

Indicator development as a site of collective imagination? The case of European Commission policies on the circular economy

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ABSTRACT

In recent years the concept of the circular economy gained prominence in EU policy-making. The circular economy promotes a future in which linear 'make-use-dispose' cultures are replaced by more circular models. In this paper, we use the concept of sociotechnical imaginaries to ask how an imaginary of circularity has been assembled and stabilized, which imaginative resources were drawn on, and how goals, priorities, benefits and risks have been merged with discourses of innovation, sustainability and growth. Drawing on policy documents and interviews with policy officers of the European Commission, we argue that the monitoring framework and indicator development function as a site of collective imagination in which desirable 'circular' futures are co-produced. These futures are imagined to provide novel opportunities for the private sector and to generate jobs and economic growth while at the same time improving the natural environment as measured by selected environmental indicators.

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Introduction

I was very impressed by the enormous societal and economic benefits which the report found could stem from the transition to a circular economy. So the question is not whether we want to set Europe on a circular path of growth. It is rather about how to help our economies to get there, and how quickly. (...) Once people are convinced of the impact on their pocket, on the services they receive, they will be much more receptive to listen to the wider benefits like CO2 reductions.

A 'circular path of growth' that promises 'enormous societal and economic benefits' that 'people' need to be 'convinced of'. This statement from Karmenu Vella, the European Commissioner for Environment, Maritime Affairs and Fisheries, is taken from a talk at the Circular Economy Stakeholder Conference in 2015 and nicely shows the vision for a circular future. Since then the idea of a circular economy has gained increasing traction in EU policy. More recently, at the latest iteration of the Circular Economy Stakeholder Conference in February 2018 Elżbieta Bieńkowska, the European Commissioner for the Internal Market, Industry, Entrepreneurship and SMEs, boils down the ideas behind the circular economy to 'doing more with less', thus rehearsing the credo of efficiency. The increasing importance of this area of policy-making is visible also in the European research budget: the European Commission has assigned €964 million for the Horizon 2020 focus area 'Connecting economic and environmental gains – the Circular Economy'¹ for the period from 2018 to 2020.² Almost no EU policy area can afford not to mention the circular economy nowadays, recent

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examples being the European Plastics Strategy entitled 'A European Strategy for Plastics in a Circular Economy' and a so-called 'Commission Staff Working Document' on water management and agricultural policy that includes references to circular economy policy. While there is no particular directive on the circular economy, these references point to the so-called 'circular economy package' that contains various legislative texts, communications, action plans, a monitoring framework and various other policy documents.³

Broadly speaking, the circular economy promotes a future in which linear 'make-use-dispose' cultures are replaced by more circular models. In EU visions of a circular economy, ideas about waste management, recycling, reuse, resource efficiency, sharing economies, maintenance and repair cultures are all woven together in multiple ways. The European Union is currently developing policies, action plans and regulatory measures to encourage and facilitate the transition from a 'linear' to a circular economy.

As for the exact meaning or definition of the circular economy, Kirchherr et al. count 114 (sic!) different definitions in attempts to properly conceptualize the circular economy (Kirchherr, Reike, and Hekkert 2017). So what then is circularity? What to make of all these definitions and versions of circularity? And what makes this particular idea so attractive for EU policy-makers? In this paper, we use the concept of sociotechnical imaginaries (Jasanoff and Kim 2009, 2015) to ask how an imaginary of circularity has been assembled and stabilized over recent years; which imaginative resources were drawn on; and how particular goals, priorities, benefits and risks have been merged with discourses of innovation, sustainability, and growth. Notably, within a European Commission context, operationalization takes place in the shape of action plans, monitoring frameworks and indicators. We thus argue that indicator development should be understood as a site of imagination and provide a first exploration of the construction of such indicators.⁴

Circularity – debates about concepts and implementations

While the majority of the more recent literature on the circular economy comes from industrial ecology, organization and planning studies dealing with proper ways to manage a transition from a linear towards a circular economy (Bakker et al. 2014; Bocken et al. 2016) or 'how to' type guides that explain how businesses may become more circular (Benton, Hazell, and Hill 2017; Lacy and Rutqvist 2016; Mao et al. 2016), there is also a growing body of work zooming in on the development and implementation of circular economy policies from a social science perspective (Ghisellini, Cialani, and Ulgiati 2016).

Micro level studies comparatively explore circular economy initiatives on a city level arguing that the concept is usually ambiguous or ill-defined and needs to be interpreted by the actors responsible for its implementation (Petit-Boix and Leipold 2018; Prendeville, Cherim, and Bocken 2018). This ambiguity of the concept is usually mediated in its practical application by concepts such as sustainability. Marin and De Meulder (2018) identify different sustainability frameworks and political positions that are guiding the implementation of circular economy initiatives: they argue that what they call objectivist framings tend to foreground a 'technology and entrepreneurial "applied" circular economy' (Marin and De Meulder 2018, 13) while constructivist framings focus on the social organization of consumption, thus directing attention to practices of sharing, re-using and collaborating. These different frames relate to technocratic or emancipatory political positions respectively.

Others have argued that the framing of the circular economy is too narrow and tends to disregard the social aspects of the envisioned transition as well as questions about its 'social desirability' (Murray, Skene, and Haynes 2017; Sauvé, Bernard, and Sloan 2016). In particular, a focus on consumption as a set of choices by rational actors framed as 'consumers' is criticized as such a perspective ignores the fact that production and consumption practices follow patterns that go beyond individual choices (Mylan, Holmes, and Paddock 2016; Welch, Keller, and Mandich 2016). Mylan, Holmes, and Paddock (2016) show how, from a sociotechnical perspective, food consumption needs to be

understood as a social practice consisting of complex combinations of routines and habits, shared cultural understandings and available infrastructures.⁵

Moreover, conceptual engagements with circular economy policy have traced the lineage and relation of the concept to notions such as sustainable development, sustainability, post growth, or zero waste (Corvellec and Hultman 2012; Hultman and Corvellec 2012; Valenzuela and Böhm 2017). Such comparisons show how the move from sustainable development to zero waste and circular economy did not merely shift policy objectives, but simultaneously and more subtly also altered the very concepts that underlie these policies. Waste was commodified as an object of sustainability and is no longer a signifier of unsustainable practices; it has become a resource in an 'optimization business' (Hultman and Corvellec 2012). This reconceptualization of waste was the precondition for naturalizing and de-politicizing the idea of permanent growth and establish an 'economic naturalism' (Valenzuela and Böhm 2017). Circular economy policy thus is shown to share some of the problems of predecessor notions such as sustainable development (Kovacic, Strand, and Völker 2019) in the sense that it is 'appropriating critique and then selling it back to the ethically-driven, sustainability-wary subject' (Valenzuela and Böhm 2017, 50).⁶

In a similar vein, a number of authors more recently take the imaginative resources and the promissory logics involved in the development of CE policy as their starting point, stressing in particular the need to critically engage with the multiple meanings and futures of circularity. Such futures are currently being negotiated and start to manifest for example in the distribution of R&D funding and in the implementation of indicators for measuring progress towards circular futures. Lazarevic and Valve (2017) describe circular economy documents in terms of a hero's journey as a transition to a circular economy. This narrative builds on imaginations of a perfect circle of slow material flows, a move from consumers to users together with ideas of de-coupling economic growth from environmental protection, but it still relies on current notions about competitiveness and security. In a similar vein Welch, Keller, and Mandich (2016) direct attention to the imagined everyday futures of circular economy policies arguing that these policies attempt to merge conflicting orders of worth in a way that marginalizes ecological matters. They diagnose a 'crisis of political imagination' (Welch, Keller, and Mandich 2017, 51), call for critical engagement with these futures and especially highlight the incompatibility of different orders of worth. Others argue that circular economy policies rest on a moral economy that brings together 'discourses of ecological modernisation, environmental justice and resource (in)security' (Gregson et al. 2015).

As this brief overview of the literature on circular economy shows, there is a burgeoning discussion about both the culturally shared meaning(s) of circularity and potential circular futures. We aim to add to this discussion a concern with how collective imaginations of circular futures are currently translated into circular economy indicators in European policy. In this paper we investigate how the circular economy is enacted, and by whom. To address these questions we draw on the concept of sociotechnical imaginaries (Jasanoff and Kim 2009, 2015) and propose to look at indicator development as a novel site of imagination.

Conceptual framing: sociotechnical imaginaries, centres of calculation and indicator politics

For capturing the relation between visions of desirable futures and contingencies in policy choices we use the conceptual lens of 'sociotechnical imaginaries'. This concept allows for asking how particular social, scientific, political and moral orderings are being stabilized through collectively shared ideas about the future. Introduced by Jasanoff and Kim (2009, 2015) it brings together work on the role of imagination in stabilizing social orderings (Anderson 1991; Appadurai 2006 [1990]; Fujimura 2003; Taylor 2002) with work on technoscientific development (Bijker, Hughes, and Pinch 1987; Winner 1986).

Imagination is understood as a collective practice that is at the same time situated within particular cultural settings and constitutive for the emergence of social, scientific, political and moral orderings. Sociotechnical imaginaries are defined as

collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through and supportive of, advances in science and technology. (Jasanoff 2015, 4)

This quote addresses the main elements of imaginaries: they need to be *collectively held* and tend to be more stable when they are *institutionalized* in some form. Imaginaries thus can become visible in exercise of power such as the allocation of resources, the development of research priorities or in particular institutional configurations. Then, imaginaries also need to be *publicly performed* in order to be stable. Analysing imaginaries in that sense also means focusing on the processes of their on-going assemblage and stabilization as well as on moments of contestation. In her work on nuclear energy in Austria, Felt (2015) has shown how visions of desirable futures are created through particular memory practices and continuous processes of articulation and rehearsal. This understanding emphasizes the importance of public performance and rehearsal as central means in *collective self-imagination* (Anderson 1991; Pfothenhauer and Jasanoff 2017). Additionally, a focus on collective imaginations directs attention to the actors and institutions, the 'epistemic communities' (Haas 1992), contributing to their articulation and stabilization. Finally, imaginaries focus on *desirable futures* that are entwined with ideas about social order and scientific and technological progress. Through bringing in ideas about desirable futures, the concept of imaginaries allows for capturing the normative dimensions that are part and parcel of scientific and technological projects and which become palpable through policy visions,

[f]or imaginaries not only help reconfigure actors' sense of possible spaces of action but also their sense of the rightness of action. (Jasanoff 2015, 23)

Sociotechnical imaginaries thus can be thought of as underlying (normative) but rarely explicated rationales and justifications of policy choices. Exploring imaginaries directs attention to

how different imaginations of social life and order are co-produced along with the goals, priorities, benefits and risks of science and technology. (Jasanoff and Kim 2009, 141)

For our case, this means exploring the underlying rationales and justifications of circular economy policy by asking how ideas about attainable futures are combined with particular goals, priorities, benefits and risks as well as with discourses of innovation, sustainability, and growth.

The development of circular economy policies brings together European institutions with organizations at the national level, their various epistemic commitments and ideas about desirable futures. To understand how these actors create and negotiate sociotechnical imaginaries of circularity, it is useful to think of their activities in terms of an attempt to stabilize 'centres of calculation' (Asdal 2008; Latour 1987) and to create a measurable object that is the circular economy. In a study on carbon accounting at the Norwegian Ministry of Finance Asdal describes centres of calculation as sites

through which all governmental proposals that involve budget expenses or have consequences for 'the economy' must pass. (...) The Ministry of Finance has been enacted, and continuously enacts itself, as the ministry that draws things (i.e. the economy) together. (Asdal 2014, 2113)

As with any policy field characterized by issues and institutions that heavily rely on scientific and technical concepts and expertise, the study of how the circular economy makes worlds and enacts and shifts power therefore has to address the seemingly mundane activities of monitoring frameworks, evidence and indicators. As Turnhout and co-authors remind us,

measuring can never be a completely neutral activity. It involves the exercise of power in the sense that rendering an object of interest measurable or legible (Scott, 1998) involves critical choices about what to measure and how. (Turnhout, Neves, and de Lijster 2014)

This combination allows for exploring how processes of indicator development for ‘measuring progress towards a circular economy’ (COM (2018) 29) are guided by imaginaries of circularity while simultaneously rehearsing and re-shaping them. We argue that indicator development should be understood as a site of collective imagination and thus provides a fitting place to study the performative features of imagination in policy-making; as Turnhout so poignantly states, ‘*only what is counted counts*’ (2014).

Building on this conceptual background we can now refine the questions posed in the introduction and articulate our research questions:

- What are the main elements of collectively shared imaginations of circular futures in European circular economy policy?
 - What are the implicit goals, priorities, benefits and risks visible in this policy?
 - What role do discourses of innovation, sustainability and growth play?
- How, in which sites and by which actors has the imaginary of circularity been assembled, rehearsed and stabilized?
- What indicators are used to monitor progress towards a circular economy and which circularities are enacted through these indicators?

Case and material

The empirical analysis presented in this paper builds on a core set of policy documents and reports relevant for the development of circular economy policy. This includes the main documents on the circular economy policy (including staff working documents) as well as documents related to this policy area (see Table 1).

In addition, we included public statements by European Commission officials addressing the circular economy. These statements include opening and closing remarks of Jyrki Katainen, Frans

Table 1. Core set of circular economy policy documents and reports.

| Title | Document type | Published |
|---|---|------------|
| Towards a circular economy – a zero waste programme for Europe | Communication – COM(2014) 398 + Annex | 02.07.2014 |
| Towards a circular economy – a zero waste programme for Europe | Staff Working Document – SWD (2014) 206 | 02.07.2014 |
| Towards a circular economy – a zero waste programme for Europe | Staff Working Document – SWD (2014) 211 | 02.07.2014 |
| Ellen MacArthur Foundation – Towards the Circular Economy Vol.1-3 | Strategy Document | 2013–2014 |
| Closing the loop – An EU action plan for the Circular Economy | Communication – COM(2015) 614 + Annex | 02.12.2015 |
| Circular Economy in Europe – Developing the knowledge base | EEA Report 2/2016 | 18.01.2016 |
| European Innovation Partnership on Raw Materials – Raw Materials Scoreboard | Report | 29.09.2016 |
| Ecodesign Working Plan 2016–2019 | Communication – COM(2016) 773 | 30.11.2016 |
| Report on the implementation of the Circular Economy Action Plan | Communication – COM(2017) 33 | 26.01.2017 |
| The role of waste-to-energy in the circular economy | Communication – COM(2017) 34 | 26.01.2017 |
| Proposal Hazardous substances in electronic equipment | Proposal – 2017/0013 (COD) | 26.01.2017 |
| Roadmap for the Development of a Monitoring Framework for the Circular Economy | Roadmap | 05.04.2017 |
| Communication on a monitoring framework for the circular economy | Communication – COM(2018) 29 | 16.01.2018 |
| Measuring progress towards circular economy in the European Union – Key indicators for a monitoring framework | Staff Working Document – SWD (2018) 17 | 16.01.2018 |
| A European Strategy for Plastics in a Circular Economy | Communication – COM (2018) 28 | 16.01.2018 |
| A European Strategy for Plastics in a Circular Economy | Staff Working Document – SWD (2018) 16 | 16.01.2018 |
| Report on Critical Raw Materials and the Circular Economy | Staff Working Document – SWD (2018) 36 | 16.01.2018 |
| The circular economy and the bioeconomy – partners in sustainability | EEA Report 8/2018 | 27.08.2018 |

Timmermans and Karmenu Vella at the 2015 circular economy Stakeholder Conference and speeches by the same actors plus Elżbieta Bieńkowska at the 2018 edition of this conference.

This core set of materials is contextualized with four interviews with policy-makers from the European Commission Directorate-General for Environment (DG ENV, 2 interviewees), the Directorate-General for Agriculture and rural development (DG AGRI) and the European Environment Agency (EEA). These semi-structured interviews were conducted as a part of a larger interview sample for a project on the so-called water-energy-food nexus. They took place after the document analysis, followed an interview guide and were designed to discuss central policy-narratives. The interviews lasted between 60–90 min. In addition, the analysis draws on data from a focus group, which was part of a half-day workshop that included brief presentations of work done in the larger project and two separate discussions, lasting around 60 and 40 min respectively. Actors from the Directorates-General for Environment, Agriculture and rural development, and Energy (DG ENER) as well as a representative from the European Parliament's Panel for the Future of Science and Technology (STOA) participated in this focus group. The interviews and focus group discussions were audio-recorded and transcribed. The data were coded and analysed by the authors of this paper. The coding structure was developed on the basis of the conceptual framework presented above. A framework matrix (Srivastava and Thomson 2009) was then used to structure, compare and contrast the findings. This framework was further developed in an iterative process during analysis.

Drawing on these materials we explore the main elements of an 'imaginary of circularity' that is currently assembled, rehearsed, contested and stabilized in the development of European circular economy policy. Building on this analysis we look at indicators that are currently in development for monitoring and 'measuring' progress towards circularity and show how indicators need to be understood as a specific site in which collective imaginations are negotiated.

Empirical analysis – circular economy as a policy in-the-making

In this section we present insights from on-going research on the development of circular economy policies and debates about indicators for measuring progress towards circular economies in Europe. We will proceed by first describing the development of the imaginary of circularity in circular economy policies, then we will briefly address how different circularities become visible in some of the most prominent circular economy representation before we zoom in on the currently on-going process of indicator development.

Developing policies and assembling imaginative resources

Circular economy policy at the moment is a policy 'in-the-making' and as such a site in which both environmental and economic policy priorities are being negotiated. The EU Sustainable Consumption and Production Action Plan (COM (2008) 397) needs to be considered an antecedent of the circular economy, for it introduced 'life cycle thinking' in policy discourses. However, while waste was dealt with in the waste framework directive (Directive 2008/98/EC) in that year, there is no mention of ideas of circularity and waste management in the Sustainable Consumption and Production Action Plan.⁷ The idea of a circular economy entered the stage of European-policy making around 2013. Interestingly the starting point is provided by reports produced by the Ellen MacArthur Foundation (EMF). EMF is a registered charity with the stated aim to promote the transition to a circular economy. Not being an official institution of the European Union it does so mainly through producing reports and assessments pushing for such a transition.

Two years later, in 2014, the European Commission published the communication 'Towards a circular economy. A zero waste programme for Europe' (COM (2014) 398). Circularity at this stage is framed mainly in terms of resource efficiency and waste reduction with the goal to reduce material inputs into industry, which is supposed to have an 'overall savings potential of €630 billion per year' (COM (2014) 398: 2). A central issue and priority in this document, however, is to turn waste into a

resource; a resource that is so far ‘leaking from our economy’ (COM (2014) 398: 2). This prioritization is also visible in a number of waste reduction targets.

This first circular economy package was cut as soon as the Juncker Commission entered office. In conversations with actors from EC policy DGs the rationale that is usually given for this is that the Juncker Commission was very heavily influenced by the economic crisis and wanted to foreground economic issues. As a consequence environmental concerns decreased in significance.⁸ It was also pointed out to us that the only way to get environmental concerns on the agenda during the times of austerity was through an economically focused policy package. Thus, after protests from various sides the circular economy package was brought back, with the requirement to be more economically focused. This means that instead of the initial package the new Commission wanted a ‘more ambitious package’ that was less focused on waste management. ‘Greater ambition’ is the framing that is most common within DG ENV when talking about the process of re-shaping the circular economy package and was also used for example by Jyrki Katainen in a speech delivered at the 2015 edition of the circular economy stakeholder conference.

This process led to the second circular economy package called ‘Closing the loop – An EU action plan for the Circular Economy’ in 2015 (COM(2015) 614). In this document the circular economy is defined as an economy ‘where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised’ (COM (2015) 614). This definition shows the close relation between economic narratives, resource efficiency and waste. Volatile prices as a consequence of scarce resources are a central risk that makes a transition towards a circular economy necessary. It thus comes as no surprise that ‘Closing the loop’ primarily frames waste in economic terms as ‘lost business opportunities’ (COM (2015) 614: 4).

2016 saw the publication of a Communication on Eco-design (COM (2016) 773) and the Raw Materials Scoreboard (Vidal-Legaz et al. 2016), which included first proposals for ‘measuring’ the potential circularity in the use of materials. Potential circularity is measured based on circular economy indicator 15 called ‘Material flows in the circular economy’, which provides a measure of all the material flows of the economy, aggregated by weight. This representation draws from the ecological economics understanding of the economy as an entropic process, in which total quantities of energy and materials consumed are maintained (inputs must equal outputs) but degraded in the process (energy inputs are balanced with emissions as outputs).

These documents related to the circular economy package build on the assumption that enabling a transition towards more circularity is a matter of improving product design and designing more sustainable ways (eco-design) of producing and consuming. It is worth pointing out that such a techno-optimist model rehearses an understanding of innovation and problem solving in which a seemingly inevitable technological progress provides solutions for societal challenges (Strand et al. 2016).

A range of different policy documents that relate to the circular economy were published in 2017, including a Communication on waste-to-energy (COM (2017) 34) in partial response to criticism and worries about the limited circularity of energy, an implementation report (COM (2017) 33), and the first proposal for a Directive on the restriction of hazardous substances in electrical and electronic equipment (COM (2017) 38). Additionally, the ‘Roadmap to a monitoring framework for the Circular Economy’ was also published. These documents build on collaborations between a range of European institutions in the attempt to create a measurable and thus governable object that is the circular economy. These activities have led to the publication of the Monitoring Framework (COM (2018) 29), with the definition of 10 indicators of circularity, and the publication of the new European Plastics Strategy (COM (2018) 28) that explicitly relates to attempts to transition towards a circular economy.

Compared to the initial definitions the Monitoring Framework mobilizes a broader set of imaginative resources and includes a range of hopes and promises:

The transition to a circular economy is a tremendous opportunity to transform our economy and make it more sustainable, contribute to climate goals and the preservation of the world’s resources, create local jobs and generate competitive advantages for Europe in a world that is undergoing profound changes. The importance of the circular economy to European industry was recently highlighted in the renewed EU industrial policy strategy. The

transition to a circular economy will also help to meet the objectives of the 2030 Agenda for Sustainable Development. (COM(2018) 29)

In this quote a broad range of elements is mobilized, while the circular economy is more narrowly confined to the industrial sector (and hence primarily to issues of durability, recycling and repair). Economic visions are framed in terms of *tremendous opportunities for transformation*.

These visions of change and transformation implied in this policy are interesting as also in conversations with policy-makers involved in the development of circular economy policy the idea of transformation figured quite prominently. Transformation was explicitly mentioned as a deliberate contrast to a more radical revolution of the economic system and thus needs to be understood as signifying gradual shifts in the European economic system and not fundamental critique. We argue that the mode of transformation, defined as gradual changes and in opposition to revolutions, is another crucial element in the assemblage of the circular economy imaginary. Different and sometimes opposing narratives are brought together through moderation, setting the stage for 'win-win' solutions, middle ground and compromises. What we also see in this quote is 'boundary work' (Gieryn 1983) that distinguishes Europe from the rest of the world, a world in which *profound changes* (sic) are taking place. These changes need to be mitigated through circular economy policy.

Attention has also been given to critical raw materials, which invoke the security discourse and give support to the circular economy as a means to keep critical materials in the economy for longer through targeted recycling. This indicates a risk framing of environmental policy in terms of resource scarcity that is prominent in a number of EU policy documents. Such a 'securitization' of environmental policy has been problematized in relation to EU policy on the water-energy-food nexus (Leese and Meisch 2015).

Over the years, we thus see a gradual shift and purposeful expansion of visions and imaginative resources that guide circular economy policy-making. Starting from waste management and environmental concerns, the focus shifted towards economically-centred visions for a future Europe and to security concerns. The main strength of circular economy policy so far has been its ability to establish win-win scenarios for the future, visions of a transition that is at the same time profound and a mere evolution and a governance mode focused on moderation (Kovacic, Strand, and Völker 2019). However, while circular economy initially went from a waste management to an economy-centred policy, more recently environmental discourses seem to re-enter the policy as direct links to the Paris Agreement⁹ and the 2030 Agenda¹⁰ are made.

Visualizing circularity

When talking about the policy development and the related shifts in the collective imagination of circularity, it is necessary to consider the ways in which circularity has been visualized by various epistemic communities. While so far we have used two of the more common definitions of the circular economy to illustrate the broad range of imaginative resources mobilized in attempts at conceptualizing circularity, the story gets even more interesting by including visualizations or 'viscourses' (Knorr Cetina 2001) of the circular economy into the analysis. We thus want to briefly direct attention to three exemplary visualizations used in high level documents to stress the multiple circularities in play. This selection is not exhaustive and merely serves as a first gaze into such visualizations.¹¹

The visualization in [Figure 1](#) is taken from the first legislative proposal on the circular economy called 'Towards a Circular Economy'.

This graph shows a neat circle with only a limited amount of 'residual waste' and of primary inputs that come from outside the circle. The arrows in the graph are not represented to scale, thereby promising a great potential of circularity in consumption and production processes. The processes mentioned as examples are industrial processes, reflecting the influence of industrial ecology thinking in this representation, and reflecting the policy focus of the European Commission on industry.

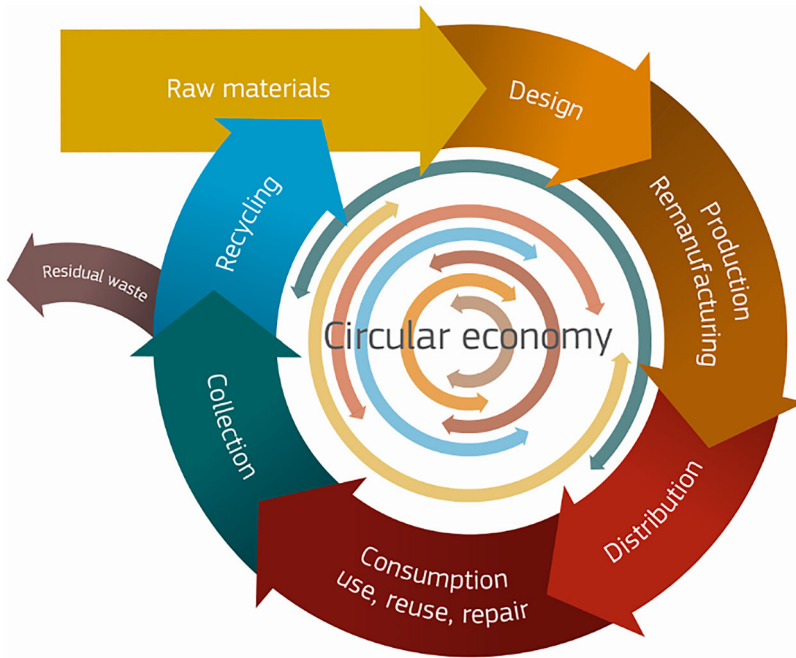


Figure 1. Representation of the circular economy. Source: EC Communication 'Towards a Circular Economy' (COM (2014) 398).

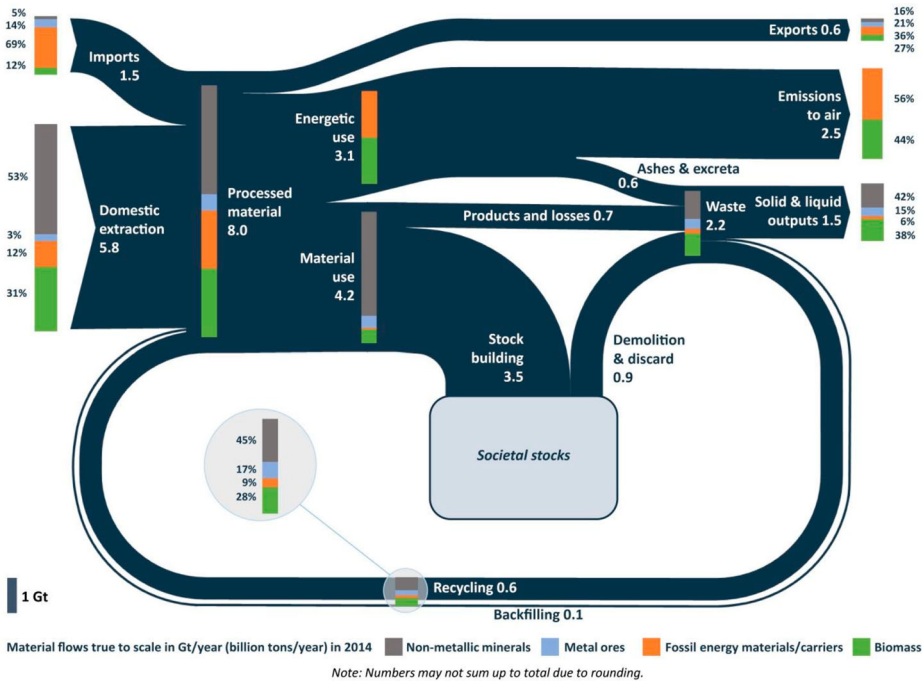


Figure 2. Sankey diagram of material flows in the economy (EU-28, 2014). Source: SWD (2018) 17.

In contrast, another frequently used representation of circularity tells a different story. What is depicted in Figure 2 is a so-called Sankey diagram, which is based on material flow analysis to assess the potential circularity of the economy.

multiple processes, each with their own paces, which recycle nutrients, some are short term, and some are long term; it thus highlights the fact that industrial recycling does not include natural resources such as water and biomass, for which the economy still depends on the ecosystem. Through the representation of faster and slower loops, this is the only representation that takes temporality into account.

This distinction between 'biological nutrients' and 'technical nutrients', introduced by McDonough and Braungart (2002), implicitly rehearses a divide between nature and culture. In doing so it upholds an image of nature as external to human action, which brings with it particular ideas about scientific and political power that Latour (1993) described as the 'modern condition'. This dichotomous conception becomes consequential in a number of ways: it provides the basis for discourses of restoration and protection (Hopwood, Mellor, and O'Brien 2005; Robinson 2004); it frames nature as an object of engineering, techno-fixes and natural science (Asdal 2003, 2008); and it stabilizes a classical imagination of science-policy relations in terms of measurement and control (Porter 1995; Turnhout, Neves, and de Lijster 2014).

'Measuring' circularity and establishing centres of calculation

The development of circular economy policy is a collaborative effort led by the European Commission Directorates-General for Environment (DG ENV), Climate Action (DG CLIMA) and Growth (DG GROW). The same institutions collaborate on the development of indicators for measuring progress towards a circular economy, with support from statistical and technical expertise in DG ESTAT and the Joint Research Centre (DG JRC). Additionally, experts from Agencies (such as the European Environment Agency) are involved in developing these indicators, and some NGOs and academic actors also take part in the debate.

Indicators about the circular economy first appeared as a part of a broader set of indicators in the Raw Materials Scoreboard in 2016 (Vidal-Legaz et al. 2016). In the same year, the European Environment Agency published a scoping report identifying a list of indicators, both available and to be developed, that could be used to monitor progress towards a circular economy, and assessing data availability for each indicator (European Environment Agency 2016). Afterwards, the European Commission started developing of a 'monitoring framework', which was published in January 2018 (COM (2018) 29) and consists of a set of indicators for measuring progress towards a circular economy. Here we want to focus on these indicators.

The indicators are grouped under four headings, 'production and consumption', 'waste management', 'secondary raw materials', and 'competitiveness and innovation' (see Table 2 for the complete list of indicators). In order to display how choices are made, and accordingly how futures are imagined, it is necessary to enter into some technical detail about waste management, reuse and recycling.

A recurrent challenge in waste generation and in waste management is to know how much waste is generated and, as a consequence, which are the main waste streams that need to be regulated. Waste accounting is challenging because not all waste is managed by public agencies and private companies do not report waste in the same way. For instance, when companies sell their waste to other sectors or to other countries, they do not always report discarded materials as waste. If the accounting is done in monetary terms, (companies report the revenues from the sale of discarded materials, not the quantities). Waste is measured by sector (e.g. construction waste, municipal solid waste) and by stream (e.g. plastics, electronic equipment, packaging), and there are important gaps in both cases. There are, for example, no statistics on waste produced by the agricultural and mining sectors; wastewater is generally not accounted for. While some of the indicators proposed by the monitoring framework aim to fill some of these knowledge gaps, such as the food waste indicator, there is no monitoring of the 'overall picture'. This means that it is impossible to know if the EC is monitoring a small or a large part of its waste production. Indeed, the technical argument can be made that it is impossible to know if the EC is monitoring 10% or 80% of its waste production.

Table 2. Monitoring Framework – Circular Economy indicators (COM (2018) 29).

| | |
|---|--|
| 'Production and consumption' indicators | EU self-sufficiency for raw materials; green public procurement (under development); generation of municipal waste per capita; generation of waste per unit of GDP; generation of waste per unit of Domestic Material Consumption; food waste (under development) |
| 'Recycling rates' indicators | recycling rate of municipal waste; recycling rate of all waste excluding major mineral waste; recycling rate of packaging; recycling rate of plastic packaging; recycling rate of wooden packaging; recycling rate of electrical and electronic waste; recycling rate of biowaste; recovering rate of construction and demolition waste |
| 'Secondary raw materials' indicators | end-of-life recycling of critical raw materials; circular material use rate; trade in recyclable materials |
| 'Competitiveness and innovation' indicators | gross investment in tangible goods in the recycling sector; number of persons employed in the circular economy sectors; gross value added in the circular economy sectors; number of patents related to recycling and secondary raw materials |

Many indicators refer to municipal solid waste, which is thought to represent about 10% of total waste in the European Union, and is a sector for which there are reliable data. The focus on municipal solid waste can be seen as a case of 'lamp-posting', in which availability of data and indicators drive policy goals.

There is also the question of how to measure waste: different pictures emerge if waste is measured by weight, by critical raw materials, or by hazardous materials. The monitoring framework focuses on the first two types of measurement, thus giving priority to the characterization of waste flows (how much waste is generated and how much is recycled, following a material flow analysis approach to circularity). This reinforces a risk-framing that highlights concerns about security and self-sufficiency in the provision and trade of critical raw materials.

There are no indicators so far that reflect ideas about repair, reuse, sharing, product durability, and standardization of designs, which may help substitute parts rather than the whole product. In the case of recycling and reuse, there is also uncertainty and a number of data gaps, as different materials have different recycling possibilities. For instance, paper and textile cannot be recycled an unlimited number of times, because fibres are degraded. For this reason, there has been criticism from the circular economy literature (Allwood 2014) stressing that the maintenance, reuse, remanufacture, and recycle loops on the biological nutrient side of the EMF representation tend to overestimate the possibility of circularity for wood, paper and textiles. The European Environment Agency report 'Circular Economy in Europe. Developing the Knowledge Base' (European Environment Agency 2016), which looked at policy objectives, indicators and data availability, had suggestions for indicators on product durability and standardization. Even though the circular economy is not just about waste, as the formulation of the policy progresses, the 'more than waste' parts are so far omitted. This omission has already been criticized (Welch, Keller, and Mandich 2016, 2017) and in addition current discussions also circle around question such as what actually is understood by the term 'sharing economy' and how (and if) it fits into the concept of the circular economy. Our point here is not to argue in favor of one set of indicators over others, but rather to direct attention to the fact that these indicators (together with certain omissions) produce very particular trajectories and temporalities of Europe and other collectives describing where we come from and pre-scripting the desirable futures we ought to actualize.

This general future-orientation is accompanied by particular spatio-temporalities when for example waste on a municipal level is described in certain time-periods: 'EU municipal waste generation per capita has dropped by 8% between 2006 and 2016 to an average of 480 kg per capita per

year' (COM(2018) 29). In a similar manner the monitoring framework describes an increase in recycling rates for packaging waste between 2008 and 2015. The trajectories thus created are enforced by narrative framings like being a 'steady improvement' (ibid.) or when the document states that trade with certain types of waste has 'increased considerably between 2004 and 2016' (ibid.). The pasts, presents and futures created in this way are indeed literal plurals as the time-periods for measurement are rather arbitrary and depend on data availability.

Additionally they create inner-European geographies of circularity by performing comparability between countries in terms of their achievements and potentials in regard to a progress towards a circular economy. In this sense, the indicators stabilize the Euro-centric nature that has already been criticized for circular economy policy as a whole (Gregson et al. 2015); any discussion about how these European biophysical flows are embedded within global waste streams gets side-lined by a focus on European indicators and technical debates about measurement and data availability. As a consequence, concerns about global environmental justice are systematically underrepresented. The focus on European industry ignores the fact that industrial production has been increasingly outsourced to emerging economies, and that the focus on 'sharing', the shift from 'consumption' to 'lease', from production of goods to provision of services, may further accentuate the outsourcing of non-circular economic activities.

When it comes to imagining the drivers of the transition to a circular economy the indicators show a clear emphasis on technological innovation. What is stabilized here is an 'innovation imperative' (Pfothenhauer, Juhl, and Aarden 2019) together with a traditional view of innovation advocating for technology-focused and expert-driven change (Pfothenhauer and Jasanoff 2017; Strand et al. 2016). This becomes especially visible in the indicators under the heading 'competitiveness and innovation', which measure private investments, jobs and gross value added together with the number of new patents (sic!); patents on recycling technologies for different materials. Additionally, there are mentions of changing markets, which further points to the imagination of a producer-led transition towards a circular economy, and opens up the possibility for new actors to emerge, such as the 'prosumer'.

We may summarize that the indicators rehearse a collective European self-imagination that frames sustainability and environmental protection in terms of industrial activity and economic growth within Europe, a technology-centred idea of innovation, and a particular model of science-policy relations that promotes governing through monitoring, command and control.

Conclusions

In this paper, we have argued that the circular economy is a policy-in-the-making that currently enjoys great attention in European policy circles as well as in academic debates. We showed how this policy assembles a broad range of imaginative resources that weave together particular goals, priorities, benefits and risks with discourses of innovation, sustainability, and growth. As a consequence, there are several meanings of circularity that are currently embedded within this set of legislative proposals. Among them are circularity as a feature of biophysical flows (a feature that, notably, is not achievable); circularity as a distinct market model that focuses on renting and sharing instead of ownership; as an industrial production guideline focused on the quality (in the sense of longevity) of products; and as a bureaucratic policy of procurement. As a consequence, the circular economy is highly promissory, which makes it all the more necessary to approach it in terms of the collective imaginations that are instrumental in its shaping (Jasanoff and Kim 2009, 2015). We proposed to think about currently on-going indicator development as one site to study this assemblage and ask how particular circularities are both imagined and enacted by techno-epistemic networks in centres of calculations (Asdal 2014; Foss-Ballo 2015; Haas 1992). This allowed us to hint at the set of actors and scientific disciplines that are currently shaping circular futures and their epistemic and normative commitments. What becomes clear through this first exploration is that this perspective directs attention to the world-making involved in indicator development for measuring progress

towards a circular economy. Furthermore, there is a need for additional research on the relation between indicator development, epistemic communities and their various commitments in circular economy policy development.

The current policy context in the EU is one in which economic growth is one of the main priorities, as formulated by the Europe 2020 strategy for ‘smart, inclusive and sustainable growth’. Our analysis thus confirms previous findings, which argue that specific radical environmental measures might be possible, any policy for sustainability and protection of the environment has to be seen as compatible with the general goal of economic growth and thus what comes to be collectively imagined as circular future is mediated by particular ideas of economic and sustainability goals (Marin and De Meulder 2018). This is nothing new. It is another rehearsal of how to imagine a reconciliation and compatibility of economic and environmental concerns that already was expressed by the terms ‘sustainable growth’, ‘green growth’ and ‘sustainable development’; the 1990s and 2000s imaginaries of ephemerization or dematerialization of the economy; and already with the Brundtland Commission’s concept of (simultaneous) environmental, social and economic sustainability (Hopwood, Mellor, and O’Brien 2005; Strand et al. 2016).

The imaginary of circularity also rehearses visions of technoscientific innovation and devises particular subject positions for European citizens, their behavior and (rational) choices (Godin 2006; Pfothenhauer and Jasanoff 2017). In doing so it creates moral narratives about production and consumption, recycling, repairing and maintenance, and sharing (Gregson et al. 2015) while remaining comparatively less clear about the concrete everyday futures this entails (Welch, Keller, and Mandich 2016) and about their social desirability (Sauvé, Bernard, and Sloan 2016). This moral dimension also becomes clear in discussions with actors developing indicators for measuring progress towards the circular economy. Circularity is very much discussed as ‘going in the right direction’ and as a desirable future. So much so that sometimes it gets hard to criticize notions of circularity, or to discuss some of the uncertainties and contradictions in the evidence used. As one informant put it, *mutatis mutandis*, nobody would argue for less circularity.

This leads to the pressing question of what is actually new in this policy and to what extent dominant economic narratives can be challenged through circular economy policies. In this sense one of our informants repeatedly stated – in contradiction to some of the public statements of EU officials – that circular economy was not a revolution, but a transition. The novelty of the circular economy policy does not lie in the arguments used, nor in the debates that are rehearsed through this policy, but in the modes and framings through which circularity is discussed: the key features of the circular economy policy proposal(s), which seem to make it particularly attractive for policy-makers, are the win-win framings, the substitution of trade-offs and constraints by synergies and opportunities, and a mode of policy intervention that privileges moderation. Through the change in framing, old debates are redressed as a space in which a policy that connects different interests can emerge, i.e. a ‘nexus policy’ (Stirling 2015).

Going back to the famous Mary Douglas dictum that dirt needs to be understood as ‘matter out of place’ (Douglas 1966) it can be argued that circular economy policies constitute an attempt to re-structure the ‘place’ through which dirt receives its meaning. Monitoring frameworks and indicators are then a site in which circular worlds are being measured, monitored and thus enacted together with visions of circular futures and collectives (Asdal 2012; Law 2003). The question then becomes, which worlds and futures are created as the initial promises of circularity materialize through a set of indicators for measuring progress towards a circular economy; indicators, which are themselves shaping the range of initiatives and actions of actors engaged in building a circular economy.

Notes

1. <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/cross-cutting-activities-focus-areas>, accessed November 2nd, 2018.

2. Additionally there will also be funding resources from the European Structural and Investment Funds, the European Fund for Strategic Investments (EFSI), and the LIFE programme.
3. When we talk about 'circular economy policy' we refer to a range of policy texts and activities, which use the circular economy as a common denominator or label, not to a specific directive.
4. The research presented in this paper has been further developed into a book entitled 'The Circular Economy in Europe. Critical Perspectives on Policies and Imaginaries' (Kovacic, Strand, and Völker 2019). While partly drawing on the same empirical material, this book broadens the scope beyond questions of indicator politics and socio-technical imaginaries.
5. Similarly the role of plastics for contemporary societies and socio-material ways of living has been problematized by showing how waste is not only a by-product, but a fundamental aspect of our current ways of living (Gabrys, Hawkins, and Michael 2013).
6. Criticism like this resonates with arguments made by ecological economists who, influenced by the work of Georgescu-Roegen (1971), have pointed out that notion of a circular economy is misleading since perfect circularity is a theoretical impossibility (Haas et al. 2015; Martínez Alier 2015; Kovacic, Strand, and Völker 2019).
7. A systematic comparative analysis of circular economy policies and the Sustainable Consumption and Production Action Plan (COM (2008) 397) would be a worthwhile endeavour for future research. However, it is not within the scope of this paper.
8. This already becomes visible when looking at the 10 priorities of the Juncker Commission, from which environmental concerns are mostly absent. https://ec.europa.eu/commission/priorities_en, accessed June 10, 2018.
9. https://ec.europa.eu/clima/policies/international/negotiations/paris_en, accessed November 2nd, 2018.
10. <https://sustainabledevelopment.un.org/post2015/transformingourworld>, accessed November 2nd, 2018.
11. For an overview of different visual representations of waste and resource management frameworks see Blomsma and Brennan (2017). They provide an analysis of such visualizations and show how circularity is mainly framed in terms of extending resource life. This underlying framing, they argue, was a precondition for the circular economy to emerge as an 'umbrella concept'.

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References

- Allwood, Julian M. 2014. "Squaring the Circular Economy: The Role of Recycling Within a Hierarchy of Material Management Strategies." In *Handbook of Recycling*, edited by Ernst Worell and Markus A. Reuter, 445–477. Amsterdam: Elsevier.
- Anderson, Benedict. 1991. *Imagined Communities: Reflections on the Origin and Spread of Nationalism*. London: Verso.

- Appadurai, Arjun. 2006 [1990]. "Disjuncture and Difference in the Global Cultural Economy." In *Media and Cultural Studies: Key Works*, edited by Meenakshi Gigi Durham, and Douglas M. Kellner, 584–603. Malden, Oxford and Victoria: Blackwell Publishing Ltd.
- Asdal, Kristin. 2003. "The Problematic Nature of Nature: The Post-Constructivist Challenge to Environmental History." *History and Theory* 42 (4): 60–74.
- Asdal, Kristin. 2008. "Enacting Things Through Numbers: Taking Nature Into Accounting." *Geoforum; Journal of Physical, Human, and Regional Geosciences* 39 (1): 123–132.
- Asdal, Kristin. 2012. "Contexts in Action—And the Future of the Past in STS." *Science, Technology & Human Values* 37 (4): 379–403.
- Asdal, Kristin. 2014. "From Climate Issue to Oil Issue: Offices of Public Administration, Versions of Economics, and the Ordinary Technologies of Politics." *Environment and Planning A* 46 (9): 2110–2124.
- Bakker, Conny, Feng Wang, Jaco Huisman, and Marcel Den Hollander. 2014. "Products That Go Round: Exploring Product Life Extension Through Design." *Journal of Cleaner Production* 69: 10–16.
- Benton, Dustin, Jonny Hazell, and Julie Hill. 2017. *The Guide to the Circular Economy: Capturing Value and Managing Material Risk*. London: Routledge.
- Bijker, Wiebe E., Thomas P. Hughes, and Trevor J. Pinch. 1987. "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other." In *The Social Construction of Technological Systems*, edited by Wiebe E. Bijker, Thomas Hughes, and Trevor Pinch, 17–50. Cambridge: MIT Press.
- Blomsma, Fenna, and Geraldine Brennan. 2017. "The Emergence of Circular Economy: A new Framing Around Prolonging Resource Productivity." *Journal of Industrial Ecology* 21 (3): 603–614.
- Bocken, Nancy MP, Ingrid de Pauw, Conny Bakker, and Bram van der Grinten. 2016. "Product Design and Business Model Strategies for a Circular Economy." *Journal of Industrial and Production Engineering* 33 (5): 308–320.
- Corvellec, Hervé, and Johan Hultman. 2012. "From "Less Landfilling" to "Wasting Less" Societal Narratives, Socio-Materiality, and Organizations." *Journal of Organizational Change Management* 25 (2): 297–314.
- Douglas, Mary. 1966. *Purity and Danger: An Analysis of Concepts of Pollution and Taboo*. London: Praeger.
- Ellen MacArthur Foundation. 2013. *Towards the Circular Economy, Vol. 2: Opportunities for the Consumer Goods Sector*. Cowes: Ellen MacArthur Foundation.
- European Commission. 2008. *Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan (COM (2008) 397)*. Brussels: EC.
- European Commission, European Parliament and Council. 2008. *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives*. Brussels: EC.
- Felt, Ulrike. 2015. "Keeping Technologies Out: Sociotechnical Imaginaries and the Formation of a National Technopolitical Identity." In *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, edited by Sheila Jasanoff and Sang-Hyun Kim, 103–125. Chicago: Chicago University Press.
- Fischer-Kowalski, Marina, Fridolin Krausmann, Stefan Giljum, Stephan Lutter, Andreas Mayer, Stefan Bringezu, Yuichi Moriguchi, Helmut Schütz, Heinz Schandl, and Helga Weisz. 2011. "Methodology and Indicators of Economy-Wide Material Flow Accounting: State of the art and Reliability Across Sources." *Journal of Industrial Ecology* 15 (6): 855–876.
- Foss-Ballo, Ingrid. 2015. "Imagining Energy Futures: Sociotechnical Imaginaries of the Future Smart Grid in Norway." *Energy Research & Social Science* 9: 9–20.
- Fujimura, Joan H. 2003. "Future Imaginaries. Genome Scientists as Sociocultural Entrepreneurs." In *Genetic Nature/Culture: Anthropology and Science Beyond the Culture Divide*, edited by Alan H. Goodman, Deborah Heath, and M. Susan Lindee, 176–199. Berkeley: University of California Press.
- Gabrys, Jennifer, Gay Hawkins, and Mike Michael. 2013. *Accumulation: The Material Politics of Plastic*. London: Routledge.
- Georgescu-Roegen, Nicholas. 1971. *The Entropy Law and the Economic Process*. Cambridge: Harvard University Press.
- Ghisellini, Patrizia, Catia Cialani, and Sergio Ulgiati. 2016. "A Review on Circular Economy: The Expected Transition to a Balanced Interplay of Environmental and Economic Systems." *Journal of Cleaner Production* 114: 11–32.
- Gieryn, Thomas. 1983. "Boundary Work and the Demarcation of Science From Non-Science: Strains and Interests in Professional Ideologies of Scientists." *American Sociological Review* 48 (December): 781–795.
- Godin, Benoît. 2006. "The Linear Model of Innovation: The Historical Construction of an Analytical Framework." *Science, Technology, & Human Values* 31 (6): 639–667.
- Gregson, Nicky, Mike Crang, Sara Fuller, and Helen Holmes. 2015. "Interrogating the Circular Economy: The Moral Economy of Resource Recovery in the EU." *Economy and Society* 44 (2): 218–243.
- Haas, Peter M. 1992. "Introduction: Epistemic Communities and International Policy Coordination." *International Organization* 46 (1): 1–35.
- Haas, Willi, Fridolin Krausmann, Dominik Wiedenhofer, and Markus Heinz. 2015. "How Circular is the Global Economy?: An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005." *Journal of Industrial Ecology* 19 (5): 765–777.
- Hopwood, Bill, Mary Mellor, and Geoff O'Brien. 2005. "Sustainable Development: Mapping Different Approaches." *Sustainable Development* 13 (1): 38–52.

- Hultman, Johan, and Hervé Corvellec. 2012. "The European Waste Hierarchy: From the Sociomateriality of Waste to a Politics of Consumption." *Environment and Planning A* 44 (10): 2413–2427.
- Jasanoff, Sheila. 2015. "Future Imperfect: Science, Technology, and the Imaginations of Modernity." In *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, edited by Sheila Jasanoff, and Sang-Hyung Kim, 1–47. Chicago: Chicago University Press.
- Jasanoff, Sheila, and Sang-Hyun Kim. 2009. "Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the U.S. and South Korea." *Minerva* 47 (2): 119–146.
- Jasanoff, Sheila, and Sang-Hyun Kim. 2015. *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago: University of Chicago Press.
- Kirchherr, Julian, Denise Reike, and Marko Hekkert. 2017. "Conceptualizing the Circular Economy: An Analysis of 114 Definitions." *Resources, Conservation and Recycling* 127: 221–232.
- Knorr Cetina, Karin. 2001. "'Viskurse' der Physik. Konsensbildung und Visuelle Darstellung." In *Mit dem Auge Denken. Strategien der Sichtbarmachung in Wissenschaftlichen und Virtuellen Welten.*, edited by Bettina Heintz, and Jörg Huber, 305–320. Wien: Springer.
- Kovacic, Zora, Roger Strand, and Thomas Völker. 2019. *The Circular Economy in Europe: Critical Perspectives on Policies and Imaginaries. Routledge Explorations in Sustainability and Governance*. London: Routledge.
- Lacy, Peter, and Jakob Rutqvist. 2016. *Waste to Wealth: The Circular Economy Advantage*. London: Palgrave Macmillan.
- Latour, Bruno. 1987. *Science in Action. How to Follow Scientists and Engineers Through Society*. Cambridge: Harvard University Press.
- Latour, Bruno. 1993. *We Have Never Been Modern*. Cambridge: Harvard University Press.
- Law, John. 2003. *Traduction/Trahsion: Notes on ANT*. Lancaster: Centre for Science Studies, Lancaster University.
- Lazarevic, David, and Helena Valve. 2017. "Narrating Expectations for the Circular Economy: Towards a Common and Contested European Transition." *Energy Research & Social Science* 31: 60–69.
- Leese, Matthias, and Simon Meisch. 2015. "Securitising Sustainability? Questioning the 'Water, Energy and Food-Security Nexus'." *Water Alternatives* 8 (1): 695–709.
- Mao, Jiansu, Chunhui Li, Yuansheng Pei, and Linyu Xu. 2016. "Circular Economy and Sustainable Development Enterprises.".
- Marin, Julie, and Bruno De Meulder. 2018. "Interpreting Circularity. Circular City Representations Concealing Transition Drivers." *Sustainability* 10 (5): 1–24.
- Martínez Alier, Joan. 2015. "La Economía No Es Circular Sino Entrópica." *La Jornada*, June, 14 2015.
- Mayer, Andreas, Willi Haas, Dominik Wiedenhofer, Fridolin Krausmann, Philip Nuss, and Gian Andrea Blengini. 2018. "Measuring Progress Towards a Circular Economy: A Monitoring Framework for Economy-Wide Material Loop Closing in the EU28." *Journal of Industrial Ecology* 23 (1): 62–76.
- McDonough, William, and Michael Braungart. 2002. *Cradle to Cradle: Remaking the way we Make Things*. New York: North Point Press.
- Murray, Alan, Keith Skene, and Kathryn Haynes. 2017. "The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context." *Journal of Business Ethics* 140 (3): 369–380.
- Mylan, Josephine, Helen Holmes, and Jessica Paddock. 2016. "Re-introducing Consumption to the 'Circular Economy': A Sociotechnical Analysis of Domestic Food Provisioning." *Sustainability* 8 (8): 794.
- Petit-Boix, Anna, and Sina Leopold. 2018. "Circular Economy in Cities: Reviewing How Environmental Research Aligns with Local Practices." *Journal of Cleaner Production* 195: 1270–1281.
- Pfotenhauer, Sebastian, and Sheila Jasanoff. 2017. "Panacea or Diagnosis? Imaginaries of Innovation and the 'MIT Model' in Three Political Cultures." *Social Studies of Science* 47 (6): 783–810.
- Pfotenhauer, Sebastian M, Joakim Juhl, and Erik Aarden. 2019. "Challenging the "Deficit Model" of Innovation: Framing Policy Issues Under the Innovation Imperative." *Research Policy* 48 (4): 895–904.
- Porter, Theodore M. 1995. *Trust in Numbers. The Pursuit of Objectivity in Science and Public Life*. Princeton: Princeton University Press.
- Prendeville, Sharon, Emma Cherim, and Nancy Bocken. 2018. "Circular Cities: Mapping Six Cities in Transition." *Environmental Innovation and Societal Transitions* 26: 171–194.
- Robinson, John. 2004. "Squaring the Circle? Some Thoughts on the Idea of Sustainable Development." *Ecological Economics* 48 (4): 369–384.
- Sauvé, Sébastien, Sophie Bernard, and Pamela Sloan. 2016. "Environmental Sciences, Sustainable Development and Circular Economy: Alternative Concepts for Trans-Disciplinary Research." *Environmental Development* 17: 48–56.
- Scott James, C. 1998. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. London: Yale University Press.
- Srivastava, Aashish, and S. Bruce Thomson. 2009. "Framework Analysis: A Qualitative Methodology for Applied Policy Research." *Journal of Administration and Governance* 4 (2): 72–78.
- Stirling, Andy. 2015. *Developing "Nexus Capabilities": Towards Transdisciplinary Methodologies*. Brighton, UK: University of Sussex.
- Strand, Roger, Andrea Saltelli, Mario Giampietro, Kjetil Rommetveit, and Silvio Funtowicz. 2016. "New Narratives for Innovation." *Journal of Cleaner Production* 197 (2018): 1849–1853.
- Taylor, Charles. 2002. "Modern Social Imaginaries." *Public Culture* 14 (1): 91–124.

- Turnhout, Esther, Katja Neves, and Elisa de Lijster. 2014. "Measurementality in Biodiversity Governance: Knowledge, Transparency, and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)." *Environment and Planning A* 46 (3): 581–597.
- Valenzuela, Francisco, and Steffen Böhm. 2017. "Against Wasted Politics: A Critique of the Circular Economy." *ephemera: Theory & Politics in Organization* 17 (1): 23–60.
- Vidal-Legaz, B., L. Mancini, G. Blengini, C. Pavel, A. Marmier, D. Blagoeva, C. Latunussa, P. Nuss, J. Dewulf, and V. Nita. 2016. *EU Raw Materials Scoreboard*. Luxembourg: Publications Office of the European Union.
- Welch, Daniel, Margit Keller, and Giuliana Mandich. 2016. "Imagined Futures of the Circular Economy." In *Everyday Futures*, edited by Nicola Spurling, and Lenneke Kuijter, 23–31. Lancaster: Institute for Social Futures.
- Welch, Daniel, Margit Keller, and Giuliana Mandich. 2017. "Imagined Futures of Everyday Life in the Circular Economy." *interactions* 24 (2): 46–51.
- Winner, Langdon. 1986. *The Whale and the Reactor: A Search for Limits in an Age of High Technology*. Chicago: University of Chicago Press.