accountability are distributed across public and private actors at multiple levels.

Yet most CE research still focuses on the circular future that most resembles current institutional and

cultural arrangements – circular modernism – and pays less attention to alternative futures. It often assumes a relatively homogeneous environment that is Western, market-oriented, and growth-driven, underestimating institutional diversity, especially in futures characterised by strong redistribution, equity, justice, or post-growth aspirations [7, 37]. This limits our understanding of how different institutional mixes allocate the benefits and burdens of circular practices, and how alternative governance designs might redistribute access to circular value creation within and across societies.

Gaps and approach: a strategic–relational framework

While circular futures research has illustrated diverse trajectories, it has yet to systematically address the institutional architectures and power relations that determine how such futures materialise. Existing scholarship often leaves the institutional frameworks required to sustain these pathways under-specified, overlooking that transitions are relational processes in which state bodies, companies, and citizens actively co-create possibilities. As a result, circular futures can be oversimplified by assuming a fixed relationship between a specific future and a single practice family (e.g., prioritising recycling over reuse). This neglects the reality that the same practices can take multiple, contested forms depending on who enacts them, under which logics, and with what distributional consequences.

Conversely, CE studies grounded in institutional theories are usually historically or contemporarily oriented and rarely employ prospective methods. Institutions are often portrayed as a static backdrop rather than as dynamic arenas of negotiation, obscuring the power asymmetries that stabilise or suppress different circular futures. Integrating institutional analysis with circular futures enables examination of how these trajectories emerge under different conditions – an urgent task as material-intensive lifestyles conflict with planetary stability. Addressing these gaps requires an integrated framework that links institutional diversity to circular practices and imaginaries, connecting them to questions of governance, agency, and allocation.

To this end, we adopt Jessop's strategic–relational approach (SRA) as our conceptual anchor [38, 39]. We treat the SRA as an institutional theory with a relational core: institutions selectively privilege some strategies and actors while constraining others, and actors work within and upon those structures over time. We also foreground agency,actors engage in institutional work that creates, maintains, or disrupts rules and meanings, navigating overlapping state, market, and community logics [40]. Coordination frequently becomes polycentric, with multiple centres of authority operating across levels [41]. Thus, structural selectivity frames the macro level, while institutional work and logics explain meso–micro mechanisms of agency.

Building on this perspective, we approach the CE as a multi-level selection environment. We analyse how institutions shape circular adoption by focusing on six dimensions proposed by Jessop: representation (agenda-setting access), articulation (coordination across levels), intervention (state steering capacity), social base (the sustaining coalition), state project (the strategic economic aim), and hegemonic vision (the cultural narrative). These dimensions can be linked to Scott's [42] pillars: intervention reflects the coercive pillar,representation and social base reflect the normative pillar; and hegemonic vision reflects the cultural–cognitive pillar. In our study, a future is defined as a configuration across these six dimensions rather than a single label, maintaining focus on mechanisms and avoiding premature simplification.

Jessop's framework is well suited to this task because it links institutional selectivity to situated action. We adapt it to trace, within each configuration, which actors are authorised to act, which interventions are credible, and which narratives legitimise specific practice variants (e.g., corporate leasing versus community hire). This institutional reading replaces the assumption of a homogeneous context with an explicit map of diversity. It explains why identical instruments, such as right-to-repair or modular eco-design, may entrench proprietary loops in one configuration yet enable commons-anchored loops in another. By treating scenarios as plausible bundles of access rules, coordination routines, and strategic projects, we provide a strategic–relational account of how governance architectures select particular organisational centres and circular practice variants across contrasting institutional mixes.

Research method

We use a futures-oriented, scenario-based comparative design [43, 44] based on the authors' expertise and structured self-reflection. The design follows three stages (Fig. 1). First, we specify institutional axes and construct future scenarios using Jessop's six dimensions. Second, we code organisational archetype centrality and the dominant variants of practice families in each scenario using a transparent rubric. Third, we conduct a pattern analysis that combines visual inspection with descriptive, non-inferential rank associations to identify patterns that motivate testable propositions. This is, therefore, an abductive, theory-led futures exercise. Its purpose is to compare alternative institutional futures for the circular economy and to make explicit how different governance configurations may privilege different organisational centres and circular practice variants. All coding is expert-elicited and auditable in Tables 3 and 4 and Supplementary Material A.

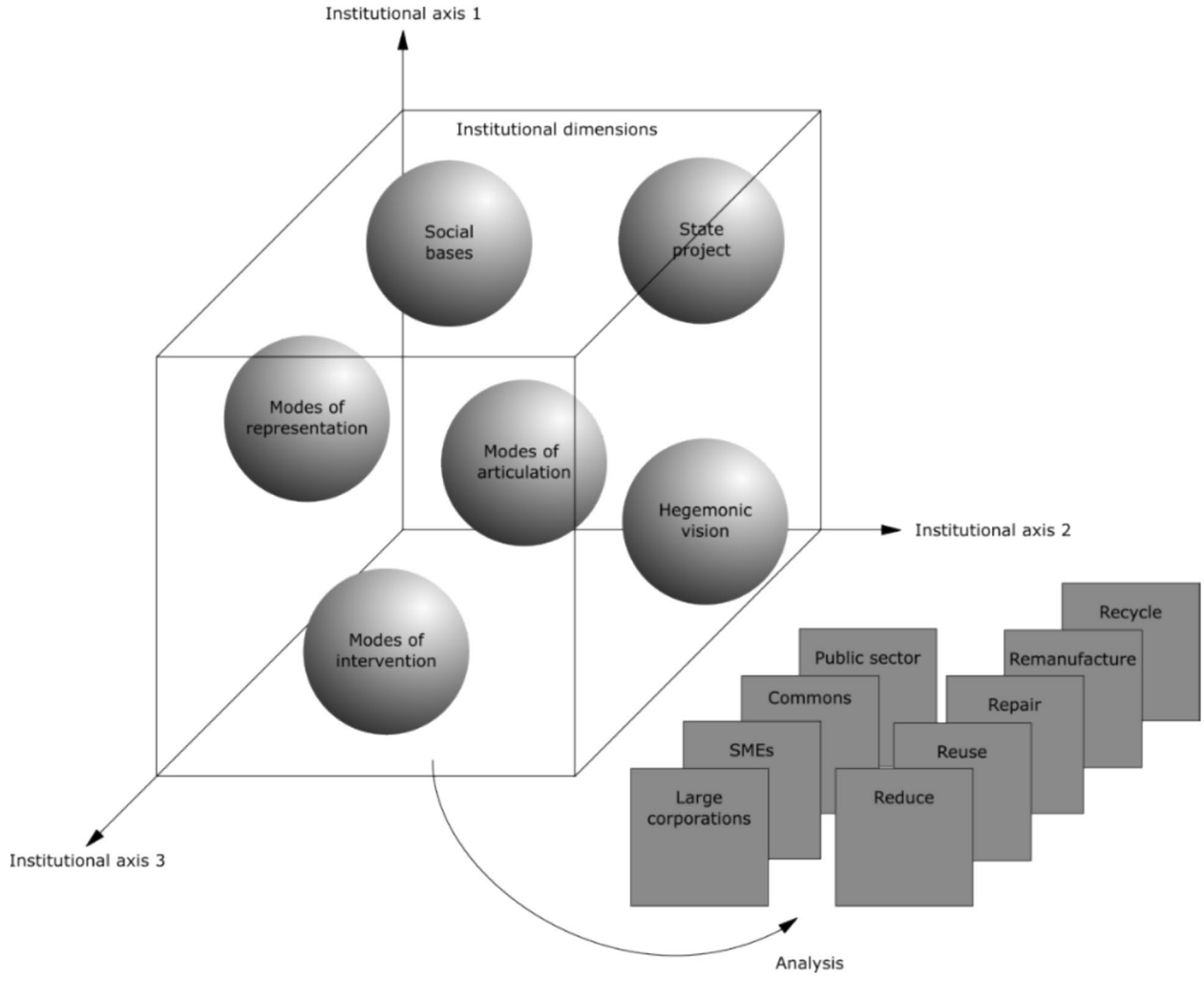


Fig. 1 Methodological process. Selection of institutional axes, development of scenarios using Jessop's dimensions, and analysis of organisational archetypes and CE practices in each scenario

Table 1 Institutional axes used in this research

Axis	Rationale	Coding
Axis 1. Centralisation of authority	Shapes the scope of decision-making and the distribution of power	High/Low
Axis 2. Growth orientation	Distinguishes growth-promoting modernization from post-growth logic	Pro-growth/ Post-growth
Axis 3. Redistribution capacity	The ability/willingness of the state to redistribute value and mitigate inequality, both internally and externally	Extensive/ Limited

Phase 1: selecting the institutional axes

We first identified three macro-institutional axes that capture salient variation in institutional contexts for CE research (Table 1). Drawing on Bishop et al. [44] and Amer et al. [43], axis selection followed three standard principles for robust scenario design: (i) plausibility and relevance (axes must span credible ranges observed in contemporary or historically attested political economies and be decision-relevant for CE),(ii) independence/orthogonality (axes should represent non-redundant sources of uncertainty to avoid overlap and enable genuinely distinct futures); and (iii) internal consistency (axes must be conceptually compatible so that their cross-combinations yield viable, interpretable institutional configurations rather than contradictions).

The central axes were selected and screened against these criteria within the ExPliCit project. After reviewing many candidate axes, they were screened against the above criteria in targeted meetings. The final binary coding on each axis yields eight archetypal institutional configurations (Table 2).

Phase 2: building the scenarios

We developed scenarios using Jessop's [39] six institutional dimensions (Table 3). This produced an 8×6 matrix, with rows representing scenarios (S1–S8) and columns representing dimensions. These are termed

Table 2 Scenarios used in this research

Axis 1	Axis 2	Axis 3	Scenario code	Reference name
High	Pro-growth	Extensive	S1	Corporatist redistributive
		Limited	S2	Corporatist clientelist
	Post-growth	Extensive	S3	Technocracyredistributive
		Limited	S4	Technocracy clientelist
Low	Pro-growth	Extensive	S5	Pluralist redistributive
		Limited	S6	Distributed market
	Post-growth	Extensive	S7	Community redistributive
		Limited	S8	Localist patchwork

"scenarios" because each represents an internally consistent, plausible trajectory for how the political economy of a society could evolve, together with its own logic of governance, economic priorities, and social relations. The set of cells reflects the institutional diversity shaping circular transitions. The original matrix was refined based on feedback from two public workshops held within the ExPliCit project (Brussels, March 2024; Pontevedra, June 2024), attended by 38 participants from academia, policy, business, and civil society.

During the workshops, participants played the Scenario Exploration System [45, 46], using the version adapted for circular economy contexts within the project [47]. The Scenario Exploration System is a participatory foresight tool that uses structured prompts, role-based interaction, and discussion to explore how alternative futures unfold and where tensions or inconsistencies arise. In this study, it was used to gather insights on the internal coherence of the eight scenario configurations and to identify missing links between Jessop's dimensions. As play progressed – manifested through participant choices, questions, and encountered frictions – we noted points of ambiguity and missing links across Jessop's dimensions. The feedback collected during the game helped clarify wording and resolve internal inconsistencies in the scenarios. The authors then made revisions in dedicated meetings and completed the evaluation of the level (low, medium, or high) of each institutional dimension within each scenario. The detailed matrix is provided in Supplementary Material A (Table A1).

We then characterised each cell by inserting one of the descriptors listed in Table 3. The three-level scale (low-medium–high) in Table 3 is theory-driven. We

Table 3 Institutional dimensions used in scenario characterisation. Based on Jessop [39]

Institutional dimension	What this dimension asks	How to recognise it in practice	Descriptors		
			Low (L)	Medium (M)	High (H)
Representation	Who gets routine, agenda-setting access and voice? Not just who is consulted, but who shapes options early	Who sits permanently on councils/boards? Are NGOs there by right or ad hoc? Are hearings binding or symbolic? Diversity of actors in drafting phases	Elite-centred. Early access for governing elites/flagship firms; civil society invited late or symbolically	Limited pluralism. Business and unions have standing seats; some NGO input on specific files	Inclusive pluralism. Civil society, municipalities and marginalised groups have guaranteed seats and co-draft
Articulation	How coherently do institutions coordinate across levels and sectors?	Overlaps/gaps in mandates; frequency of inter-ministerial meetings; shared targets and timelines; existence of joint delivery bodies	Fragmented. Siloed agencies, duplicated pilots, unclear ownership of tasks	Coordinated. Committees/corporatist forums align plans; periodic joint programmes	Integrated. Stable multi-level programmes with shared KPIs; either strong centre or polycentric networks with routine coordination
Intervention	How far does the state steer outcomes (beyond signalling)?	Share of binding rules vs. soft tools; public investment share; presence of SOEs/municipal utilities; enforcement capacity	Market-led. Light rules, reliance on competition and voluntary schemes	Incentive-based. Eco-taxes, subsidies, tradable permits, green vouchers	Directive/public leadership. Mandatory standards/bans, strategic public investment, SOEs deliver core services
Social base	How broad and organised is the coalition that sustains the project?	Number/diversity of organised backers; union and municipal buy-in; community mobilisation; stability across elections	Narrow bloc. Government and/or major firms; little organised support beyond them	Multi-sector coalition. Business + selected unions/NGOs; support is real but uneven	Broad cross-class coalition. Municipalities, unions, SMEs, commons and movements align and stay mobilised
State project	What strategic economic aim orients choices when trade-offs arise?	Language in strategies/budgets; what "wins" when goals conflict; metrics used to judge success	Growth prioritisation. GDP/competitiveness trump distribution/ecology	Eco-modernisation. Green growth via upgrading and clean tech	Post-growth. Wellbeing within planetary limits guides targets and trade-offs
Hegemonic vision	Which cultural narrative makes CE legitimate and desirable?	Dominant frames in media/education; symbols and stories leaders use; public campaigns	Competitiveness. Merit, efficiency, market success as virtue	Sustainability. Impact reduction and social protection as shared goals	Conviviality. Collective care, justice and sufficiency as common sense

Table 4 Organisational archetypes and circular practices

Category	Variable	Operational description	Coding scheme
Organisational archetypes	Large corporations (C)	Multinationals and national champions (≥ 250 employees)	0 = Marginal; 1 = Present; 2 = Central
	SMEs (S)	Independent firms (< 250 employees)	0 = Marginal; 1 = Present; 2 = Central
	Commons-based organisations (O)	Member-owned or mission-driven ventures (e.g., co-operatives, community enterprises)	0 = Marginal; 1 = Present; 2 = Central
	Public-sector organisations (P)	Government agencies, municipal utilities, state-owned enterprises	0 = Marginal; 1 = Present; 2 = Central
Circular practice	Reduce (R)	Strategies that lower material and energy throughput at source	R1 Eco-efficiency; R2 Consumption caps; R3 Industrial symbiosis; R4 Circular public procurement; R5 Sharing economy
	Reuse (U)	Keeping products in use without major transformation	U1 Coordinated distribution (B2B pooling); U2 Deposit–return schemes; U3 Subscriptions (corporate leasing); U4 Servitisation of the economy; U5 Exchange platforms; U6 Product hire schemes
	Repair (P)	Restoring function to extend product life	P1 OEM-authorised repair; P2 Independent repair; P3 Subscription-based repair; P4 Anti-obsolescence; P5 Modular eco-design for repairability
	Remanufacture (M)	Industrial refurbishment of products/components to like-new performance	M1 OEM remanufacturing; M2 Independent remanufacturing; M3 Autonomous remanufacturing
	Recycle (C)	Reprocessing materials at end-of-life	C1 Large-scale treatment plants; C2 Decentralised recycling; C3 Zero-waste programmes; C4 Upcycling; C5 Energy recovery

Abbreviations: *SME* Small and Medium-sized Enterprise, *SOE* State-Owned Enterprise, *OEM* Original Equipment Manufacturer, *B2B* Business-to-Business

established the institutional profile of an "average OECD country" as a baseline reference, defined by the authors as moderate pluralism, committee-based coordination, mixed incentive/regulatory policies, cross-sector coalitions, green growth orientation, and balanced sustainability discourse. Descriptors well above this benchmark were classified as high, those well below as low, and those in between as medium. This baseline allowed for systematic comparison and provided a consistent classification of scenarios, improving both analytical clarity and interpretive accuracy.

Phase 3: codifying and assessing organisational archetypes and circular practices

Phase 3 occurs in three stages. First, we constructed two original matrices: one connecting the eight scenarios to four organisational archetypes (Large Corporations, SMEs, Commons-based organisations, Public-sector organisations), and another linking the scenarios to circular practices (Reduce, Reuse, Repair, Remanufacture, Recycle). For each scenario and practice family, we coded the dominant variant as the one most consistent with the scenario's institutional profile and expected to attract the largest share of activity and legitimacy. Where two variants were equally plausible, we recorded co-dominance and resolved ties during consensus meetings. These judgements were based on published literature, workshop feedback, and the internal logic of the scenarios as specified in Table A1 in Supplementary Material A. The full matrices can be found in Tables A2–A3 in Supplementary Material A.

Second, we applied the coding scheme in Table 4. For organisational archetypes, we coded centrality on a three-point scale (0 = Marginal; 1 = Present; 2 = Central). For the circular practices, we identified the dominant form of each circular practice in each scenario using a mutually exclusive set of codes. Final codes were agreed by the authors after iterative rounds informed by workshop feedback. Our coding of practice variants is indicative, not exhaustive. It reflects current knowledge of plausible forms under each institutional configuration. Other variants may already exist or may emerge over time. The aim is to identify the most probable and illustrative forms given the scenarios, not to catalogue all possibilities.

Third, we complemented heatmaps with descriptive Spearman rank associations (used solely as heuristics, without significance tests), given the small-N, synthetic nature of the observations. These associations do not confirm hypotheses; they merely motivate the propositions developed later.

Results

The results presented in this section show the logical outcomes of our scenario model. Rather than being empirical observations of current events, they are theoretical expectations of which types of organisations and circular practices would dominate if a given institutional scenario became reality.

Scenarios' institutional configurations

Figure 2 displays, in a visual matrix, the eight scenarios (rows) across the six institutional dimensions (columns), coded according to the scheme in Table 3. As noted in Methods, these are author-specified, theory-driven codings, and each scenario should be interpreted as a plausible, simplified institutional archetype rather than a probabilistic forecast.

The Corporatist redistributive scenario (S1) closely resembles the OECD reference used to calibrate the descriptors: five of six dimensions are medium, indicating moderate pluralism, committee-based coordination, incentive-led intervention, an eco-modernist state project, and a sustainability hegemonic vision, with a high social base as the defining feature. From this midpoint, S2 (Corporatist clientelist) suggests a setting characterised by strong elite influence—narrow representation, fragmented coordination, and laissez-faire intervention—in which CE initiatives may be more likely to emerge when they align with incumbent interests. By contrast, S3 (Technocracy redistributive) combines integrated coordination and directive intervention with a post-growth/justice orientation, while representation remains medium given technocratic gate-keeping. A second pairing contrasts S4 (Technocracy clientelist)—high intervention and high articulation but low representation and low social base, suggesting possible elite capture of significant state capacity—with S5 (Pluralist redistributive), where high representation and high articulation meet medium intervention and medium social base/project; here, governance relies on multilevel deliberation and incentives, potentially yielding broad but uneven support for CE.

Among decentralised variants, S6 (Distributed market) features low intervention and a low state project with medium coordination and representation, so CE progress largely depends on entrepreneurial initiative, which may produce spatial and social unevenness. S7 (Community redistributive) is also decentralised but combines high representation and articulation and a high social base with medium intervention – the state funds and sets direction while municipalities, co-operatives, and civil society coordinate implementation. Finally, S8 (Localist patchwork) shares S7's post-growth aim but, with low articulation, intervention and social base, relies on autonomous local initiatives, often resulting in fragmented, geographically uneven CE capacities. A complete table with narrative justifications is provided in Supplementary Material A (Table A1). In what follows, we present three cross-cutting regularities within the author-coded matrix, reflecting internal consistency in our coding.

First, a straightforward scan of the 8 × 6 author-coded matrix shows that the state project tends to align with the hegemonic vision ($\rho \approx 0.83$), reflecting, for example, that post-growth state projects are found alongside justice and wellbeing narratives. Beyond this, the six dimensions vary largely independently, which is what we intended



Fig. 2 Heatmap for scenarios and institutional dimensions. Descriptors are based on Table 3 (H = High; M = Medium; L = Low)

when selecting orthogonal axes; this independence makes the cross-scenario combinations distinctive and interpretable.

Second, the association between redistributive capacity and social base is notable. Scenarios oriented towards redistribution (S1, S3, S5, S7) display broader social bases, with three high and one medium score, compared to low scores in non-redistributive scenarios (S2, S4, S6, S8). Consistent with this, we observe a positive rank-correlation between social base and hegemonic vision ($\rho \approx 0.71$) and a moderate positive association with representation ($\rho \approx 0.59$), indicating that broader coalitions co-occur with more inclusive access and justice-oriented narratives within our coding.

Third, the scenarios suggest that considering the three axes together is crucial for defining their institutional diversity. Sharing two axes does not imply similar institutional realities. S7 and S8 both combine low centralisation with a post-growth project, which might overlap with low-tech and bottom-up governance in Bauwens et al. [6]. However, their different scores on articulation, intervention, and social base produce two very different realities: coordinated community polycentrism in S7 versus fragmented localism in S8. Likewise, post-growth objectives may be advanced through technocratic centralisation (S3) or through decentralised communitarianism (S7). Thus, goals alone do not determine institutional structure,rather, in our framework, the specific institutional mix selects likely centres of authority and determines which CE variants are legitimate, viable, and scalable.

Organisational centrality under different selection environments

Figure 3 illustrates how four organisational archetypes – corporations, SMEs, commons-based organisations, and public-sector organisations – perform across eight scenarios on a three-point scale (0 = marginal; 1 = present; 2 = central). We focus on (i) which archetypes are central in each scenario and (ii) how this centrality relates to the institutional configuration.

Corporations are coded as central in three scenarios (score = 2) in our coding. In our coding, their centrality typically arises where political access is narrow, representation is low, and the social base is limited (S1, S2, S4). However, the underlying logic differs considerably across these cases. In S1 (Corporatist redistributive), corporations share influence within a balanced tripartite arrangement with unions and state agencies. In contrast, in S2 (Corporatist clientelist) and S4 (Technocracy clientelist), corporations tend to dominate in line with restricted pluralism, weak mobilisation, and limited redistribution. Overall, the coding patterns indicate that corporate centrality increases as representation narrows (Spearman $\rho \approx -0.69$) and declines when commons-based organisations gain ground ($\rho \approx -0.77$), consistent with a potential crowding-out of grassroots actors under elite-centred governance.

SMEs are coded as central in two scenarios (score = 2): S5 (Pluralist redistributive) and S6 (Distributed market). SME centrality tends to be higher in these scenarios under conditions characterised by moderate to high political articulation and limited to moderate state intervention. This combination creates a balance for

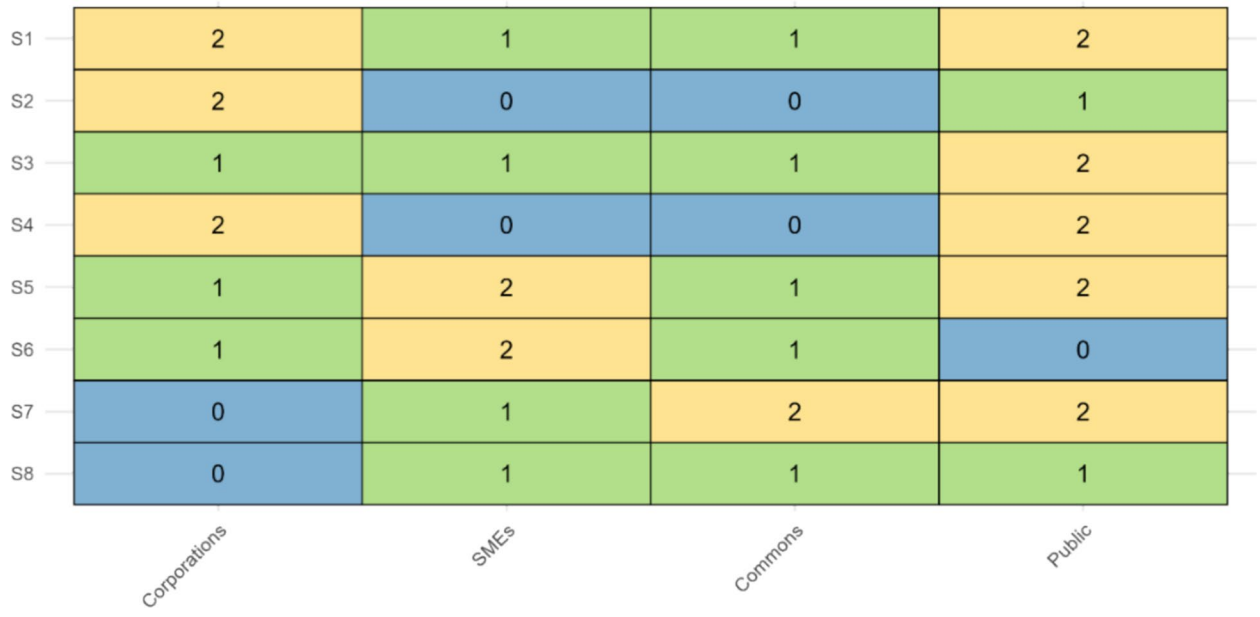


Fig. 3 Heatmap for scenarios and organisational archetypes. Descriptors are based on Table 4 (0 = marginal; 1 = present; 2 = central)

SMEs between coordination with peers and supply-chain partners and regulatory flexibility that enables SMEs to expand their circular activities. By contrast, SMEs face challenges under highly directive regimes (S3–S4, scores 0–1), where compliance costs are higher, and in fragmented contexts (S2, S8), where the absence of coordination fora may limit partnering and market access. Moreover, SME centrality tends to rise with broader representation ($\rho \approx 0.75$), consistent with their affinity for inclusive, participatory governance.

Commons-based organisations (co-operatives and community-led ventures) are coded as central only in S7 (Community redistributive) (score = 2). There, inclusive representation, strong articulation, redistribution, and a post-growth agenda align to elevate commons-based organisations. In S1, S3, S5, S6, and S8, commons-based organisations are present but peripheral (score = 1); in S2 and S4, they are marginal. The clearest pattern in our heuristic associations is with representation ($\rho \approx 0.89$), suggesting that inclusive access is a strong enabling condition for commons-led circularity to move beyond niche status.

Public-sector organisations are coded as central in five scenarios (S1, S3–S5, S7), making them the most frequently central archetype in this set. Their prominence appears closely related to institutional arrangements characterised by a high degree of intervention and articulation. Strong, directive states (S3, S4) tend to strengthen public institutions by investing in state-owned enterprises and infrastructure, thereby enhancing public-sector organisations' capacity. The Pluralist redistributive (S5) and Community redistributive (S7) scenarios also bring public-sector organisations to prominence through multi-level coordination, community leadership, and decentralised implementation. Conversely, where intervention is weak or coordination fragmented (S6, S8), public-sector organisations are coded as peripheral or marginal. Overall, public-sector centrality correlates positively with intervention ($\rho \approx 0.79$) and articulation ($\rho \approx 0.77$), consistent with the idea that coherent state capabilities enable public-led CE roll-outs.

Which practice variants recur under which institutional mixes

We mapped the practice variants defined in Table 4 onto the eight scenarios to examine how each family – reduce, reuse, repair, remanufacture and recycle – takes shape in different institutional settings (see Table A3 for the full matrix). Below, we define the dominant variants – those most likely to gain legitimacy and scale within that configuration – based on our author-elicited coding.

For reducing, the picture shifts from eco-efficiency to sufficiency measures, with industrial symbiosis present in many settings. Industrial symbiosis (R3) is coded as dominant in S1, S4 and S6, which aligns with both state-steered industrial strategy (S1 and S4, where eco-parks and coordination are funded or enabled by government and incumbent corporations are central) and entrepreneur-led efficiency under light intervention (S6, where SMEs dominate and ministries largely act separately). Eco-efficiency (R1) is the dominant coded variant in S1, S2, S5 and S6, aligning with pro-growth agendas and competitiveness narratives; incentives, taxes and energy-efficiency programmes in S1 and S5 appear to stabilise incremental upgrades, while standards in S2 privilege particular product architectures. By contrast, sufficiency instruments appear where strong direction or legitimacy for demand reduction exists. In S3, consumption caps (R2) are mandated to curb material and energy footprints and are reinforced by circular public procurement (R4) that sets a floor for design and lifetime. In S7, voluntary caps (R2) sit alongside a sharing ethos (R5) rooted in broad coalitions and commons narratives, while S8 shows uneven adoption as capabilities and support vary across municipalities. S3 also combines symbiosis (R3) with high public control, indicating that efficiency and sufficiency can co-exist when state capacity, planning and funding align.

Reuse practices move along a spectrum from firm-controlled access to open or community-led access. Subscriptions and corporate leasing (U3) are prominent in S1, S2 and S4, where incumbent corporations retain life-cycle control and policy frameworks accommodate long-term service contracts; in S2 and S4, this is paired with deposit–return schemes (U2) run by incumbent corporations, while in S1 deposit–return (U2) operates with state support. In S3, deposit–return is brought under public control (U2) and coordinated distribution (B2B pooling, U1) is mandated, channelling flows through integrated logistics; this pattern suggests that central coordination and incumbent strength favour closed-loop, asset-controlled reuse. Where coordination is used to solve collective action problems rather than to entrench control, pooling arrangements emerge for cost reasons: in S5, firms adopt B2B pooling (U1) across sectors to save on capital and utilisation. Pluralist and community settings broaden the menu: servitisation (U4) grows as a market opportunity in S5 and S6, but in S7 it is led by co-operatives and commons-based spaces; exchange platforms (U5) and product hire schemes (U6) scale in S5–S7 and appear with unequal access in S8, where local wealth and capacity shape who can participate.

Repair shows a clear split between brand-controlled ecosystems and independent or community repair, with design and anti-obsolescence provisions shaping feasibility. OEM-authorised repair (P1) is central in S1, S2 and S4, often reinforced by warranties, permits or subscription services (P3) in S2 and S4, suggesting that where

representation is narrow and incumbent corporations are strong, downstream value capture remains with brands. Independent repair (P2) recurs widely but takes different forms: in S1, vouchers help authorised independent providers; in S3, subsidised official networks expand access and are underpinned by the right to repair; in S5 and S6, SMEs compete on price and convenience under moderate or light intervention; in S7, public–community hubs (repair cafés) and self-guided repair at home are commonplace; in S8, formal and informal arrangements mix, with coverage depending on local initiative. Measures that change product rules alter the balance. Anti-obsolescence (P4) arrives through stringent law in S3, through standards promoted by large corporations in S4, and via mobilisation around the right to repair in S7; modular eco-design for repairability (P5) is mandated in S3 with a common standard, pursued competitively in S5 as a differentiation strategy, and developed openly in S7 through peer-to-peer learning. Together, these combinations suggest that inclusion, standard-setting and design rules create space for independent and community repair to scale, whereas exclusive permits and service contracts keep repair within OEM circuits.

Remanufacturing ranges from closed OEM loops to independent and autonomous models. OEM remanufacturing (M1) underpins S1, S2, and S4, and in S3 it is combined with centralised reverse logistics—consistent with strong coordination, public procurement, and the presence of national champions. Independent remanufacturing (M2) expands through public–private consortia in S1 (combining access to parts with private execution), through SME competition in S5 and S6 (lower entry barriers and local market niches), and as dispersed activity in S8, where scale is limited but experimentation continues. Autonomous remanufacturing (M3) is enabled in S3 by standardisation and open guidance, scales through SME–Common based organisations collaboration in S5, anchors public–community hubs in S7 with local employment objectives, and is likely to scale in home-based or informal forms in S8. The contrast between S3 and S7 is instructive: both expand M3, but one does so via mandatory standards and state guidance, the other through commons capabilities and municipal support.

Recycling alternates between large, centralised facilities and more local, distributed approaches, with upcycling and energy recovery emerging in specific contexts. Large-scale treatment plants (C1) dominate in S2 and S4 and operate under public control in S3; S1 features public–private configurations with licensed operators alongside regional infrastructure. This pattern aligns with centralised finance, risk-bearing, and incumbent participation. Decentralised recycling (C2) appears in S1 through licensed operators, in S5 via public–private initiatives, in S6 through private competition for waste streams, and in S8 with uneven provision, suggesting that articulation and resources shape coverage and quality, and that coordination gaps result in patchy service. Zero-waste programmes (C3) are mandatory in S3 and municipal or community-led in S5 and S7, indicating that both directive and participatory routes can institutionalise prevention and separation. Upcycling (C4) supports competitiveness strategies in S5, where firms capture niche value, while energy recovery (C5) is likely to scale in S2 and S4 for residual streams and is more plausible in formal and informal forms in S8 when other loops fail to close.

Discussion

Reflections on scenario regularities and propositions

Our cross-case comparison invites a broader discussion on how different institutional configurations actively govern circular economy transitions, challenging the apolitical character of dominant CE narratives. Taken together, the scenario patterns show that circular governance is not primarily a technical design issue but a distributional one: who gains access, how coordination is organised, and which narratives legitimise action together determine which versions of circular loops scale. From these patterns, we derive five propositions, listed in Table 5 with their practical implications. Future empirical work – using case studies, longitudinal designs or system simulations – can test and refine these propositions.

First, who gains routine access to decision-making arenas, and how broad the supporting coalition is, together shape both the organisational landscape and the ownership of circular loops. Narrow access tends to favour incumbent corporations and closed, firm-controlled models. Broad access combined with redistribution creates opportunities for SMEs, municipalities and commons-based organisations, and with them, more open forms of circularity. In our scenarios, S2 and S4 elevate corporations and corporate-owned loops, S7 brings commons-based organisations and public–commons loops into the mainstream, and S5 expands opportunities for SMEs alongside public bodies. This pattern underpins two propositions. P1 states that limited access with competitiveness-led steering tends to centre corporations and consolidate proprietary loops such as leasing, OEM repair and closed-loop remanufacturing. P2 states that broad representation with redistributive capacity makes it more likely that SMEs and commons become central, and that inclusive variants gain legitimacy and scale, such as public–community repair and autonomous remanufacturing. These patterns show how different access rules and coalitions underpin distinct governance architectures for circular practices.

Second, steering and decentralisation function differently depending on redistribution and coordination.

Table 5 Main propositions (scenario-informed) and practical implications

Proposition	What the results show	Practical implications
P1: Access by ownership	When access to decision-making is limited and state steering is strong within competitiveness frameworks, corporations become central and proprietary loops dominate. This may consolidate leasing, OEM repair, and closed-loop remanufacturing	If policy prioritises e.g. reuse or repair under these conditions, proprietary circuits will dominate unless rules deliberately ensure open access
P2: Inclusive access	Broad representation, combined with redistributive capacity, is the most powerful option to enable SMEs and commons to become central, thereby supporting inclusive forms of circular practices (e.g. public–community repair and autonomous remanufacturing)	To foster more inclusive forms of circularity, it may be necessary to design programmes with co-production, municipal anchoring, and stable funding for grassroots infrastructures
P3: Articulation effect	Greater coordination across levels and sectors enables collective action and reduces transaction costs, for example by facilitating pooled distribution, shared logistics, and organised reverse flows	To enable, for example, reuse and remanufacturing networks to operate reliably across jurisdictions, it may be necessary to invest in durable coordination bodies and shared metrics
P4: Intervention as capacity-building	Some important circular practices –such as standards-based repair and the institutionalisation of zero-waste programmes– require intervention to move beyond signalling and promote enforceable rules	Governments can combine regulatory instruments with public procurement, finance, and enforcement
P5: Narrative alignment	Justice and wellbeing frames enhance the legitimacy of sufficiency measures compared with efficiency alone. Within these narratives, consumption caps and sharing strategies, for example, become more acceptable and actionable	Narrative alignment requires embedding wellbeing indicators alongside economic metrics and aligning communication and education strategies with ecologically sustainable and socially just goals

Strong steering without redistribution can entrench incumbents, as in S4 where corporate leasing, OEM repair and closed-loop remanufacturing dominate. Decentralisation without redistribution fragments provision and reduces access, as in S8 with uneven independent repair, dispersed remanufacturing and patchy recycling. Where redistribution is present, decentralisation becomes a strength rather than a source of unevenness, as in S7. This supports two further propositions. P3 states that better coordination across levels and sectors lowers transaction costs and enables collective action, making pooled distribution, shared logistics and organised reverse flows more feasible across jurisdictions. P4 states that to embed practices such as standards-based repair and zero-waste, intervention must go beyond signalling, combining rules with procurement, finance and enforcement to build delivery capacity. In this sense, multi-level coordination and public intervention are not merely background conditions but central mechanisms through which circular governance is organised.

Third, the dominant narrative shapes legitimacy and therefore what scales. Frames centred on equity and wellbeing align with public or commons options, for example independent repair through public–community hubs and autonomous remanufacturing, whereas growth and competitiveness frames stabilise proprietary circuits such as corporate leasing and OEM repair. P5 follows from this. It states that justice and wellbeing frames increase the acceptability of sufficiency measures – for example, consumption caps and sharing – compared with efficiency alone, which improves their chances of adoption and scale. Narratives and imaginaries thus work as a cultural infrastructure for governing circular futures, making some trajectories appear reasonable and others excessive or unthinkable.

These propositions point to practical steps. It is helpful to clarify intended outcomes for ownership and access alongside technical targets. Strengthening coordination can reduce future transaction costs, even if it requires more effort initially. Rules are more effective when paired with procurement, finance and enforcement. Choices within repair, remanufacturing and recycling depend on the variant that policymakers wish to favour, since different variants require different approaches to access, standards, finance and oversight. Finally, instruments are more effective when the narrative that surrounds them fits their aims. Equity and wellbeing frames appear to increase the acceptability of sufficiency and open variants, although discourse alone will not deliver inclusion without matched institutional change.

Main contributions to circular futures research and governance

Our results yield three main contributions. First, we present a transparent and repeatable method for constructing institutionally plausible scenarios. We define the selection environment using Jessop's six dimensions, then code organisational centres and likely practice variants with a clear rubric and descriptive checks. This makes our assumptions visible, reusable, and open to challenge. Other researchers can adapt the matrix, thresholds, and cases to different sectors, regions, or time periods. Unlike typologies such as Bauwens et al. [6] or Calisto-Friant et al. [7], which mainly describe what different futures look like based on diverse imaginaries, our framework draws on established scenario design criteria discussed by Bishop et al. [44] and Amer et al. [43], such as plausibility, independence between axes, and internal consistency, and offers a systematic way to compare governance configurations for circular economy transitions.

Second, we propose five conditional propositions linking institutional mixes to organisational centrality and circular practice variants. The scenarios reveal a clear pattern: narrow access under competitiveness tends to favour corporations and proprietary loops, while broader access with redistribution creates more space for SMEs, commons-based organisations, and open variants. Strong coordination reduces transaction costs for pooled distribution and reverse flows. Interventions that combine rules with procurement, finance, and enforcement build delivery capacity. Frames of justice and wellbeing make sufficiency measures more acceptable. These are hypotheses to test rather than claims to assert, but they provide a clear map of how representation, articulation, intervention, social base, state project, and hegemonic vision may shape outcomes. This directly addresses debates on CE as a field shaped by value capture, ownership, and private accumulation [2, 9, 19], or alternatively by more plural and redistributive arrangements. It also connects our fifth proposition to work on depoliticisation and competing CE narratives [10, 16, 20, 37] by showing that justice and wellbeing frames do not merely describe futures,they also help make some variants more legitimate and actionable.

Third, we show that the same policy instrument often functions very differently across contexts, and that small institutional shifts can tip the balance. Comparing nearby scenarios that differ on only one dimension reveals how modest changes can reweight ownership and actor centrality. Moving from low to medium representation, or improving articulation through a standing intergovernmental forum, can plausibly shift repair from OEM-authorised to independent or public–community forms. High intervention combined with low representation under a competitiveness frame still entrenches proprietary circuits, as in S4, whereas high representation and articulation with redistribution broadens participation, as in S7. In short, outcomes depend on who has routine access, how competences are coordinated, what capacities are funded, and which narratives legitimise policies. This underlines the importance of context-sensitive governance design and can help policymakers tailor right to repair, modular eco-design, circular procurement, and related tools to the institutional mix they encounter. It also helps explain why broad typologies are useful as imaginaries but less able to anticipate implementation outcomes: they do not specify the institutional conditions that shape delivery, ownership, and scale.

Limitations of the study

Several limitations should be considered regarding the generalisation and reproducibility of results. First, as this research is based on a foresight exercise, some ideal–typical simplification is unavoidable. Each scenario deliberately highlights particular combinations of centralisation, growth orientation, and redistributive capacity to sharpen contrasts and achieve theoretical clarity. Real governance settings rarely match these extremes; they are hybrid, dynamic, and shaped by history, institutional legacies, and shifting coalitions. Most circular transitions will fall between our archetypes or move across them over time. Future research could explore such hybrids by pairing scenario analysis with in-depth case studies or comparative historical work.

A second limitation is small-N inference. Our descriptive checks (frequencies and Spearman ranks) are based on eight synthetic observations and therefore cannot support conventional significance testing. Correlations should be interpreted as heuristic indicators that aid interpretation rather than as confirmations. Stronger quantitative analysis would require more stylised cases or longitudinal, country-level data that operationalise the same dimensions, followed by cross-national comparisons using historical-institutional methods.

Third, subjective coding affects interpretability. Although our H/M/L classifications and centrality judgements follow a transparent rubric and were refined through targeted meetings, workshop feedback, and iterative consensus, some subjectivity remains. Different expert panels or participatory methods (for example, Delphi surveys with policymakers, industry, and civil society) might produce different thresholds or scores. Future work could complement expert coding with automated text analysis of policy documents, institutional records, or expert discourse to increase transparency and reduce coder bias.

Finally, the scenarios offer static snapshots. They capture institutional and organisational archetypes at a single analytical moment and abstract from feedback through

which circular practices may reshape institutions. Grassroots successes may broaden coalitions; incumbents may adapt strategies as values shift. While modelling such feedback lies beyond our scope, process tracing and longitudinal mixed methods could examine how dimensions co-evolve and how practice variants shift as coalitions and narratives change.

Conclusions

In this article, we have considered circular futures as institutionally selected rather than technology-led. Using Jessop's six dimensions, we developed eight plausible future scenarios and examined how organisational archetypes and circular practice families shift across them. This approach shifts the debate from counting loops to explaining which versions of those loops gain legitimacy and scale, and why, highlighting the governance arrangements through which circular practices are organised, authorised, and stabilised.

In doing so, we directly addressed our two research questions. Regarding RQ1, we illustrated that the centrality of different organisational archetypes (corporations, SMEs, commons, public sector) is heavily contingent on specific institutional configurations, such as the degree of representation and redistributive capacity. Addressing RQ2, we showed that these institutional mixes, and the privileged actors within them, actively shape the specific variants of circular practices (reduce, reuse, repair, remanufacture, recycle) that gain legitimacy, moving beyond homogeneous interpretations of circular loops. In summary, the research presents three key contributions to circular futures research and governance.

First, we provide a transparent and repeatable method for building plausible future scenarios. The matrix of six dimensions, the coding rubric for organisational centrality and practice variants, and the simple pattern checks make our assumptions explicit and easy to reuse or challenge. Together, they offer a structured way to compare alternative governance architectures for circular futures.

Second, we present five propositions linking institutional mixes to who becomes central and which practice variants thrive: (i) narrow interests representation combined with non-redistributive mechanisms tends to centre corporations and proprietary loops; (ii) broader interests representation with redistribution creates space for SMEs and commons-based organisations, supporting variants of circular economy outcomes beyond corporate control; (iii) improved coordination in multi-level governance lowers transaction costs in the mid- and long-term, enabling required circular variants; (iv) regulatory instruments are crucial to complement incentive measures, promoting enforceable rules and moving beyond signalling; and (v) post-growth frames, narratives and discourses have the potential to drive changes towards scenarios that integrate environmental sustainability and social justice. These propositions connect specific institutional dimensions to concrete outcomes in terms of agency, coordination, and the allocation of circular value.

Third, we explain why identical instruments often work differently across contexts. Small shifts in a single institutional dimension can change who owns and operates circular practices. In this regard, the same instrument (e.g. right-to-repair rule or modular eco-design requirement) can entrench closed privately controlled loops in one context and enable public–community repair or autonomous remanufacturing in another, depending on the exact combination of representation, articulation, intervention, social bases, state project, and hegemonic view.

These insights suggest practical steps. Policymakers should clarify desired outcomes for ownership and access alongside technical targets. They can strengthen coordination to reduce future transaction costs, and pair regulation with procurement, finance, and enforcement to build circularity. They should align communication and education with post-growth goals when the aim is to legitimise circular economy variants that align with environmental sustainability and social justice. Above all, they can adjust access rules, coordination routines, and redistributive tools to favour the versions of circularity that match declared social and environmental goals, recognising that these choices are fundamentally questions of governance rather than purely technical design.

The framework therefore offers a clear path for empirical work. Future studies can track institutional mixes and practice variants over time, examine how overlapping configurations coexist within sectors and territories, and use discourse data to study how narratives interact with instrument design. At its core, this agenda recognises that the CE is institutionally diverse. What scales depends not just on technology, but on whose interests are better represented in policymaking, how coordination is organised, the level of governmental intervention, which initiatives are more supported, and which narratives make policies seem more natural and obvious. Making these selection mechanisms visible helps design circular policies that are effective, context-aware, and place environmental sustainability, social justice, and wellbeing at the centre of transition.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40309-026-00270-2.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements

All authors acknowledge the HORIZON-MSCA-2021-SE project ExPliCit (GA: 101086465). Brais Suárez-Eiroa acknowledges the support of the Postdoctoral

Program Xunta de Galicia under grant ED481B-2023-011, funded by the Consellería de Cultura, Educación, Formación Profesional e Universidades. Aitor Alonso-Rodríguez acknowledges the support of the Predoctoral Program Xunta de Galicia under grant ED481A2024-190 – Grant co-financed by the European Union under the FSE+ Galicia 2021-2027. Funding for open access charge: Universidade de Vigo/CISUG.

Authors' contributions
All authors contributed to conceptualisation, methodology, investigation, formal analysis, interpretation of results, writing of both the original draft and the review and editing. All authors read and approved the final manuscript.

Funding
This work was partially supported by the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie Actions Staff Exchanges project ExPliCit – Exploring Plausible Circular futures [grant agreement No. 101086465]. Brais Suárez-Eiroa acknowledges the support of the Postdoctoral Program Xunta de Galicia under grant ED481B-2023–011, funded by the Consellería de Cultura, Educación, Formación Profesional e Universidades. Aitor Alonso-Rodríguez acknowledges the support of the Predoctoral Program Xunta de Galicia under grant ED481A2024-190 – Grant co-financed by the European Union under the FSE+ Galicia 2021-2027. Funding for open access charge: Universidade de Vigo/CISUG.

Data availability
All data are explicitly provided in the article and supplementary material files.

Declarations

Ethics approval and consent to participate
Ethical approval was not required.

Consent for publication
Consent for publication was not required.

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

Received: 5 February 2026 / Accepted: 14 April 2026
Published online: 04 May 2026

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