Future-Proofing Capitalism: The Paradox of the Circular Economy for Plastics

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Abstract

The marine plastics crisis sparked a wave of corporate interest in the circular economy, a sustainable business model that aims to eliminate waste in industrial systems through recycling, reduction, reuse, and recovery. Drawing on debates about the role of corporations in global environmental governance, this article examines the rise of the circular economy as a dominant corporate sustainability concept, focusing on the flagship example of the circular economy for plastics. It argues that corporations across the plastics value chain have coordinated their efforts to contain the circular economy policy agenda, while extending their markets through developing risky circular economy technologies. These corporate strategies of containment and proliferation represent attempts to "future-proof" capitalism against existential threats to public legitimacy, masking the implications for environmental justice. The paradox of the circular economy is that it seems to offer radical challenges to linear "take-make-waste" models of industrial capitalism, backed by international legislation, but it does not actually give up on unsustainable growth. We need to tackle the plastics crisis at its root, dramatically reducing the global production of toxic and wasteful plastics.

In March 2019, the annual World Petrochemical Conference in Texas introduced a special sustainability seminar to its main corporate agenda devoted to the problem of plastic waste. "There is no plastics crisis," insisted one industry analyst during the lively debate. "Rather, it is a moment of reflection for industry."[1] Images of plastic in oceans went viral in December 2017, after millions of people watched the final BBC episode of David Attenborough's *Blue Planet II* with its scenes of marine wildlife choked in plastic. In January 2018, the European Commission issued the European Strategy for Plastics in a Circular Economy, the first European Union policy framework to adopt a material-specific life cycle approach to implementing the circular economy. It included the ambitious target to make

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1. Project researcher's field notes, World Petrochemical Conference, San Antonio, Texas, March 19, 2019.

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all plastics recyclable in Europe by 2030. China's National Sword policy came into effect in March 2018, banning foreign imports of plastic and metal waste and throwing a spanner in global recycling systems (see O'Neill 2019, 156–159). The petrochemical industry went on high alert. "We need to make plastic fantastic again," said a senior industry adviser in his keynote speech on the "Future of Polyolefins" in January 2019. "We need to get the image of plastic in oceans out of the public's mind."[2]

But just how worried is the industry? And why is the circular economy so prominent in corporate responses to environmental crises, from plastics waste to food and transportation systems? Derived from oil and gas, petrochemicals are the basic materials in thousands of consumer products, including plastics, paints, rubbers, and solvents. Plastics account for 80 percent of petrochemical markets (Cetinkaya et al. 2018). "This is the first major disruption that the industry has witnessed," a petrochemical executive told me. "Instead of a technological disruption, it is a social disruption."[3] Major petrochemical and plastics corporations have scrambled to pledge money for ocean cleanups, develop new recycling technologies, and join voluntary alliances with other industry stakeholders. The pillar behind these corporate responses to the plastics crisis is the circular economy, a sustainable business idea that promotes a circular rather than linear economy based on the aspirational idea of "zero waste" through the reduction, recycling, and reuse of resources.[4]

The industry *is* worried, but it is also very good at turning a crisis into an opportunity. The circular economy is a convenient way of doing so. Focusing on the flagship example of the circular economy for plastics, this article examines how corporations have sought to contain the circular economy policy agenda to secure public legitimacy and protect and extend markets. It argues that the circular economy offers something grander yet more nebulous than other corporate sustainability discourses: a technological fix to "take-make-waste" models of industrial growth, without actually giving up on growth. The promise of circular growth lies in the fiction that it is materially possible to "close the loop," ignoring basic thermodynamic laws that recycling requires energy (Korhonen et al. 2018). The circular economy for plastics appears to threaten business as usual, with increasing bans around the world on single-use plastics and ambitious recycling targets. While the petrochemical industry commits to the aspiration of a circular economy with less waste and maximal efficiency, it continues to invest in unsustainable projects[5] with environmental justice and climate change consequences.

2. Author's field notes, Future of Polyolefins Conference, Antwerp, January 16, 2019.
3. Author's interview with a petrochemical representative, Antwerp, January 16, 2019.
4. There are various combinations of *R*s in concepts of the circular economy, including the 3R principle of reduction, reuse, and recycle; the 4 *R*s of reduce, reuse, recycle, and recover; and the 5 *R*s of reduce, reuse, refurbish, repair, and recycle, among others (Ellen MacArthur Foundation 2013; Murray et al. 2017).
5. Some examples include INEOS petrochemical projects in Europe, which rely on liquefied national gas; coal-based projects in China; and massive crude-to-chemicals (COTC) projects under development in China and Saudi Arabia.

By highlighting the paradox of the circular economy as a technocratic project for "future-proofing" capitalism against environmental threats, this research extends debates about the role of corporations in global environmental governance (see Clapp 2018; Dauvergne 2018b; Eckert 2019; Levy and Newell 2005; Ponte 2019). In particular, the research builds on political economy literatures in global environmental politics that examine how transnational corporations use sustainability governance to maintain and increase their power by capturing discourses, setting standards, and securing capital accumulation (Dauvergne 2018b; Levy and Newell 2005; Ponte 2019). The article elaborates a political economy framework for analyzing corporate strategies for containing and capitalizing on the circular economy. Like other forms of sustainability governance, corporations use the circular economy discourse to enhance their strategic power, but there are differences in terms of scale, complexity, and intensity. The stakes of the circular economy are over the future of global industrial transformation, operating across multiple scales, complex value chains, and competing political interests.

The article starts with a brief review of the global environmental politics literature on the role of corporations in sustainability governance. Next, it situates the concept of the circular economy in relation to these debates, showing how the circular economy discourse differs from other sustainability discourses, with political implications for how to tackle complex environmental problems. A case study of the circular economy for plastics is then outlined, based on participant observation at petrochemical industry events in the United States and Europe between 2016 and 2020, qualitative interviews with corporate stakeholders, and a range of corporate and policy documents. The research analysis situates two corporate circular economy strategies in relation to intensifying "wars of position" (Gramsci [1934–1935] 1971) over the future of industrial transformation: first, containment, tracing the rise and consolidation of the circular economy discourse within the petrochemical industry, and second, proliferation, focusing on the example of chemical recycling, a technological solution with uneven toxic risks that experts consider vital for realizing the circular economy.

The Role of Corporations in Sustainability Governance

Corporations and industries play an important role in shaping global environmental governance. Corporate strategies for engaging in environmental governance aim to sustain public legitimacy and market advantage, using a range of defensive and proactive tactics to neutralize threats and seize opportunities. Many sociologists, historians, political scientists, and organizational scholars have examined corporate strategies for addressing environmental challenges, including toxic disasters, environmental regulations, and public pressure (see Dauvergne 2018b; Hoffman 1999; Levy and Newell 2005; Markowitz and Rosner 2002; Ponte 2019). Until the 1990s, most corporations responded reactively to sustainability pressures, but by the early twenty-first century sustainability had become a mainstream business strategy (Dauvergne 2018b; Ponte 2019). There is now a

strong "business case" for corporations to engage proactively with sustainability: "to help mitigate reputational risk, add to the bottom line, create new product lines, enhance brand loyalty, and increase their power" (Ponte 2019, 14). According to Dauvergne (2018b, 40), the corporate sustainability discourse serves three strategic purposes:

> to soften criticism and generate praise for big business, including from human rights and environmental groups; to enhance corporate power over sustainability governance; and to justify a regulatory setting amenable to maximising production, profit, and sales. This is the real business of CSR.

Corporations have increasingly sought to enhance their power through their role in multistakeholder and business-led initiatives on sustainability, particularly through developing standards and metrics (Bartley 2018; Dauvergne 2018b; Ponte 2019). A key concern with private-led sustainability governance is regulatory capture.

While many corporations have participated in multistakeholder sustainability initiatives across global value chains, for example, in wine, coffee, and biofuels (Ponte 2019), other industries have been less enthusiastic. In particular, transnational corporations in contested industries have lobbied against environmental legislation and denied the health risks of their industries (Clapp 2012; Dauvergne 2018a; Markowitz and Rosner 2002). In *Deceit and Denial*, Markowitz and Rosner (2002) show how the lead and chemical industries have manufactured doubt and uncertainty over the dangers of toxic pollution throughout the twentieth century. ExxonMobil's history of climate change lobbying is another infamous example of corporate deception (Dauvergne 2018b, 68–70). In the first decade of the twenty-first century, Clapp (2012) details how the plastics industry responded to public concerns about plastic waste by launching public campaigns to defend plastics as an environmentally sound plastic choice, blaming consumers for waste and lobbying governments, resulting in a "regulatory chill" where local authorities failed to enact plastics legislation for fear of litigation. Yet since the growth of the circular economy, even the most recalcitrant corporations have gotten on board with sustainability, signing up to a plethora of multistakeholder initiatives. What explains this shift?

The Growth of the Circular Economy

Within just a few years, the concept of the circular economy has become a dominant corporate sustainability discourse. The idea of the circular economy has roots in late nineteenth-century industrial ecology, based on the idea of a cyclical, closed-loop system (Murray et al. 2017). As a sustainable business model, the circular economy has been adopted within official state policies in Japan and Germany since the 1990s and in China since 2006 (McDowall et al. 2017). The Ellen MacArthur Foundation, a UK charity launched in 2010, has led the global business case for a circular economy "based on the principles of designing out

waste and pollution, keeping products and materials in use, and regenerating natural systems" (Ellen MacArthur Foundation 2019). Within the corporate world, momentum behind the circular economy picked up in 2013, when the Ellen MacArthur Foundation established a network of 100 global corporations, the "Circular Economy 100," and advised the European Commission, which unveiled its own Circular Economy Action Plan in 2015.

Since 2015, the idea of the circular economy has gradually saturated global corporate and policy sustainability discourses, rippling across interconnected industries and value chains (see D'Amato et al. 2019). By 2018, even the oil, gas, and petrochemical giant ExxonMobil had joined the raft of corporate pledges to the circular economy (Toto 2018). International environmental NGOs have also incorporated the concept. "Develop a circular economy" was at the top of Friends of the Earth's 2018 list of things that people could do to reverse destructive consumer habits. Alongside the explosion of corporate and policy interest in the circular economy, there has been growing academic interest in the topic, from a range of disciplinary perspectives.[6] Several scholars have analyzed the concept of the circular economy, tracing its origins and comparing it with other models and concepts, particularly sustainability (D'Amato et al. 2019; Kirchherr et al. 2017; Korhonen et al. 2018). Unlike the concept of sustainability, the circular economy lacks any consideration of future generations, and its main underlying value is economic efficiency (Kirchherr et al. 2017). Some researchers have also evaluated circular economy programs in practice, for example, regional waste management strategies (Gregson et al. 2015; O'Neill 2019) and the sharing economy (Hobson and Lynch 2016).

Many scholars are critical of the circular economy concept, stressing its business and policy origins and its lack of engagement with civil society (Gregson et al. 2015; Hobson and Lynch 2016; Korhonen et al. 2018; O'Neill 2019). Three critical perspectives on the circular economy are particularly relevant for examining its implications for corporate sustainability governance: Korhonen et al.'s (2018) critique of the limits of the industrial model from the perspective of environmental sustainability, Hobson and Lynch's (2016) analysis of its political implications, and O'Neill's (2019) reflections on its technocratic elitism within global environmental politics. Korhonen and coauthors (2018) argue that the circular economy model has significant material and political limits. According to the laws of thermodynamics, recycling consumes resources and produces its own waste and emissions. The scale of the economy poses physical limits, and problems are often shifted along the product life cycle. These material limits are exacerbated by technological limits, given the path dependency of locked-in technologies and infrastructure. Furthermore, new business models of the circular economy require extraordinary intraorganizational governance of complex physical flows of material and energy.

6. Interdisciplinary literature on the circular economy is so extensive that it is not possible to cover the full range of literature.

Expanding on the problem of political limits, Hobson and Lynch (2016, 15) argue that the circular economy is "framed as a technologically driven and economically profitable vision of continued growth in a resource-scarce world." The authors suggest that while the circular economy may appear radical within the business world, it actually reduces citizens to consumers. Similarly, O'Neill (2019) notes discomfort with the way that the circular economy is presented as a technocratic vision by global elites, arguing that there are "shadows," or unintended negative impacts, cast by circular economy policies. In particular, O'Neill points to the problem of "leakage," the transfer of wastes from one part of the world to another, and the potential environmental justice consequences of large-scale global transitions for vulnerable and marginalized populations in the Global South. Rather than radical, the circular economy appears apolitical, masking competing interests in the outcomes of different waste and recycling schemes (O'Neill 2019). While critical of circular economy policies, O'Neill (2019, 186) argues that elements of circularity are in fact crucial for the global governance of waste. O'Neill contrasts competing visions of the circular economy between waste prevention by "zero-waste" activists and waste diversion by corporate elites. This points to the paradox of the circular economy: for all its flaws, it has the potential to transform our global economy to minimize the risks of waste. However, there is a high risk of regulatory capture when corporations succeed in controlling the economic and technological pathways forward. The analysis that follows contributes to these debates by examining the implications of the circular economy—given its material and political limitations—for corporate strategies to maintain control over sustainability.

Managing Complexity Through the Circular Economy

In the twenty-first century, transnational corporations have faced increasing sustainability risks in a complex and uncertain global economy. Within this context, Levy and Newell (2005, 49) have developed a Gramscian political economy framework for examining corporate environmental governance that "points to particular patterns of strategies likely to be adopted in bargaining over complex regimes, and highlights the dynamic and somewhat indeterminate path of regime evolution." Gramsci ([1934–1935] 1971, 57) argued that social groups gain cultural and ideological hegemony through a combination of "domination" and "intellectual and moral leadership." According to Levy and Newell (2002, 93), "Gramsci's concept of hegemony provides a basis for a critical approach to corporate political strategy that emphasizes the interaction of material and discursive practices, structures, and stratagems in sustaining corporate dominance and legitimacy in the face of challenges from social actors and economic rivals." My analysis builds on this political economy framing of corporate strategic power in environmental governance, extending the analysis to the circular economy: a complex, global arena of political struggle over the future of industrial transformation.

Three types of corporate power in the political economy literature on managing corporate sustainability risks are particularly useful for understanding the corporate circular economy: Ponte's (2019) "institutional power," Bartley's (2018) "corporate provider," and Eckert's (2019) "operator."[7] Ponte (2019, 59) describes institutional power within multistakeholder sustainability standard-setting bodies as "arenas where powerful actors jockey for the inclusion of terms that are especially favourable to them, for example when lead firms are able to shape the definition of minimum standards on environmental impact as a way to lower the costs of compliance." In multistakeholder circular economy initiatives, leading companies have exerted indeed considerable influence on the development of standards. This resonates with Bartley's (2018, 146) corporate providers, who "are not pushing for or against intergovernmental agreements but rather pushing private standards for safety, sustainability, technical specifications, and human rights through their global supply chains." Technical specifications are particularly important for circular economy projects, which rely on multiple forms of expertise, including—in the case of plastics—engineering, chemistry, industrial design, economic modeling, and complexity science, among others. Eckert's (2019, 39) operators have detailed technical knowledge about important infrastructure, which is difficult for nonexperts to challenge, and thus they can use informational asymmetries to become direct providers of global governance.

These three types of corporate power demonstrate different ways that powerful corporations have achieved regulatory capture of sustainability standards through institutional jockeying, private-led initiatives, and monopolizing technical expertise. In the analysis that follows, I argue that corporations have mobilized each of these types of extensive corporate power in order, first, to contain threats to business from the circular economy discourse (containment) and, second, to extend their markets through the contradiction of the circular economy (proliferation). Corporate containment and proliferation strategies seek to control circular economy discourses and closely resemble ideas of regulatory capture (Dauvergne 2018b; Eckert 2019; Ponte 2019), but with greater speed and intensity, in response to global existential threats. The term *containment*, with its militaristic connotations, conveys a proactively defensive strategy in the face of escalated "wars of position"—Gramsci's ([1934–1935] 1971) term for ideological and cultural struggles for hegemony within capitalist societies. Corporate proliferation strategies operate through a green growth contradiction, appearing to challenge conventional growth models, while accelerating growth in new plastics markets. *Proliferation* also evokes analogies with war and links closely to ideas of "green capital accumulation" (Ponte 2019), with additional dynamics of uncontrollable expansion. The corporate strategies of containment and proliferation extend debates about private-led sustainability governance by examining intensive processes of regulatory capture within existential wars of position, amid complex and unpredictable threats.

7. Each type is situated alongside other types of corporate power, and often blurs or interacts with other types.

Over the past two decades, corporations and governments have adopted models of "neoliberal systems thinking" in their strategies to manage uncertainty and complexity by designing resilience into systems (Walker and Cooper 2011). Examples include financial risk management; geoengineering and climate science; Big Data and the new complexity science; and security responses to climate change, natural disasters, pandemics, and terrorism. Walker and Cooper argue that neoliberal systems thinking is effectively "a call to permanent adaptability in and through crisis" (154). Complex adaptive systems are highly resilient and self-regulating through circular feedback, and they have the remarkable ability to absorb external shocks.

Inspired by complex systems theory, the concept of "volatility, uncertainty, complexity, and ambiguity" (VUCA) was first advanced by the US military to describe post–Cold War contexts, and it has since become a management buzzword, including within the petrochemical industry. In *Managing in a VUCA World*, Mack et al. (2015, 6) define complexity as "a situation, where interconnectedness of parts and variables is so high, that the same external conditions and inputs can lead to very different outputs or reactions of the system." The circular economy model is also based on systems thinking, taking up the challenge of complexity and the need for collaboration across value chains (Crippa et al. 2019; Ellen MacArthur Foundation 2013). The idea of "future-proofing" is a core theme within systems thinking, designing resilience into industrial systems to withstand unexpected shocks or events (Masood et al. 2018; Maxwell 2015). Reports about the circular economy abound with case studies and examples of how to future-proof buildings, technologies, businesses, infrastructures, and cities (Crippa et al. 2019; Ellen MacArthur Foundation 2013).

The circular economy is a business model promoting radical systemic change, yet it is rooted in the industrial ecology of complex systems, which are designed for adaptability. Through systems thinking and cross–value chain collaboration, corporations have sought to resolve the problem of complexity in the circular economy (see Korhonen et al. 2018; O'Neill 2019), aiming to find solutions to manage the production and flows of waste, recycling, and reuse across multiple materials and borders. Very swiftly, despite their differences, corporate stakeholders across value and supply chains have organized to fill needs for governance and management. The circular economy is the unifying banner behind this movement.

The Circular Economy for Plastics

The problem of plastic pollution in the oceans has been around for decades, although it has only recently come to widespread international attention. In the late 1990s, large concentrations of plastic waste were found floating in the Pacific Ocean, raising public awareness about the scale of the problem. Around the world, local, regional, and national governments have introduced regulatory initiatives to tax or ban different forms of plastics, particularly plastic bags, bottles, and microbeads (Clapp 2012; O'Neill 2019). For years, the plastics industry denied and deflected

responsibility for plastic pollution, undermining communities' efforts to introduce plastics legislation (Clapp 2012). While global governance of plastics has improved, it remains characterized by "fragmented authority, weak international institutions, uneven regulations, uncoordinated policies, and business-oriented solutions" (Dauvergne 2018a, 22).

The marine plastics crisis was a game changer for the petrochemical and plastics industries. Throughout 2018 and 2019, the CEOs were all talking about it in conferences and boardrooms.[8] Negative public perceptions threatened the industry's "social license to operate."[9] With bans on single-use plastics and targets for plastics recyclability, identifiable plastics markets would be affected. As the dust settled from the storm of plastic outrage, every corporation operating across the plastics value chain had to have its own circular economy statement.[10] But as Mirowski (2013) argues, capitalism never lets a serious crisis go to waste. Industry is always poised to navigate uncertain markets.

The following analysis focuses on a case study of the corporate-backed circular economy for plastics, drawing on research that was conducted as part of a large European Research Council (ERC)-funded project on the global petrochemical industry led by the author, including participant observation at twenty-five industry events in the United States and Europe between 2016 and 2020; dozens of semistructured and informal qualitative interviews with corporate stakeholders; and analysis of corporate documents, reports, websites, and trade magazines.[11] Petrochemical and plastics industry events aim to facilitate corporate networking, analyze market trends, assess risks and regulations, showcase the latest developments in science and technology, and provide forecasting across multiple spheres. Conferences are key sites of knowledge circulation and business activity within industry (see Cook and Ward 2012; Leivestad and Nyqvist 2017). As exclusive quasi-private spaces, industry events offer a unique glimpse into internal dynamics and debates about corporate strategies and worldviews.

In the following sections, this article analyzes two themes of containment and proliferation in corporate strategies to future-proof plastic markets. These two corporate strategies of containment and proliferation constitute a shift in the scale, complexity, and intensity of corporate sustainability governance, evident, first, in the rapid coordination across global value and supply chains to maintain market control in response to existential threats and, second, in the deployment of

8. Author's interview with petrochemical representative, London, September 28, 2018.
9. Author's field notes, Future of Polyolefins Conference, Antwerp, January 16, 2019, and project researcher's field notes, World Petrochemical Conference, San Antonio, Texas, March 19, 2019.
10. Author's field notes, petrochemical training event, London, September 26, 2018.
11. Industry events included conferences, training workshops, seminars, and multistakeholder events. Participants have access to speakers' video presentations and slides, industry reports and magazines, training manuals, and marketing material. All interviews were conducted with informed consent and confidentiality. The author conducted the majority of the participant observation at these events, and two other project researchers also attended and reported on meetings.

complex systems thinking and other forms of technocratic expertise to anticipate, design, and control the new systems. Together, containment and proliferation constitute rapid, coordinated, and systematic strategies within escalated wars of position. In my research, petrochemical industry representatives frequently invoked metaphors of "winning the war" when discussing sustainability and the circular economy.[12]

Containment

One of the first ideas of the circular economy has been traced to a speech in 1848 by Wilhelm von Hoffman, the first president of the Royal Society of Chemistry, who stated that "in an ideal chemical factory there is, strictly speaking, no waste but only products. The better a real factory makes use of its waste, the closer it gets to its ideal, the bigger is the profit" (cited in Lancaster 2016, 24). Before the plastics issue flooded corporate boardrooms, several petrochemical industry representatives argued that the circular economy, while a policy buzzword, had always been the industry's way of doing things, in order to maximize plant efficiency.[13] For example, one petrochemical representative told me in 2016,

> And then we have this new fashion, which is the star in this moment, which is the so-called circular economy, for everybody is speaking about the circular economy. We the chemical industry I think started thirty years ago to talk about circular economy because if you take a cracker it's a perfect example of which everything is coming in a way or another is going out and only very little part of it is waste.[14]

The idea of the circular economy superficially resonates with the model of integrated petrochemical clusters, which concentrate petrochemical producers and related industries next to logistics networks, with the aim of more efficient production (López-Navarro et al. 2015).

The first petrochemical conference that I attended was the European Petrochemical Conference in Amsterdam in March 2016. The circular economy was just one of many corporate sustainability discourses at this time, and climate change rather than plastic waste was at the forefront of industry discussions about environmental challenges, particularly in the aftermath of the COP21 Paris talks. European industry was on the defensive: high environmental regulations and unfair regional competition, particularly from the United States and China, were "killing" them.[15] Corporate panel discussions focused on managing to survive, to stay in the game. By contrast, environmental concerns made a minimal appearance at the World Petrochemical Conference in Houston in 2016, with a few

12. Author's and project researcher's field notes, multiple industry events, 2016–2020.
13. Author's interviews with various petrochemical representatives: May 2016, Brussels; June 2016, Antwerp; January 2017, London.
14. Author's interview with a petrochemical representative, Brussels, May 31, 2016.
15. Authors' field notes, European Petrochemicals Conference, Amsterdam, March 3, 2016.

references to "pushback against fracking by environmental groups."[16] Throughout 2017, the plastics issue started to percolate in European industry debates, and the circular economy became part of the language, appearing in several talks.[17] The industry lobbied the European Commission on its forthcoming plastics strategy, opposing bans and binding regulations (Corporate Europe Observatory 2018).

In January 2018, the European Commission launched its Strategy for Plastics in a Circular Economy, noting that the new plastics economy would "fully respect reuse, repair and recycling needs" (European Commission 2018, 1) but failing to mention "reduce" beyond the context of waste (i.e., excluding production). On the same day, PlasticsEurope, the biggest plastics lobby group in Europe, launched its own voluntary initiative, Plastics 2030 (PlasticsEurope 2018). The public backlash over the marine plastics crisis spread quickly in 2018, and the problem of plastic waste rose to the top of corporate agendas. Exactly one year after the launch of the Strategy for Plastics, a number of corporations created the Alliance to End Plastic Waste, pledging US$1 billion toward tackling ocean plastic waste (Harvey 2019). More than twenty-five corporations joined this alliance, including petrochemical companies Shell, Dow, BASF, and ExxonMobil and the consumer goods giant Procter and Gamble. The plastics and petrochemical industries used their "institutional power" (Ponte 2019) to pursue their own industry-led voluntary standards and to set the terms for cross–value chain collaboration.

At industry events in the United States and Europe throughout 2018 and 2019, representatives from across the plastic value chain detailed how their companies had forged partnerships, participated in multiple beach cleanups, and collaborated with recycling companies.[18] Corporate consultants issued special reports on the implications of the plastic waste crisis for markets, drilling down to specific end products across the whole value chain (IHS Markit 2018). Polymer scientists and engineers detailed technological solutions on how to make plastics more recyclable, identifying structural and material challenges, such as multiple material plastics, contamination issues, quality, and cost. Analysts shared detailed knowledge of recycling targets, plastics bans, and plastics regulations across different countries and regions. Consultants proposed ideas for how to "future-proof" plastic markets by creating new systems and assessments for quality standards of recycling. Corporations blamed consumers for the problem of waste, as well as countries in the Global South, which had poor waste infrastructure (see Eckert 2019; Dauvergne 2018a). Despite disagreements about the scale of the threat and the nature of the problem, industry stakeholders all agreed on the need to take control of the situation by setting their own industry standards and benchmarks, echoing other research on private-led sustainability governance (Bartley 2018; Dauvergne 2018b; Ponte 2019).[19]

16. Due to the US "shale gas revolution," natural gas had become the main petrochemical feedstock in the United States, a regional competitive advantage. Project researcher's field notes, World Petrochemical Conference, Houston, March 15, 2016.
17. Author's field notes, multiple industry events, 2017.
18. Author's and project researcher's field notes, multiple industry events, 2018–2019.
19. Author's field notes, Future of Polyolefins Conference, Antwerp, January 16, 2019.

During the course of my research, the circular economy discourse rapidly shifted from being a relatively niche policy buzzword to a dominant corporate sustainability concept. Within just a few years, the top players in the petrochemical industry, despite internal differences, had fully embraced the circular economy discourse (see Table 1). In adopting the circular economy discourse, many corporations reframed their existing corporate sustainability concepts and practices rather than developing new ideas. For example, BASF applied the circular economy idea to its concept of *Verbund*, a design principle of integrated and efficient industrial complexes, and Mitsubishi adapted the circular economy to its concept of KAITEKI, "sustainable well-being of people, society, and our planet Earth."

The extent of collaboration across the petrochemical value chain over the plastics crisis has been impressive, in terms of both speed (within months) and scope (from waste management companies to plastics convertors to big retail brands and oil majors). The petrochemical industry is dominated by vertically

Table 1
Top Ten Chemical Companies and Circular Economy, 2018

2018 Ranking	*Company*	*HQ Location*	*Date the "Circular Economy" Entered Corporate Reports (in English)*
1	DowDuPont	United States	Dow since 2014; DuPont since 2019 (separate sustainability reports despite 2017 merger)
2	BASF	Germany	Since 2018
3	Sinopec	China	Since 2011, but not in years 2012, 2014, or 2018
4	SABIC	Saudi Arabia	Since 2015
5	INEOS	Switzerland	Since 2016
6	Formosa Plastics	Taiwan	Since 2017 in annual report, but not in CSR or EHS reports
7	ExxonMobil	United States	No direct use of CE in documents, but joined circular economy recycling initiative in 2018
8	LyondellBasell	Netherlands	Circular polymers since 2017; sustainability report 2017; CE specific report in 2018
9	Mitsubishi Chemical	Japan	Since 2019 (joined CE 100)
10	LG Chem	South Korea	Since 2018

Source: Created by the author based on the Chemical and Engineering News's annual survey of the Global Top Fifty chemical companies, 2018, and corporate annual reports.

integrated multinational oil companies, multinational chemical companies, and national oil companies, with powerful barriers to entry and fierce geopolitical competition (Chandler 2009; Verbeek and Mah 2020). While consumer-facing global value chains have collaborated on corporate sustainability issues, squeezing suppliers to produce more sustainable products (Ponte 2019), major oil companies are the main suppliers, with less interest in downstream products due to lower profitability, at least until recently (Inkpen and Ramaswamy 2017). When I asked one petrochemical representative about cross–value chain collaboration on sustainability issues, he said that in general, there was more cooperation the further you went down the supply chain, toward consumer-facing plastics manufacturers.[20] By contrast, the further up the supply chain you went, the less cooperation there was.

A catalyst engineer from a major petrochemical company told me she had been on countless beach cleanups in Texas and that all the companies were doing the same things.[21] She said that the most inspiring and interesting thing that she had learned through engaging in circular economy debates was the importance of collaboration rather than competition among different companies, which was different than anytime before. She had been working in the industry for more than thirty years and characterized the industry as highly competitive, with intense rivalries between leading companies over patents. But the stakes were high: if they didn't cooperate on making compatible recycling standards and waste streams, then they wouldn't be able to operate, so their business strategies for adapting their systems to meet recyclability goals depended on collaboration. The alternative, she said, was leaving it to the regulators.

Corporations have collaborated to defend plastic markets, but they have also blamed other actors in the supply chain for problems. The CEO of a controversial planned methanol plant in Louisiana told critics that shipping was the real polluter, with emissions from large liquefied natural gas ships coming in and out of the facility.[22] A manager in a major petrochemical company blamed transporters for the heaps of tiny plastic pellets littering industrial port shorelines.[23] These dynamics underscore the spatial limits of the circular economy, where sustainability problems shift along the life cycle of a product (Korhonen et al. 2018).

In March 2019, the European Commission issued a press release confirming that "three years after adoption, the Circular Economy Action Plan can be considered fully completed." The 244-page report *A Circular Economy for Plastics* (Crippa et al. 2019) detailed the "future-proof" plans to implement the Plastics Strategy, drawing on insights from scientific research and innovation, which were drafted in consultation with multiple policy and industry stakeholders across the plastics value chain. Industry experts advised on business models for the circular

20. Author's interview with a petrochemical representative, London, September 28, 2018.
21. Author's interview with a catalyst engineer, petrochemical company, Antwerp, January 17, 2019.
22. Project researcher's interview with the CEO of a methanol company, St. James, Louisiana, April 24, 2018.
23. Author's interview with a petrochemical representative, Antwerp, January 16, 2019.

economy, the feasibility of recycling technologies, and the development of new industrial standards. In particular, the report identified the need for "more cross–value chain collaboration and systems thinking" (Crippa et al. 2019: 8) and for new investments in "high-risk, disruptive innovations" (10), including chemical recycling. Through their technical input into the circular economy strategy, the plastics and petrochemical industries had been successful in containing the threat of the circular economy discourse to unsustainable plastics production. Continued growth in global plastics end markets remained central to European policy makers' plans for a circular economy for plastics.

The industry hasn't achieved an all-out coup in the war over plastics. It failed to prevent the European Directive on Single-Use Plastics, legislation introduced in June 2019 banning single-use plastics by 2021 and placing more responsibility on plastics producers (European Commission 2019). On the eve of the COVID-19 pandemic, sustainability remained a key feature in petrochemical business agendas due to increasing public pressure on plastics and climate issues. Yet within weeks of the pandemic, single-use plastics were back in high demand (Pipoli 2020). In April 2020, the World Petrochemical Conference in New Orleans was rescheduled as an online event, focusing on the implications of COVID-19 and the crude oil crash. An industry analyst reflected on this unexpected shift:

> Ironically, sustainability, the issue that was dominating the conversation until just a few weeks ago, seems to be fading into the background, at least for the moment. And polyethylene may even be gaining some public favor as it plays a high profile role in combatting the greatest health risk to our planet in modern history.[24]

Plastics were fantastic again. The industry acted quickly to exploit anxieties from the crisis to overturn bans and taxes on single-use products (Schlegel and Gibson 2020). Yet industry representatives were cautious. An industry expert at the conference's circular economy and sustainability summit warned that although some bans on single-use plastics had been delayed because of the coronavirus, "we think it is going to come back with a vengeance after the epidemic is over."[25] Indeed, the European Commission refused the industry's COVID-19-related request to lift its ban on single-use plastics (Simon 2020).

Proliferation: The Promise and Peril of Chemical Recycling

Despite the bad press about plastics throughout 2018, industry forecasts for global plastics markets remained optimistic. In fact, the petrochemical industry unveiled plans for unprecedented fossil fuel–based expansion. Plastics were predicted to be the biggest driver of future oil demand, given the role of plastics in green technologies (e.g., solar panels, electric cars, and wind turbines) and rising consumption in emerging economies. New mega crude-oil-to-chemicals projects,

24. Author's field notes, World Petrochemical Conference Online, April 7–14, 2020.
25. Author's field notes, World Petrochemical Conference Online, April 7–14, 2020.

with ten times the capacity of existing world-scale petrochemical plants, were scheduled to start operations in China by 2020 and in Saudi Arabia by 2025 (Eramo 2018). By the end of 2019, the industry was weathering uncertain markets yet again, but according to petrochemical industry analysts, there was hope on the horizon:

> During a time of uncertainty and downturn throughout the petrochemical industry, one green shoot has been the emergence of circular economy projects globally. While there is definitely some way still to go, such initiatives have provided a vision for a long lasting sustainable plastics and petrochemical future.[26]

Since adopting the circular economy discourse, corporations have sought to extend their markets through providing the technological solutions to meet new circular economy demands for recycled plastics. The problem, according to industry experts, is that the supply of recycled plastics cannot keep up with demand (Crippa et al. 2019; Sykes 2018). Rather than reducing the global production of plastics, they propose to recycle plastics on an unprecedented scale through developing chemical recycling (alternatively known as enhanced or advanced recycling). By pushing for a type of recycling that is still in an early developmental stage, with significant barriers to economic feasibility, the industry could also carve out time in which it can continue to produce virgin plastic.

A Circular Economy for Plastics (Crippa et al. 2019, 140) defines chemical recycling as "any reprocessing technology using chemical agents or processes that directly affect either the formulation of the plastic or the polymer itself."[27] The rationale behind chemical recycling is that we need to bring plastics back to their molecular chemical levels in order to achieve full recyclability. Current mechanical recycling systems have inherent problems with contamination and poor quality that cannot be fully resolved through product redesign (Crippa et al. 2019; Ragaert et al. 2017; Sykes 2018).[28] Contamination is of particular concern for food packaging. The advantage of chemical recycling is that it can produce close to "virgin-grade" plastics. "Unbaking the cake" is an analogy that industry has used to explain chemical recycling (Sykes 2018). However, arguably a more appropriate one would be "having your cake and eating it too."

Most forms of chemical recycling require high volumes in order to be cost-effective and require building costly and energy-intensive industrial facilities.

26. Industry marketing communication, European Petrochemical Conference, November 28–29, 2019, Rotterdam.
27. There are three broad types of chemical recycling: first, solvent-based purification; second, depolymerisation; and third, feedstock recycling. Solvent-based purification and depolymerization both yield outputs that can be directly converted into polymer materials, whereas feedstock recycling requires further processing in order to be converted back into a polymer (Crippa et al. 2019, 146).
28. Corporate scientists and engineers have also focused on designing recyclability into projects, for example, developing monomaterial rather than multimaterial packaging, reducing contamination from inks and other additives, and developing recycling compatibilizers to "upcycle" (or reuse) plastic waste.

There have been debates over whether some forms of chemical recycling (i.e., feedstock recycling) can even be called recycling because they produce fuel and thus count as energy recovery (Crippa et al. 2019, 140). While pointing to the need for chemical recycling to comply with recycling targets, some industry analysts recognize that the environmental gains are not straightforward because chemical recycling "has an adverse carbon lifecycle assessment (LCA) footprint" (Mitra and Morgan 2019). However, industry experts downplay issues of toxicity, treating these as technological hurdles. Many forms of chemical recycling produce noxious waste streams including dioxins, particularly for certain types of plastics such as polyester and PVC (Huggett and Levin 1987; Ragaert et al. 2017).

Plastics production, whether based on recycled or new materials, is highly toxic, with health risks and environmental justice consequences across the whole value chain (Azoulay et al. 2019). The health effects from exposure to toxic petrochemicals include cancer, lung disease, neurological damage, and other illnesses (Mudu et al. 2014). The most polluting petrochemical factories around the world are located next to low-income, ethnic-minority, and working-class communities, following global patterns of environmental injustice (Bullard and Wright 2009). Residents and workers in many of these petrochemical communities have endured struggles with toxic pollution and environmental hazards (see Auyero and Swistun 2009; Wiebe 2016).

The technocratic language of chemical recycling masks the potential environmental justice consequences of its operationalization. In 1991, the chief economist for the World Bank, Laurence Summers, wrote an internal memo that was leaked to the press, in which he presented an economic case for dumping international toxic waste in Africa. This memo sparked an outcry within global environmental movements, and it is still an infamous moment within the history of environmental justice (Pellow 2007). Arguably, a similar statement about chemical recycling has been published, rather than leaked, by a key industry analyst for the petrochemical industry (Mitra and Morgan 2019):

> For plastics recycling to be financially attractive, there must be a workable margin for everyone in the recycling chain—including municipalities, sorters, processors, and mechanical and chemical recyclers. And the best solution may vary by geography. The mega-cities of China could favor an approach for polyester linked to the existing gasification infrastructure. In Europe, certain major cities are located near petrochemical production, which may lead them to polyethylene pyrolysis for liquids cracking.

The euphemism that the "best solution may vary by geography" offers a clue about the injustice that lies behind this statement. However, to understand the environmental justice implications, one would need to know that polyester presents particularly hazardous toxic issues for chemical recycling and also requires vast scales for production (Crippa et al. 2019; Huggett and Levin 1987; Ragaert et al. 2017). In comparison, polyethylene pyrolysis is relatively safe and can

be done on smaller scales. The message is thus to export risky, dangerous toxic technologies requiring vast scales of production to the megacities of China, while developing relatively small-scale, safe, and tested technologies within Europe.

Business-led circular economy plans fail to account for the environmental justice and climate change implications of new chemical recycling technologies. O'Neill (2019, 11) argues that the risks of waste management as well as waste solutions have magnified, disproportionately affecting economically disadvantaged communities, particularly in the Global South. The unequal toxic burdens of waste solutions constitute some of the "shadows" cast by circular economy policies (O'Neill 2019, 186). Indeed, there are many unintended consequences of circular economy policies. Rather than despairing over China's National Sword policy banning the import of plastic waste, petrochemical companies celebrated the opportunity to sell more virgin resins to make plastic products in China. As one petrochemical representative put it, "China could be the savior in the export market."[29]

Whether circular economy–based proliferation strategies will play out in the aftermath of COVID-19 has yet to be seen. The low price of oil threatens the viability of plastics recycling, and circular economy recycling projects have stalled as a result of the coronavirus (Patawari 2020; Pipoli 2020). How could recycled plastics compete with cheap virgin materials? The future of the circular economy for plastics remains uncertain.

Conclusions

The circular economy for plastics is both a corporate battleground for containing environmental crises and a catalyst for intensifying expansion. Faced with industry-level threats to public legitimacy and future markets, corporations across the petrochemical value chain have banded together to contain the circular economy policy agenda, appearing to be sustainable while proliferating unsustainable markets. Corporations have achieved this through deploying their advantage in technological expertise and understandings of complexity. The industry attempts to future-proof capitalism from the shocks of green transition by designing and controlling the new systems. Yet within intensifying wars of position over global environmental issues, the battleground is never stable. While industry has become more sophisticated at dealing with complexity, it has also exposed its vulnerability to systemic threats through the speed and extent of its response. There has been mounting pressure for industrial transformation of plastics, including climate divestment, plastic-free, environmental justice, and zero-waste campaigns, coming not only from grassroots movements but also from regulators and investors.[30]

29. Author's field notes, European Petrochemical Conference, Rotterdam, February 7, 2018.
30. From a green investment angle, the think tank Carbon Tracker (2020) issued a report called *The Future's Not in Plastics*, questioning the oil industry's long-term investment strategy in plastics, which would become stranded assets in the green transition.

In order to address problems of overconsumption, waste, and environmental injustice, there is an urgent need for systems thinking and collaboration. We need to find new forms of interpretation and intervention to confront environmental crises and challenge technocratic corporate visions of the circular economy. The most urgent priority is to reduce toxic and wasteful global plastics production, which means challenging entrenched corporate and societal views about growth. This will not be easy, given the powerful interests at stake. However, there is growing momentum among scholars and activists to advocate "degrowth," a critique of capitalist economic growth that advocates the shrinking of production and consumption, reorienting societies to use fewer natural resources and to live more sustainably (D'Alisa et al. 2015; Kallis et al. 2020; Martínez-Alier et al. 2010). These debates connect to Mariana Mazzucato's (2015) idea of "sustainable growth," reframing growth to constitute making rather than extracting value in the global economy. Reducing plastics needs to be seen as part of the necessary green transition away from fossil fuels, as opposed to expanding plastics as a hedge against it.

Current circular economy policies fail to challenge the capitalist imperative for growth, glossing over "reduction" among the *R*s of the circular economy. One starting point toward plastics "degrowth" would be to reorient public debates to more radical versions of the circular economy, pointing to the need to *reduce* the production and consumption of single-use plastics and to *redesign* products that can be *reused* and *refilled* affordably, safely, and efficiently. This would mean acknowledging the dilemmas and unintended consequences of possible "solutions," particularly in terms of environmental justice. However, on a deeper level, which goes beyond the limits of the circular economy, we need to tackle questions about values, inequality, and future generations. With vested interests in making profits, corporations should not have the monopoly on the social, economic, and technological solutions to environmental problems.

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