



Is Convergence Around The Circular Economy Necessary? Exploring the Productivity of Divergence in US Circular Economy Discourse and Practice

Brianne Berry¹ · Jamie Haverkamp² · Cindy Isenhour³ · Melissa M. Bilec⁴ ·
Sara Sophia Lowden¹

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Abstract

Amid the growth of circular economy research, policy, and practice, there are increasingly loud calls for a unified and singular definition of circularity. This unity is needed, proponents argue, to enable swift action in the face of climate and environmental crises. Our work interrogates the ideal of convergence around the circular economy. We ask whether circularity must be singular and uniform in order to be effective. Based on convergence science research and social theory rooted in ideas of divergence, our paper draws on observations of a convergence science workshop, focus groups, interviews, and questionnaires with US-based circular economy professionals to explore shared and divergent understandings and practices of circularity. We find that even among a relatively homogeneous group of research participants (in terms of race, class, and education), there is significant divergence in terms of both practices and perceptions of circular economy principles. We focus in this paper on how research participants understand innovation in the circular economy as just one potential illustration of divergent circularity. Our research contributes to an understanding of circular economy knowledge politics, illuminating how circularity is contested even among those who advocate most strongly for its implementation. We ultimately find opportunity and promise precisely in the spaces of contestation, and see divergence as a way to hold space for multiple ways of being and relating to economies, materials, and beings. These more inclusive pathways, we argue, may be necessary to ensure just and effective transitions to more circular economic forms.

Keywords Convergence · Divergence · Circular economies · USA · Innovation

✉ Brianne Berry
Brianne.berry@maine.edu

¹ Department of Anthropology, University of Maine, 5773 South Stevens Hall, Orono, ME 04469, USA

² Department of Sociology & Anthropology, James Madison University, Harrisonburg, VA, USA

³ Department of Anthropology & Climate Change Institute, University of Maine, Orono, ME, USA

⁴ Department of Civil and Environmental Engineering, Mascaro Center for Sustainable Innovation, Pittsburgh, PA, USA

Introduction

Attention to circular economies has been rapidly growing in academic, policy, and business spheres in recent years [35, 36]. Amid this growth, however, is a persistent cry that “the” circular economy lacks a singular definition that can orient and unite those eager to transform linear systems [55]. Indeed scholars have argued that there is an urgency to more clearly conceptualize The Circular Economy¹ so that it does not “fall victim to dissonant views” [84, 259]. The need to transform economies of take-make-waste [26] into more circular systems is motivated in part by urgent climate and environmental crises, propelled by wasteful economic systems that extract, produce, consume, and dispose of goods at truly astonishing rates.

Despite urgent calls for convergence around The Circular Economy [e.g., 76]—a singular, global economic model—policies and programs have emerged with significant variation on an international scale [84]. Some regions have prioritized an industry-led and market-based approach to facilitate the emergence of new business models [54]. Others have focused on top-down technological shifts and governmental directives for industrial collaboration [67]. Geographical differences aside, it seems “paradigmatic clarity regarding the concept of CE has yet to emerge” on any scale [11, 610]. Some have argued that the concept of circular economy is an “empty signifier” which currently allows for a wide range of disparate interpretations [32, 101] that may limit its effectiveness as a concept for sustainability [33].

This paper joins recent efforts to document divergent conceptualizations of circular economies in the academic literature and among practitioners [11, 84, 20, 32, 34]. As participants in two large transdisciplinary research projects focused on convergence science for circular economies in the USA, our work has taken particular interest in diverse actors’ ideas about, expertise, and experiences with circular economies. The Circular Economy seems a good space for convergence science—an approach to working across systems of expertise and experience, one that theoretically goes beyond multi- or transdisciplinary research to solve complex societal challenges [77]. The goal is to create new ways of thinking and innovations that would otherwise not be possible by simply combining disciplinary insights—results greater than the sum of their parts [86]. Members of our author team collaborated in a National Science Foundation workshop designed to foster convergence around waste reduction as well as a large interdisciplinary research project that emphasized convergence around The Circular Economy. In both these efforts, researchers and stakeholders from diverse positions in practice and within academia were brought together to explore the potential for more circular systems of production, consumption, and disposal. In this paper, we draw upon our observations as participants in these projects, as well as a series of questionnaires, focus groups, and interviews to document significant divergence in the ways that circular economies are conceptualized among US sustainability experts and professionals.

This paper was inspired by our observations—in our convergence science research engagements—that there is a tendency to gloss over divergences in the interest of convergence which

¹ “The Circular Economy” is invoked here as a totalizing economic form of circularity and as opposed to “circular economy” or “economies” plural. The Circular Economy should be read as an undifferentiated monolith, ontologically and epistemologically homogenous. It is the dominant form of the global circular economy that emerges as “ideal,” “rational,” and legitimate and as the arbiter of all forms of alternative circularity.

was imagined as a kind of consensus, where researchers and stakeholders are meant to come to a shared understanding of both a problem and potential solutions. We see promise in the concept of convergence as it suggests that we should be working toward shared broad goals, even if we approach these issues from diverse perspectives [86].

Given these observations, our overarching research question asks if convergence is necessary, or even desirable, to make progress toward more circular economic systems. While we agree that circularity is critical to addressing the climate and environmental crises, we argue that the urgency of the problem risks—in the race to create The Circular Economy—the exclusion of more just, effective, and diverse circular economies. Thus, we question whether the idea of convergence, without intervention and additional clarity, might be flattening differences and silencing some voices—pushing us to work toward The Circular Economy—a (singular) and hegemonic version of circularity based on a technocratic approach to resource efficiency and “weak” rather than “strong” forms of sustainability [20, 40, 105]. Scholars have demonstrated the risks of such totalizing narratives, articulating how singular ideas all too often present significant threats to equitable and effective sustainability programming [16, 17]. Indeed, in our work, we found meaning and value precisely in areas of *divergence*.

The overarching aim of this paper is, therefore, to create more space for divergent conceptualizations of circularity within convergence frameworks—divergence that does not flatten differences but enables multiple pathways and equitable outcomes for diverse actors. In this work, we build on the research of scholars who have argued that divergences may “facilitate as opposed to thwart coordination among heterogenous actors” [92, 191, 105], and which might open “the imaginary regarding the many circular futures that can exist” and allow for the “cross pollination of ideas, policy options, strategies, practices and solutions” [32, 2]. While we recognize the urgency of problems related to climate, consumption, resource use, and waste, we draw upon our research with stakeholders to argue that it is important to maintain and create space for divergent thinking to ensure the emergence of strong and just forms of circularity.

In what follows, we outline the discursive urgency that has prompted rapid action on convergence around The Circular Economy, and how circularity and convergence have been conceptualized in the scholarly literature. We then explain our methods for exploring the potential for convergence on core circular economy principles, with a particular emphasis on the principle of innovation, which was repeatedly ranked as the most important core principle of circular economies by participants in our focus groups. We observe that in these groups, what initially seems like strong convergence around the core principle of innovation, when explored further, actually masks underlying divergence. We conclude by reflecting on the potential for embracing divergence as a critical component of both convergence and circular economies.

Literature Review

Circular Economies and Complexity

Advocates argue that implementation of The Circular Economy on a global scale could achieve important environmental outcomes, like effectively closing the climate mitigation gap, as well as generating significant economic and environmental co-benefits [45]. But the urgent need for action is complicated by the complex nature of the challenges researchers and

practitioners are attempting to address [56]. In the context of materials economies, the problems are situated within and between numerous academic disciplines, and include questions about what economies are for and under which principles they should operate, how materials are designed, manufactured, and managed at their end-of-life, and how people can and should relate to each other and to material goods. One of the common drivers of research on circular economies is, however, an understanding that linear systems of take-make-waste [26] are ecologically unsustainable, economically inefficient, and socially inequitable.

Circular economies are intended to be complex systems with intertwined economic, social, and environmental objectives enacted by a wide range of participants, including the business community, as well as government and non-governmental actors from the local to the global scale [58]. The issues addressed by circular economies include resource use and extraction, emissions and climate change, consumption and overconsumption, resource recovery and disposal infrastructures, economic growth in the context of finite resources, and more. This broad span of interests can create tensions when scholars, policymakers, and activists seek singular definitions of circularity. Korhonen and colleagues argue that “CE should be understood as an essentially contested concept,” where there are “disagreements on how to define it, which units of analyses to use to capture the dynamism, what the conceptual cornerstones are and what methodology of enquiry is appropriate” [56, 545]. Similarly, Kovacic and colleagues describe circular economies as “a Pandora’s box of strong and contradictory claims about the economy and the environment and what ought to be done with the two” [57, 5]. Amid this complexity, contestation, and contradiction, scholars have outlined a vast range of perspectives at play in the realm of circular economies.

Various scholars have attempted to outline and classify different perspectives on circularity. Tensions exist between the dominant views of the eco-modernists—who see The Circular Economy as a strategy for green economic growth, one that can decouple resource use from ecological harm through innovation and technological efficiencies—and those who advocate for more transformative or “strong” forms of circularity based on a prioritization of principles of environmental justice, fairness, and well-being [32, 34, 44]. Scholars in the latter group cite a considerable amount of data which suggest that the eco-modernist approach is unlikely to be strong enough to avoid overlapping environmental crises [47, 1, 22, 66]. These pro- and post-growth perspectives certainly seem incompatible for convergence around shared goals for more circular economic forms [5, 34, 38, 88].

Other analytical frames have achieved more complexity by classifying perspectives on multiple axes of differentiation. Friant and colleagues, for example, classify circular economy perspectives based on their level of holism/segmented thinking and their relative optimism or skepticism. They propose four primary groups of thought: the “holistic optimists” who see circularity as an achievable project of systemic capitalist reform for human well-being; the “segmented optimists” who see an achievable path toward a technocentric approach to economic reform; the “holistic skeptics” who argue that it will be necessary to undertake a radical transformation to a circular society that is unlikely given the current dominance of eco-modernist perspectives; and finally the “segmented skeptics” who limit their scope of consideration to the economy and see no alternatives to capitalism. Corvellec and colleagues note that while more radical agendas for circularity have been proposed, they “tend to be overlooked” [20, 98].

These wide-ranging perspectives on circularity allow us to identify a range of principles that, for different actors, might underpin their perceptions of circularity. While circular economy principles have often been described in terms of implementation (i.e., 3Rs principle, sustainable design strategies) [e.g., 55, 27, 35], here we understand principles less as answering “how” questions, and more as “what” and “why” [76]. To that end, we highlight eleven principles supported in the academic literature that underpin different perspectives on circularity (see Table 1).

Table 1 Circular economy principles

Principle	Literature
Innovation	Pieroni, McAloone, and Pigosso [82], de Jesus and Mendonça [51], Kirchherr et al. [54], Prieto-Sandoval, Jaca, and Ormazabal [83]
Transformation	Chizaryfard, Trucco, and Nuur [18], Hobson and Lynch [40], Termeer and Metze [97], Zhu et al. [107]
Cooperation	Luo et al. [65], Dora [23], Jaeger and Upadhyay [48], Ruggieri et al. [87], Hjaltadóttir and Hild [39]
Efficiency	Zink and Geyer [108], Morsetto [72], Korhonen et al. [56], Tukker [99]
Fairness	Johansson and Henriksson [52], Li et al. [64], Ünal and Shao [100]
Transparency	Hjaltadóttir and Hild [39], Iacovidou et al. [42], Centobelli et al. [15]
Growth	Kirchherr [53], Millar, McLaughlin, and Börger [71]; Bauwens [5], Hysa et al. [41]; Clube and Tennant [19]
Reform	Nechifor et al. [74], Luo et al. [65], Vence and Pérez [102]
Well-being	Geissdoerfer et al. [33], Su et al. [95], Ghisellini, Cialani, and Ulgiati [35], Borrello, Cembalo, and D'Amico [12], Fioramonti, Coscieme, and Mortensen [31]
Modernization	Luo et al. [65], Park, Sarkis, and Wu [80]; Leipold [62], Sehnem et al. [89]; Clube and Tennant [19]
Environmental Justice	Pansera, Genovese, and Ripa [79]; Niskanen, McLaren, and Anshelm [75]; Gregson et al. [36]

These principles are not distinct, but rather overlapping and nuanced sets of priorities that order how circularity is understood and potential solutions ordered by different groups of stakeholders. Both scholars and, as we found, practitioners frequently disagree on the definition and meaning of these terms (see coming sections).

Amid this complexity, there is an understandable urge to come to a consensus—to find common ground, and to work toward a solution that might be mutually agreeable to all actors [84, 259; 76]. Kirchherr and colleagues, for example, raise concerns about the proliferation of definitions and understandings of circular economies [55]. Indeed, within the complex concept of circular economy, there are multiple entangled components that cannot be meaningfully separated and we are left with ambiguous terms, variously defined and often frustratingly vague. The fuzziness of the concept of circular economy, though, “is not due to lack of precision but to the fact that precision is spurious in the context of complexity. Different options refer to different representations [of the problem]” [59, 162]. As Kovacic and colleagues write, “although a lot of information can be produced about [...] the circular economy, there is no univocal way to combine these representations” [59, 162]. Similarly, Korhonen and colleagues argue that “A single universal definition [of circularity] borders the impossible and should not be attempted, because it will always exclude some interests and because it is dynamic and evolving” [56, 548]. Despite this formidable complexity, recent efforts to tackle complex challenges through the lens of convergence science have emerged, discussed below.

Convergence Science

Scholars have, relatively recently, begun to address complex challenges through the lens of convergence science. Convergence “refers to a strategy for reaching a shared goal in a system” [85, 2] by adapting, innovating, and integrating diverse forms of knowledge [4]. While convergence science has largely been used in biology, engineering, mathematics, and computational sciences [24, 367; 2], it has also been taken up by large research

funding organizations, like the US National Science Foundation's Convergence Accelerator program, which aims to "accelerate" multidisciplinary teams to "deliver high-impact solutions that meet societal needs" [78].

The convergence science literature suggests that convergence does not happen in methods or strategies, which must be diverse to be transformational, but instead at a higher level, where agreement on broad goals is what is critical [29]. Roco [85] describes a "convergence spiral" that moves through four phases: convergence-confluence, convergence-integration, divergence-innovation, and divergence-spin-off. While the convergence spiral is intended to draw on diverse epistemologies and to produce diverse practices, the model hinges on the assumption that processes of confluence and integration will result in a shared goal, one that can then be utilized to produce diverse innovation and solutions. In this paper, we are concerned with the knowledge politics of the confluence and integration stages. As knowledge systems flow together and are integrated, whose understanding of circularity influences the creation of shared goals, and in the case of divergence, whose ideas take precedence? Are all voices truly at the table? Roco talks about a "science push" towards integration that can later create a divergence "spin-off" where the components that were integrated are used to create a "technology pull" [85, 9]. But are scientists and technocrats the only actors involved in this push toward integrating knowledge for circular economies? Are communities that have never abandoned circular practices consulted or given a seat at the table?

Divergence and Plurality

If divergence is an important feature of the "convergence spiral," the conceptual narrowing that is intended to take place first might give us pause. Bainbridge and Roco write that "convergence aims at *realizing unity* in knowledge, technology, and societal systems" [4, 211 emphasis ours]. Yet, does the process towards unity engender a flattening or disavowal of alternatives and social difference, and in so doing reproduce social inequalities?

The foreclosure of diverse options and the disregard for democratic deliberation in sustainability practice is well-documented [8, 14, 73, 96]. All too often sustainability programs with the best intentions have, in either their urgency and/or lack of attention, resulted in exclusion, the reproduction of disadvantage, or novel societal rifts. Checker [17] and Tretter [98], for example, document how urban greening projects have resulted in gentrification such that long-time, low-income residents can no longer afford to live in their own neighborhoods. In rural Peru, indigenous agro-pastoralists are being pushed off their ancestral land in the name of climate adaptation, and to ensure enough clean drinking water for wealthy urbanites and agribusiness downstream [37]. In Delhi, energy efficiency initiatives have displaced communities and put hundreds of washerpeople out of work in the name of modern green aesthetics [81]. Similarly waste reduction initiatives sold as win-win solutions to urgent problems of pollution and inefficiency have exacerbated racialized societal rifts as communities dependent on discards are excluded from increasingly commodified waste streams [EJ 25]. In the context of circular economies, many scholars have now documented the danger of excluding social considerations in the transition toward more circular economic forms [7, 20, 43]. Issues associated with inclusion, access, empowerment, and justice in the transition to more circular economic forms must be addressed [32] if we are to ensure just and effective outcomes that do not (re)produce disadvantage for some segments of society. Zapata and Zapata [106], for example, document how the recent transition to circularity has often excluded the waste pickers who have historically played such an important role in resource recovery.

Social projects that operationalize a totalizing vision of sustainability have consistently been shown to yield distorting and uneven outcomes that often exacerbate harm to historically marginalized groups [3, 91]. Placing totalizing social projects in the longer historical context, scholars of science and technology studies, postcolonialism, and feminist studies have critiqued the ways in which universal dreams and schemes, articulated with notions of progress, technology, and desirable futures, promulgated global social projects such as modern colonization, modernization, and imperial nation-building [50, 68].

Thus, we are cautious of similar framings of circularity [34] that envision a totalizing formulation of The Circular Economy to the exclusion of heterogenous renderings of circular economies (plural). The Anthropocene and concomitant climate crisis is understood as an invitation for humanity to rethink and reflect different understandings about how to live sustainably and in harmony on this Earth [14]. Yet, as post-political authors argue, it appears that instead of a wide and wild array of proposals for living with nature(s), heterogenous visions are collapsed into a single proposal [9, 96]. Corvellec, Böhm, Stowell, and Valenzuela make this point explicit within the context of circular economies, stating that despite wide-ranging ambiguity around what the circular economy is, “influential economic and political actors have been allowed to hegemonize the CE discourse, [resulting in] the narrowing down of latent possibilities” [20, 97]. Such depoliticization of Anthropocene politics is an emptying out of the political from decision-making spaces, which creates conditions without the possibility for disagreement and non-consensus [96]. In these post-political approaches to contemporary grand challenges, the status quo is often “sustained” and entrenched in a single, hegemonic vision of sustainable futures [9, 96]—The Circular Economy as opposed to multiple circular economies.

Isabelle Stengers [94] calls into question the desire for convergence in science and technology worlds and suggests that there are social, economic, and political differences that cannot be reconciled into a singular, onto-epistemic domain or meta-language. Such incommensurability between divergent ideas and practices of circularity allows for no middle ground—no neutral space of common agreement—in conceptualizing and practicing circular economies. Diverging paradigms means a breakdown in communication between actors—in part due to equivocal differences [103] and the lack of a meta-language from which to organize around [94]. Thus, efforts to create a singular Circular Economy risk the erasure or negation of difference. Allowing for radical difference and incommensurability while still working towards a common goal of livable and sustainable worlds appears not to be the goal of convergence or consensus politics [96]. Advocates for “uncommoning” encourage instead a commitment to divergence [10], and for accommodating multiple possibilities in a “pluriverse” [30]. As Stengers puts it, within the fractured and multiple space of divergent worlds, “plurality means divergences that communicate, but partially, always partially” [94, 61]. That the communication across incommensurable differences is partial is precisely what enables multiplicity and precludes the emergence of totalizing social projects.

In what follows, we draw upon these two bodies of literature—convergence and divergence—to explore whether convergence around “The Circular Economy” seems desirable, or even possible among the sustainability professionals who participated in our research.

Methods

This research is part of a larger, multidisciplinary project that includes a team of engineers, industrial ecologists, chemists and materials scientists, sustainability scientists, anthropologists, and economists. As part of these larger efforts to converge around The

Circular Economy, our research sub-group sought to inform the team's work with stakeholder engagement—to better understand the perspectives and priorities of diverse actors who were likely to be involved in the transition toward more circular economic forms. We sought to understand how research participants thought about the circular economy, its ultimate goals, barriers to adoption, key action priorities, and the possibilities for convergence. Our engagement efforts included a series of focus groups composed of 5–13 stakeholders each ($n=7$ focus groups) as well as a pre-focus group questionnaire ($n=65$). We conducted semi-structured interviews ($n=6$) with those who volunteered to participate but could not accommodate the focus group meeting in their schedule.

We constructed a database of 204 US-based sustainability professionals representing public, private, and non-governmental sectors from seven different locations within a conceptual circular economy: (1) thought leaders, (2) designers and engineers, (3) producers and supply chain managers, (4) retailers, (5) reuse & repair organizations, (6) materials managers, and (7) individuals engaged in circular economy policy. Potential participants were identified based on their engagement in US circular economy discourse, including membership in professional networks, authorship of gray literature (business, organizational, and policy documents), and as searches for sustainability-related titles at organizations making efforts to build more circular economies. All individuals added to the database were US-based professionals 18 years and older. We worked to ensure that our invitation lists included individuals who represented a range of geographical, gendered, and racial identities, though we note that many of our focus groups had poor representation of people of color. We invited individuals via email, which included a consent form and a link to the pre-focus group questionnaire.

Pre-focus Group Questionnaires

Prior to each focus group, we distributed an online questionnaire to determine how different participants and groups conceptualize circular economies, the core principles they prioritize, and the actions they see as most important for moving towards circularity. We provided a list of eleven principles commonly cited in circular economy literature: innovation, transformation, cooperation, efficiency, fairness, transparency, growth, reform, well-being, modernization, and environmental justice (see Table 1). Participants were also asked to indicate their familiarity with and responsibility for circular economy in their professional roles and to rank core principles of circular economies from most important to least important.

The questionnaire results were used to guide the conversations in focus groups, as well as to analyze trends across participants and groups. Because participants filled out the questionnaire in advance of the focus groups, 13 participants completed a questionnaire and could not ultimately attend a focus group, although 6 of these participants were subsequently interviewed (see below). Our team collected 65 completed questionnaires.

Focus Groups

The stakeholder engagement team generated qualitative data through the use of seven online focus groups with circular economy stakeholders based in the USA. Focus groups centered around areas of consensus and disagreement on the core principles and key action levers needed for the transition to more circular economic forms. Focus groups were conducted on a videoconferencing platform, and lasted 90 min. Each group had between 5

and 10 participants; however, to maintain a maximum group size of ten participants, our fifth focus group, reuse and repair, was divided into two separate groups (5a and 5b). Six participants were not able to attend their focus group and instead were interviewed. There were 52 individuals that participated in the focus groups and 6 in interviews, for a total of 58 participants (see Table 2).

Focus groups are used to “find out *why* people feel as they do about something” [6, 173]. Our use of focus groups was driven by our goal to understand why circular economy stakeholders prioritized specific principles and actions over others. We explored these ideas as individual attributes informed by positionality within the circular economy. As such, our focus groups were not intended to estimate population parameters or causal effects [6, 174]. We also sought to explore how participants articulated policy and principle stances in dialogue with each other. As Creswell writes, “focus groups are advantageous when the interaction among interviewees will likely yield the best information” [21, 133]. Through careful facilitation designed to encourage equal participation [21], we were able to explore convergence and divergence through multivocal dialogue.

We developed a facilitation plan for focus groups that maintained a common structure while allowing us to customize our conversations based on data generated in the pre-focus group questionnaires. We began each focus group with introductory activities meant to build comfort and establish rapport [6]. Each focus group followed an identical outline: participants were broken into small groups (Zoom breakout rooms) for 20 min with a facilitator and notetaker in each breakout room. The first breakout room conversation was dedicated to exploring the core principles of circularity. Participants were shown principle ranking results from the questionnaire and were asked to discuss the results in groups of two to four individuals. Facilitators asked probing questions, while notetakers observed not just what was said, but how dialogue unfolded—including tensions and body language. All participants returned to the full group for a moderated conversation about the key principles of circular economies, and then were led into a second round of breakout rooms to discuss key action priorities. After a 20-min facilitated breakout session, participants again returned to the full group for a closing discussion. Our use of small groups allowed us to ensure that participants were able to contribute to the conversation, particularly given the constraints of a videoconferencing platform where conversations can feel stifled and are easily dominated by a small number of contributors. By using breakout rooms, we could better prompt participants to join the conversation, resulting in higher levels of spontaneous interaction [104]. Despite the limitations of videoconferencing, we found the focus groups to be sites of rich, detailed conversations.

Members of our research team transcribed the focus groups and interviews using Trint, an online, AI-based software. We then used NVivo 12 to analyze the qualitative data. We performed three rounds of coding, first using protocol coding to organize our qualitative data “according to a preestablished [...] system” [69, 78]. Subsequent coding cycles were used to develop subcodes and identify patterns [69, 88–89]. Our analysis in this paper centers on participants’ rankings of core principles for circular economies.

Results

In this paper, we focus on a subset of our research results, participants’ views on innovation as a core circular economy principle. Innovation, in this context, serves as an illustrative case which reflects both an ideology of convergence and deep divergences among

Table 2 Focus group participants

Focus group	Description	Sectors represented	Areas of emphasis	# Participants
FG1: CE Thought Leaders	US-based professionals with leadership roles in visioning/advancing CE	Business, Non-profit, Government	Recycling, electronics, consumer goods, plastics	10
FG2: Engineering & Design	US-based professionals with ties to design (buildings, packaging, products)	Business, Non-profit	Built environment, packaging, recycling	5
FG3: Production & Supply Chain	US-based professionals with ties to production/supply chain expertise	Business, Non-profit	Consumer goods, supply chains, plastics	6
FG4: Retail	US-based professionals with ties to retail and distribution	Business, Non-profit	Electronics, consumer goods, textiles, policy	5
FG5a: Reuse & Repair	US-based professionals with ties to reuse and repair	Business, Non-profit	Electronics, repair, remanufacturing, consumer goods	5
FG5b: Reuse & Repair	US-based professionals with ties to reuse and repair	Business, Non-profit, Government, Research	Medical supplies, municipal reuse, consumer goods, electronics	8
FG6: Materials Managers	US-based professionals with ties to materials management	Business, Non-profit	Recycling, food waste	6
FG7: Policy	US-based professionals with ties to policy	Non-profit, Government	Recycling, policy, electronics, built environment	7
FG participants				52
Interview participants				6

participants that became increasingly apparent throughout our research. While we certainly could have chosen other focus group discussions to illustrate areas of both convergence and divergence, we found the conversations around innovation particularly revealing.² In what follows, we use the principle of innovation as a means to explore the nature and consequences of this divergence and what it means for our understanding of convergence and divergence in the context of circular economies.

When we structured our focus groups, we used intentionally capacious circular economy “core principle” categories that were meant to spark conversation and deep discussion among focus group participants around diverse meanings and values associated with these terms. This ambiguity was noted by several participants in reference to the term “innovation,” who commented that “innovation can be taken several different ways” (FG3), that the term is “misused and overused” (FG3), and that innovation is “kind of a buzzword that goes along with circular economy” (FG5). Yet many participants used the term in a normative sense—as in “we have to innovate because what’s been done is not working. So you have to innovate” (FG7), or the comment that “we certainly support innovation as a key lever here” (FG1). These comments, and many like them, contain layers of implicit meaning about the nature and purpose of innovation in the context of circularity.

When we began our analysis of pre-focus group questionnaire results, we were surprised by the seeming convergence around core principles of circular economies. A plurality of focus group participants—19 total, 36%—ranked “innovation” as the most important core principle to circularity. Ten participants (19%) identified environmental justice as the most important core principle, followed by cooperation (15%) and transformation (15%). The seeming convergence was all the more interesting because it transcended positional-ity—that is to say, some participants in each focus group ranked “innovation” as the most important core principle (see Fig. 1).

Because we utilized a ranking system for the questionnaire, we were able to assign scores to participants’ responses, allowing us to evaluate how important each principle was relative to all of the other principles—assessing their full weight rather than just how participants ranked their top principle. When we analyze these normalized results (see Fig. 2), we see that while innovation is again the top principle, now it is followed by cooperation, transformation, efficiency, transparency, and then environmental justice. This shift represents the fact that while a substantial number of our participants ranked environmental justice as their top principle, many others ranked it among the least important principles. This mathematical exercise illuminates some of the challenges in identifying areas of potential convergence within circular economy discourse. Indeed, how we account for (and value) difference is critical to understanding pathways toward circularity.

Yet we want to maintain a steady focus on the seeming-convergence around the principle of innovation, which was, by a plurality, the top principle for our stakeholders, as well as the most important relative to the others when we averaged results from the questionnaire. For what emerged in our conversations with participants during the focus groups was significant divergence in *how innovation is defined* and *the goals of innovation in a circular economy*. These alternative conceptualizations of innovation provide just one window into the divergence that exists among participants and their understandings of the most basic goals of the circular economy. That is to say, the agreement around the broad concept of

² We note that rich debate emerged around many principles over the course of our focus groups. Our emphasis on innovation here is motivated by its consistent ranking as a core principle of circularity across different focus groups, and does not suggest that other principles were irrelevant or uncontested.

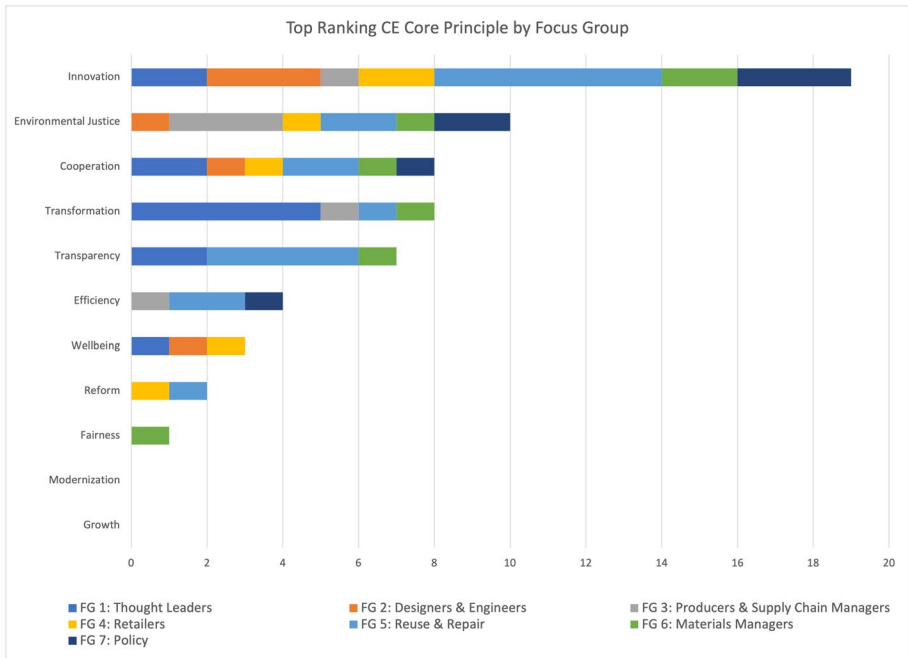


Fig. 1 Rankings of core principles by CE stakeholders

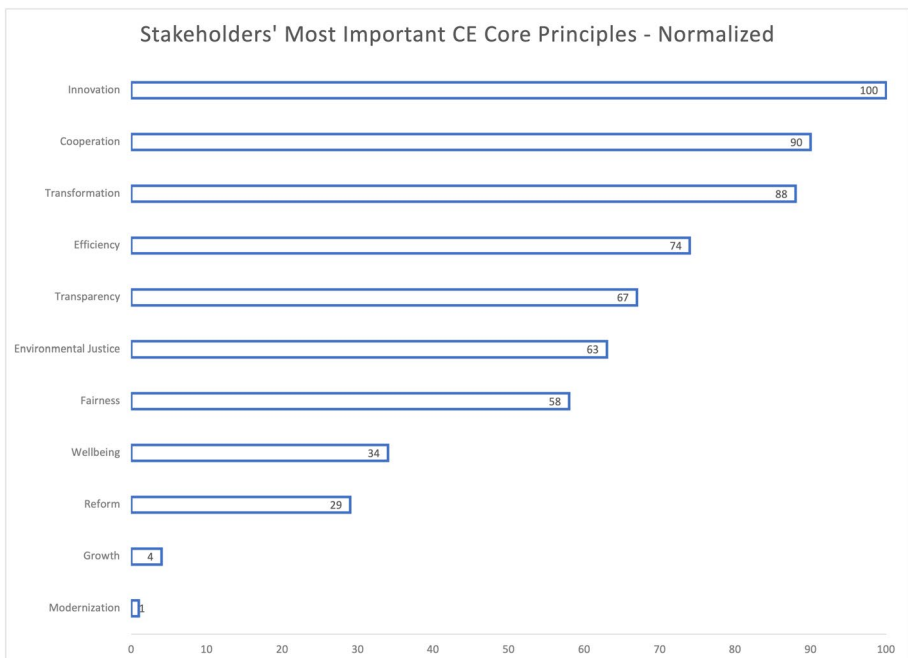


Fig. 2 Core principle rankings normalized

innovation seems to be a false convergence that draws into question whether circular economy professionals are working toward a common goal as imagined by convergence science literature. As we dove into the principle in greater detail during our conversations in the focus groups, we began to see participants organizing around several different conceptualizations of innovation.

Some participants made these divergent perspectives on innovation and its implications for understanding the goal of circular economies apparent during interviews or in sometimes charged focus group discussions. For example, one participant came back to the large group discussion from a breakout room to recount an argument:

Allyson³ and I were having a disagreement where I think the last thing the circular economy needs is more innovation. And Allyson's coming from the nonprofit world and saying, 'hey, innovation is still very important to me.' I think innovation is what got us into this mess. And we need to go back to the way things used to be... One hundred years ago we had a circular economy, right? I mean, in many parts of the world we do now. (FG5a, 4/1/21)

As we progressed through the focus groups and our analysis of transcripts, we began to see a number of different conceptualizations of innovation emerge. For some, innovation was linked to new business models or technologies. For others, innovation implied much more than technological improvements designed to increase the efficiency of production-consumption-disposal systems. In observing these different conceptualizations of a single core principle, we were struck by what they implied for convergence around a shared goal for circularity.

Innovation as technical improvement: new materials and business models

Focus group conversations about innovation often featured examples like LED light bulbs or new materials, innovative technologies that made simple but potentially important contributions to waste reduction and circularity through improved materials efficiency. Some of our participants provided specific examples from their own work. For example, Tyler, who participated in the production and supply chain group, told us:

Well, innovation for us means research and development. We spend a lot of money trying to emulate the properties of petrochemicals using natural renewable materials that are both biodegradable and compostable or at the same time can be recycled under certain circumstances. So that's innovation in that broad category." (FG3, 2/16/21)

For Tyler and others who seemed to conceptualize innovation as a technological and managerial process, efforts to move toward circularity present a win-win scenario for both the environment and business. Tyler argued that innovation provides "a profit incentive to people that normally would already have, let's say, entrenched views about how they want the economy to work" (FG3, 2/16/21). From this perspective, innovation is, in part, about figuring out how to capitalize on circular economy initiatives, to make them profitable. Tyler later went on to say:

I've got a technology that cleans up coal fly ash ... and also makes a high profit doing it...we're going to be able to take their coal and try to convert it to graphene and gra-

³ Participants have been assigned pseudonyms to protect their privacy.

phene oxide directly. So instead of converting it to carbon for forty dollars or whatever, they get two hundred dollars a ton...At that point, the coal industry has a financial incentive to stop being the enemy of sustainable practices and more importantly, to stop influencing against electrification... at that point, innovation does create a different financial paradigm around sustainability for one of the dinosaurs of our system that really is resisting it right now. So I do see that technical innovation converting to a financial windfall, which should have some influence on management, thinking and even culture. These are very, very old businesses, some of the oldest businesses that we have. But you're paying a seven million dollar check out in front of them and say, why would you take two hundred dollars when you can have this? Now you get people listening to you. So I think there's an economic innovation basis to our transformation economy. (FG3, 2/16/21)

Some participants echoed Tyler's suggestion that more circular materials and practices could be profitable to argue that innovation was not just about materials, but also about rethinking business models. While these participants talked about systems innovation, we found that they were primarily talking about business models. Take, for example, this quote from Gregory, a participant in the retail and distribution focus group who came back into the large group discussion with the comment,

we were talking about innovation in the previous group with Arjun and myself. And it was like some people think about innovation, like materials and technology, but systems innovation is super exciting and there's huge potential with systems innovation. And so for us, like a lot of these new business models for getting like to-go food delivered to your house, for example, in reusable containers instead of throwaway containers. Or reuse/refill systems for personal care products instead of just another plastic bottle. That stuff really gets us excited. (FG4, 3/18/21)

Tyler and others who seemed to think of innovation as a way to leverage markets toward greener options (also present in the thought leader and retail focus groups) often talked about innovation as a gateway to The Circular Economy. Tyler later said, for example,

I also work in innovation, in bioplastics. And for me, I see it as being like the transitional answer. I think that there's this big leap that has to happen from linear economy to a circular economy, and you can't just walk backwards. And so, I think that innovation is actually what allows that transition into the circular. (FG3, 2/16/21)

Some participants imagined that this innovation gateway to The Circular Economy would lead to additional co-benefits through the demonstration of financial benefit and establishment of trust. One participant in the reuse group, explaining why the core principles of environmental justice, well-being, and fairness ranked lower than innovation, claimed that innovation for The Circular Economy could deliver these core principles:

Environmental justice and fairness and well-being are really important to me. But those seem to be the...I don't know what the right word is, but...If we can be effective in innovating and implementing a circular economy, we will see those other things come into play. (FG5b, 4/5/21)

We note that for those who seem to think about innovation as an opportunity to improve and strengthen the current system through technological and material efficiency gains and novel business models, the competitive market is seen as a key lever to achieve the ultimate goal of The Circular Economy—a stronger and growing green economy.

Systemic Innovation as Cooperation

Some research participants reacted strongly when we presented our charts indicating that the majority of their fellow participants had ranked innovation as the most important core principle of circularity. Clearly exasperated, Arjun, an independent business owner that makes customized modular and repairable smartphones, seemed to respond to the chart and Tyler's strong claims about innovation:

I mean, we are making thinner and better and faster, but do we need faster? Do we need thinner? No one is asking that. Right? And going back to what you said, Aiden, do we have enough raw materials to keep making it? No one is thinking about that right now. Let's stop and think. And do we need to make it thinner or just thin enough that it can be repaired easily? So I think innovation, in this space, to me is just rethinking that system or maybe just the way we do things rather than new technology, new AI, a better chemical, a better polymer. (FG3, 2/16/21)

Another participant soon backed up Arjun's perspective saying:

I find the word innovation to be misused and overused. I don't think that these are-innovation in particular is a principle important to circular economy. Certainly, it's necessary to innovate, to drive change, but that doesn't mean the innovation will be circular or that it's a principle upon which you should base the circular economy. (FG3, 2/16/21)

These sentiments were echoed in most focus groups among others who argued that innovation focused on new technologies and business models was not what was needed, as one participant in the reuse focus group said:

To me, innovation means we have to just rethink things, I guess - like to put it most simply - I feel like sometimes it's taken to mean that we have to have the most advanced technology or whatever. I feel like that's often not the case. And a lot of the circular economy solutions that I think are most powerful are very, very simple and involve just a lot of communication and collaboration. (FG5b, 4/5/21)

Others echoed this sentiment, arguing that we have a long history of circular practices and that, in fact, many circular economic systems exist all over the world, "in Delhi, Accra and Nairobi and Cape Town" (FG4, 3/18/21) that deserve both recognition and support. In fact, at least one participant in each focus group made some sort of reference to looking back in time or to existing forms of circularity for inspiration. For these participants, the goal was not necessarily more modernization through innovation, but rather a more circular economic form that avoided crisis while providing for well-being. One participant, for example, said:

I think that innovation is going to be absolutely necessary, but I totally understand Brett's point of view - that it's a buzzword that could just be the way everybody imagines their way out of this. We're going to invent something to clean the carbon. You know, the exponential rate at which the human species is improving life for ourselves is coming at the expense of all of the other species. ...And I think that that future is going to have innovation, but we're most likely to get to the future without having created mass extinction and mass exhaustion of all resources... if we cooperate. (FG4, 3/18/21)

Those who critiqued innovation as a core strategy, in fact, often did so on the basis of the need for cooperation. For these participants, cooperation is also a form of innovation that implies more than the voluntary investments of individual businesses interested in competitive advantage. We heard this theme across the focus groups, most notably in the production and supply chain, retail, reuse, materials management, and policy groups who noted that they were not able to make these transitions alone. One participant in the policy group argued:

Absolutely cooperation. Yeah, it's totally essential because we've been operating as islands, which is why we find ourselves in the trouble that we're in. The word innovation, to me, that sends me off in the opposite direction, because legislatively we have the manufacturers who are the most egregious abusers of the non-circular economy saying, 'oh, but we can't do this because it'll crush innovation.' And I see that word and I go crazy because we do need a lot of innovation. We don't need it to come from the monopolies that are making all of these circular things impossible. (FG7, 5/17/21)

In contrast to perspectives on innovation intended to increase competitiveness, innovation conceived as cooperation seemed to imply rethinking the competitive pressures that drive growth in both production and consumption. Some noted with disdain that population and material use continue to grow, even in the face of significant material efficiencies and innovation. In focus group 3, one participant gave the example of apparel which she noted is “doing two to three times as many units globally than we were 15 years ago.” Another said “We can’t just continue to buy more and more stuff and expect it, because it’s quote-unquote ‘biodegradable and compostable’ to solve the problem.” A third participant agreed, noting that innovation is a consciousness-soother for employees and consumers without really “turning the ship.” The same participant later went on to say, “it doesn’t matter how innovative a product is unless you have really changed systems through that cooperation” (FG3, 2/16/21).

Alex, an architect focused on designing for circularity, identified the need for innovation that is both technical and social—one that can improve cooperation. She said:

“fundamentally we’re going to need frameworks for cooperation, which is why the circular economy framework is such an interesting one. It begins to sort of propose that it is something that needs to happen. And then, obviously, in order to execute and apply these principles, there’s going to have to be a lot of innovation across so many different subjects. I think there might be an assumption from like, I guess, from certain points of view - that innovation really has to happen in their space. But this is innovation that is both technical and social. So it’s a socio-technical innovation proposition, I think. (FG2, 12/15/20)

For some, the innovation needed was in the policy space that might help drive more systemic changes across supply chains. Participants mentioned the need for “governmental systems in infrastructure” to modify systems and provide incentives for larger systemic changes, as opposed to “one off” solutions (FG3, 2/16/21). Samantha, who runs a zero-waste non-profit consulting and advocacy group, argued:

So a really simple system innovation — which works — is the bottle bill. Like we live in a bottle bill state like, you know, like 96, 97 percent of PET plastic bottles get collected for recycling because of that financial incentive. So that’s an innovative thing

that can be replicated and scaled. And so, there's a lot of room for systems innovation, not just materials or technology. (FG3, 2/16/21)

For participants like Samantha who seemed to define innovation in terms of cooperative frameworks, the goal of circularity was an efficient and integrated system that was coordinated across different actors, perhaps increasing the effectiveness of the whole system. These participants seemed to question the neoliberal, market-based model of voluntary business-led innovation without similar commitments from governments to help coordinate and drive innovation at the systems level.

Innovation as Circular Society

Other participants seemed to understand innovation in a more philosophical and perhaps more radical way, one that demands innovations in how we think about the purpose of our economies and their ultimate goals to aim for a circular economy that is truly transformative. These participants went beyond materials, product, business, or systems innovation to think about innovation in how we conceptualize and design the relationship between society and our economic systems. Some urged rethinking how we assign value in our economic systems while others advocated thinking about innovation as a means to an end—an end that we all need to think carefully about.

Adam, the owner of an independent business that makes reusable tote bags and packaging, acknowledged that this work would not be easy, but would be necessary. He said:

we spent the last 100 years doubling up what we have right now, and it's entrenched in our thinking and policy and business models, and in order to get to a circular economy, it's going to create quite a bit of innovation and disruption in the status quo. (FG5b, 4/5/21)

In the next focus group with materials managers, we heard this theme of disruption and a fundamental shift in the purpose of economic systems come through even stronger when the Executive Director of a zero-waste non-profit organization argued that we should not associate innovation with the status quo movement toward modernization because, she asserted, “we’re trying to change the system, not just update it” (FG6, 4/20/21).

For those who felt that innovation for circular economies would constitute a shift in the entire economic system, its value propositions and its purpose, the goal seemed to be an economic system that was not only resourceful, but also designed to improve well-being. Judy, the sustainability manager for a mid-sized town in the southwest, for example, argued:

“there’s so much environmental harm being done and all kinds of forms of harm being done to marginalized groups, and as we want to — like circularity is saying we need to totally upend our current system. And in doing so, we should hopefully — I don’t think it’s a foregone conclusion, unfortunately — but we should, when we do that, we should also be transforming into a system that’s more just and fair and takes people’s well-being into account. (FG5b, 4/5/21)

These views on innovation in circular economies are likely familiar to many readers. Ranging from revisionist to more radical suggestions for fundamental systemic change, they mirror long-standing debates in discussions about sustainability and social change. And yet, as we think about the potential for convergence around the circular economy, these debates about what innovation is, and for what end, suggest that—at least in the USA—the shared goal required for convergence is currently out of reach. For some, circularity is a

technical innovation designed to improve the efficiency and reduce waste in the current economic system—The Circular Economy. For others, the goal is systemic innovation realized through changes in the distribution of resources, with a priority on equity and inclusion. The latter goal is more aligned with what has been described as a “circular society” [49]. For Jaeger-Erben and colleagues, a circular society (CS) is “an alternative framing that is going beyond growth, technology and market-based solutions. A common denominator of CS concepts is that transitions are not possible without the commitment and participation of all societal actors. CS frames transitions to circularity as a profound social-ecological transformation” [49, 1].

Discussion

The highly contested nature of circular economies [56] means that there may be no middle ground between, for example, those who hold that circular economies should create green growth compared to those who advocate for degrowth—or those who see innovation as technological improvements and those who envision a complete reworking of the economy. Yet despite these tensions, calls for the creation of The Circular Economy continue—both in policy [26–28] and in academic scholarship, where attempts to create singular definitions of The Circular Economy continue [76].

The highly diverse, and potentially paradigmatically incommensurable and irreconcilable perspectives we highlighted in this paper were articulated by a fairly homogenous⁴ sample of US-based sustainability professionals. These diverse perspectives among demographic homogeneity lead us to anticipate that we would find even more divergence if additional societal actors were brought to the table. Many scholars studying the circular economy have, indeed, noted the need to “decolonize the imaginary” [32] and to “make space” for diverse perspectives and practices in the circular economy through inclusion of non-western, non-hegemonic, and otherwise marginalized perspectives and approaches.

Although the practitioners that participated in our research came together on some shared understanding of circularity, our aim is to take the *disunity* inherent in their ways of knowing and enacting circular practices seriously. Scholars working in the interdisciplinary space of science and technology studies (STS) invite an opening up of Roco’s [85] conceptualization of convergence. Mario Blaser and Marisol de la Cadena’s conceptualization of the *uncommons* and Isabell Stengers’ notion of *divergence* enable us to rethink the confluence and integration stages of Roco’s scientific convergence model and hold the plurality of circular economy knowledges and practices coming from our research participants in productive tension.

Divergence, as Isabell Stengers [93] describes it, is a conceptual tool that helps us to understand an *ecology of practices*. In reality, heterogeneous practices intersect, brought forward through different practitioners and social contexts. As they intersect, they—together—form a web of partial-connections in which individual practices are simultaneously converging and diverging. Like an ecosystem, the multiplicity of practices is connected at their roots to a common ground, even as they maintain and manifest their distinctions. We suggest that what brings the diverse practitioners and practices of circularity together is their *interest in common that is not necessarily the same interest*. Our research participants had interests in common, rooted in an understanding of linear

⁴ Homogenous in terms of racial identity, educational attainment, and socioeconomic status.

economies as problematic and wasteful, yet their approaches to addressing this issue were not the same—*interests in common that are not necessarily the same interests*.

For Mario Blaser and Marisol de la Cadena [10], the point then is not to stay in common, unity, or at the site of convergence, but rather how to allow for *uncommoning* together while recognizing the potential productivity of divergence. These ideas echo the perspectives of multiple research participants who recognized that there are many circular economies, operating across different temporal and spatial scales. Is it possible that they can co-exist and that US-based practitioners' practices can also intersect to form an *ecology of practices*?

The alternative, if the empirical record is any indication, may be that the confluence and integration stages of convergence—without attention to knowledge politics or provisions for inclusivity—produce a single, dominant version of The Circular Economy. This “deliberately vague, but principally uncontroversial” [61, 67] conception of circularity is rooted in a hegemonic common sense that is meant “as a strategy to gain widespread support in the short term” but could “lead to a depoliticized CE, which does little towards tackling the systemic socio-ecological challenges of the Anthropocene” [32, 10]. Ironically when discussions of power, inclusion, and knowledge politics are excluded from the conversation, that status quo is often reproduced in the name of objectivism and pragmatism [90, 60]. In the process, a whole array of alternatives are foreclosed, potentially even well-established circular forms that have been in existence for long periods of time but that do not sit well within the confines of a green modern economy designed for growth but inattentive to issues like justice, fairness, equity, and well-being.

We do not want to present a romanticized notion of an ecology of practices or plurality—one that ironically would assert a new normative vision hegemonically. Thus, it is important that we also recognize that this too is a political approach. Like Stengers suggests in her *Introductory Notes on An Ecology of Practices* [93], not all positions should be allowed to flourish, indeed there may be some that are harmful, violent, or destructive. The application of Stengers' concept to our research results of circular plurality importantly reminds us that holding space for divergence is also a political and normative practice with certain commitments. A practice of divergence or uncommoning is therefore not apolitical or boundary-less. While it must be open and plural enough to avoid imperial knowledge production, on the one hand, on the other hand, it must be closed and resistant to any concept, practice, or prospect, which would enable the conditions for ongoing capitalist destruction (e.g., “sorry, but we have to”) [93].

In this paper, we have illustrated that the heterogeneous (although relatively homogenous) group of practitioners and practices that are connected by their common interest in circular economies are interests that indeed are not always the same interests. Navigating this ecology of practices is not only a matter of dialogue but of diplomacy. Staying with the scholarship of Stengers, a diplomat will never command another to just agree with this or that proposal. Instead successful diplomacy allows for modification that does not result in any final, total, convergence to overcome a previous divergence, but instead allows for getting along together in difference and partial-connection. The diplomacy that STS scholars call for then does not set up new rival contradictions (*either/or*) or zero-sum games, but turns towards contrast and co-belonging (*and, and*) [13, 93]. Diplomacy in this sense does not mandate that everyone agrees but rather affirms partial connections and divergence.

When thinking with feminist STS scholars, convergence (or commoning) that is about an equitable, democratic process, will have to refuse the reduction to a shared category or meta-language, and accept that those involved may not be committed to a homogenously common

world but rather to going on together in divergence. As one of our participants articulated, this going on together in divergence is critical for supporting circular economies:

I think that one of the least productive things we can do is actually try and tease out which is more important than the other [...] the reality is, the scale of the problem is such that there's not going to be a singular answer. You need all of them. And I think that applies everywhere. And so I like to try and move away from that thinking of like, what's the silver bullet here? (FG3, 2/16/21)

The “silver bullet” is perhaps an apt metaphor for a singularized and totalizing Circular Economy: a quick, efficient, and singular solution to a monstrous problem. Yet scholars warn that the sanitized and depoliticized ideas of The Circular Economy that offer promises of mutually beneficial industrial symbiosis have, as yet, gone unfulfilled [36, 105]. The divergence we highlight among US-based circular economy practitioners suggests that solutions may need to be plural and political [34, 56] and that we have much to learn from “non-western visions of sustainability” [32, 6]. In teasing apart divergent thinking around the principle of innovation in circular economies, we offer one example of systematically exploring whose worlds and visions are accommodated in planning for The Circular Economy [20].

Conclusion

We have argued that the shared goal needed for convergence seems to be out of reach in the context of The Circular Economy—a conclusion that may seem to some, at least, ominous. Yet we have also suggested that the plurality and divergence observed in this research suggests an alternative path toward circular futures. We worry that the push toward convergence around The Circular Economy might perpetuate a false convergence—a seeming-agreement that masks important underlying divergences. This implies the need to understand, first and foremost, the divergences that make up our ecologies of practice. If we shift our area of interest from convergence to divergence, we can envision a network of practices with partial connections—people with interests in common, but not working toward the same interest. Milios [70, 866] reminds us that the “interdependence of all actors is paramount for a CE to work,” and indeed our conceptualization of divergence allows for relationships of interdependence while accepting practices and goals that are only partially related.

The conclusion that divergence in circularity is not only present but important and beneficial echoes work in other sites of significant complexity. Scholars focused on climate change argue that plurality is likely to be a “persistent feature of global climate science” and that in the face of this plurality, climate policy should “not wait for convergence, [but] rather take the pluralistic picture as a given” [63, 253]. Rather than viewing the vast and disparate array of circular definitions and practices as a problem to be solved, then, we might see this complex assemblage of practices and circular visions as a promising starting point. To be clear, our call for divergence is not an apolitical one where all actors, practices, and visions are equal. Instead, we hope to hold space for practices that run against the grain of The Circular Economy and the status quo, and to slow and potentially disrupt the actors and practices who seek to fulfill a singular vision of circularity that refuses to allow for difference. Within the productive, pluralistic divergences on circularity, there exist multiple ways of being and ways of relating to economies, materials, and beings.

Limitations and Future Research

While the significant divergence we highlight in this paper emerged from a sample of relatively homogenous participants in terms of race, class, and educational attainment, we note that the lack of racial, class, and educational diversity among research participants was a limitation of this project. Specifically, we encourage future work that explores circular economy principles across multiple axes of difference.

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Declarations

Ethics Approval and Consent to Participate This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of the University of Maine (IRB# 20200902).

Consent for Participation Informed consent was obtained from all individual participants included in the study.

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