



Socio-technical imaginaries of a circular economy in governmental discourse and among science, technology, and innovation actors: A Norwegian case study

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ABSTRACT

A growing body of research is investigating the connections between the discursive construction of circular economy (CE) and its influences on public policies that promote the socio-technological transition towards circular production and consumption systems. However, surprisingly little attention has focused on how CE discourses interact with science, technology, and innovation (ST&I) actors. To address this gap, this research adopts the prism of socio-technical imaginaries to understand specific visions of circularity in science and innovation, exploring how competing imaginaries mobilize specific actors, institutions, and visions of a greener future. Our empirical material included archival documentation from the Norwegian government and funded research projects on CE. Our analysis identified two key tension points within these imaginaries: “International drivers versus regional and local transition arenas” and “Ecological modernization versus sectoral transformation.” We suggest that tensions are inherent in CE socio-technical imaginaries but are often silenced or minimized by institutional discourses on circularity. Our findings suggest that official CE policy programs tend to minimize or overtly ignore criticisms and contestation that are increasingly raised in academic circles. Our findings indicate the need for increased involvement of ST&I actors and other societal actors (such as NGOs and the private sector) in the CE policymaking process to avoid endless growth as an unexpected CE policy outcome.

1. Introduction

The notion of building a circular economy (CE) has become a focal point for contemporary policies and research agendas, especially in the European Union (EU). It has helped to reorient ideas about possible transitions to sustainability and has mobilized a myriad of actors involved in Science, Technology, and Innovation (ST&I) around producing a greener future through circularity (Winans et al., 2017). As a concept, CE is very much contested and open to multiple definitions (D'Amato et al., 2017; Homrich et al., 2018). The widely accepted definitions of CE, however, prioritize the “what” in terms of the desired outcome focused on new economic or business models but lack grounding in the “how,” the means to achieve these results (Giampietro,

2019). As a result, to avoid ambiguity, in this article we refer to CE following the definition of the Ellen MacArthur Foundation (2015): “A circular economy is one that is regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles. This new economic model seeks to ultimately decouple global economic development from finite resource consumption.” On many conceptions of CE, a prerequisite for transitioning towards circularity is the reconfiguration of production and consumption systems, which would require a type of environmental innovation that moves beyond new technologies (van den Bergh, 2013). Recently emerging critical literature has questioned the potential of CE to effectuate change beyond the commonplace eco-modernist perspective offered by concepts such as

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“sustainable development” or “green growth” (Hobson, 2020; Leipold, 2021). The central critique in this literature is that most debates about CE do not sufficiently challenge the legitimacy of globalized capitalism based on the *need for endless economic growth*, a condition that some argue is incompatible with the achievement of circularity (Jaeger-Erben et al., 2021) and social justice (Hickel and Kallis, 2019). This critique, which is similar to critiques of “techno-market fixes” driven by low-carbon imaginaries (Levidow and Raman, 2020) that fail to question dominant forms of sustainability innovation, highlights disputing imaginaries about how to achieve a “greener” future (Kovacic et al., 2019).

Currently, the notion of circularity is “in the making” (Kovacic et al., 2019), i.e., still being crafted and stabilized by various imaginaries, discourses, research projects, policy documents, and visions of the future (Ortega Alvarado et al., 2021). A wealth of literature now exists on the formation of CE discourse and its supporting policies (Fidélis et al., 2021; Friant et al., 2020b, 2020a; Ortega Alvarado et al., 2021). However, this paper shifts the discussion to the arena of ST&I systems. Given that many authors have characterized the CE discourse as technocratic (Genovese and Pansera, 2020), one would expect more knowledge to have developed about how discourses and imaginaries surrounding CE have been framed and conditioned by the enactment of specific CE policies on the part of ST&I actors (universities, research institutes, and the private sector). Since an innovation system arises from a process in which public infrastructure, policies, and institutions coevolve with firms and industries (Fagerberg et al., 2009), and CE is now a prominent concept in many political-institutional arenas, it has become imperative to extend knowledge on this topic. This is a present gap both among CE scholars, who have previously overlooked the impacts of ST&I actors, systems, and policies, and among innovation scholars, who have not yet adopted a central role in the CE debate.

We think that understanding the role of ST&I in the shaping of institutional CE discourse is crucial because circularity as an eco-modernist project is firmly based on technology as a legitimizing force vis-à-vis the limits imposed by the laws of thermodynamics. The entropic dissipative nature of any economic process dooms the viability of totally circular industrial processes (Georgescu-Roegen, 1971). Although the Ellen MacArthur Foundation itself has recognized the impossibility of a total CE, technology and the salvific function of innovation are still presented as mechanisms to perpetuate endless economic growth imaginaries, as the title of their famous report “Growth from within” clearly suggests. In this sense, understanding how CE discourses are constructed by neglecting or silencing the debates about the limits of technology’s ability to achieve environmental sustainability is also crucial to developing alternative CE imaginaries. These alternatives should seriously engage not only with the fundamental problems of physical limits to circularity but also with central issues such as social justice and democracy (Pansera et al., 2021).

Therefore, in this article, we employ the conceptual framework of socio-technical imaginaries to shed light on how CE is being imagined and enacted through a specific set of practices, accessed here via the analysis of government documents. This framework understands socio-technical imaginaries as “collectively held, institutionally stabilized, and publicly performed visions of desirable futures” (Jasanoff and Kim, 2015); such imaginaries help clarify both how science and technology are mobilized through the prevailing social order and how they help to co-produce it. Investigating imaginaries helps us to understand how these policies support specific visions of circularity in science and innovation; how competing imaginaries mobilize specific actors, institutions, and visions of a greener future; and how specific forms of CE become materialized through the eventual stabilization of certain imaginaries over others.

Our research focuses on a specific corpus of documents representing a set of funded projects on CE in Norway. Examining this collection helps us to understand how specific ideas of CE become stabilized, which also informs broader innovation policy in Norway. However, our focus

carries some limitations since we do not analyze other discourses (media, industry actors, civil society, NGOs, etc.). We specifically examine the extent to which socio-technical imaginaries produced by the dominant CE discourses in policy influence infrastructures to produce knowledge, technology, and innovation. The aim is to understand how socio-technical imaginaries of CE are represented throughout governmental discourse before contrasting these imaginaries with those of ST&I actors. We also highlight potential tensions emerging from this interplay. The guiding research question of this paper is thus as follows:

How do the socio-technical imaginaries of CE in governmental discourse relate to those of prominent actors in the science, technology, and innovation system?

To address this question, we conducted a case study of Norway. We view Norway as an “extreme case” (Flyvbjerg, 2006), meaning that it exhibits specific characteristics that make it either particularly problematic or well suited, thus potentially challenging existing theories or enabling new theorizing (Flyvbjerg, 2006). Norway is under the direct influence of the European Union (EU) but retains sovereignty in most aspects of its policymaking. Much previous research has focused on discourses at the EU level and highlighted knowledge gaps concerning how CE visions integrate with public policies, especially which actors and discourses are included and which are excluded (Friant et al., 2020b), how to most effectively enhance the coherence of CE policies, and how to coordinate across multiple actors and levels of governance (Fitch-Roy et al., 2020). The case of Norway allows us, therefore, to investigate a context that, while under the influence of the EU, retains enough sovereignty to be able to depart from its guidance. In addition, Norway occupies an ambiguous position as both a country dependent on extractive industries and a global leader in the “green shift” policy and research agendas. This creates a unique context in which to explore CE imaginaries, the development of technologies and practices that facilitate CE transitions, and the innovation system emerging from these trends.

This paper engages with previous research that aimed to understand emerging CE policy portfolios amid the worldwide growth of CE policy packages, despite the lack of research surrounding their implementation (Fitch-Roy et al., 2020), the influence of CE discourse on societal visions (Ortega Alvarado et al., 2021), and the connections between CE narratives and societal change (Leipold, 2021). It contributes a better understanding of how top-down (government-led) imaginaries influence STI policy priorities and tensions that are likely to emerge from ST&I actors’ own (bottom-up) priorities, thus highlighting the importance of understanding these bottom-up priorities in the early design of new policies aiming to foster CE innovation and research. This last point, in particular, adds to calls for research around this issue (Humalisto et al., 2020).

Below, we first review the current knowledge of CE as a discourse. We then summarize our methodological choices and the characteristics of our data. Findings are introduced next, followed by a discussion of these findings in light of the analytical framework.

2. The circular economy as a socially constructed discourse

2.1. Disputes around CE and its meanings and definitions

CE can be seen as a body of discourse concerning issues of environmental sustainability, production, and consumption in industrial societies. From this perspective, CE can be conceptualized as the center of a discursive struggle surrounding the meaning and function of environmental sustainability within the present “linear” chains of production that characterize globalized industrial capitalism. The theoretical foundation of CE incorporates multiple elements, including industrial symbiosis, cradle-to-cradle design, cleaner production, business models, and big data (Gupta et al., 2019; Jabbour et al., 2019; Provin et al., 2021); however, the lack of clear boundaries with related future-making concepts, such as the Bioeconomy or the Green Economy (Birch, 2016),

has hampered the development of a stable definition of CE (Kirchherr et al., 2017; Korhonen et al., 2018; Merli et al., 2018). More recently, the implementation of the concept of CE has been led and promoted by practitioners (Ellen MacArthur Foundation, 2015) and governing bodies such as the EU and the Chinese government (McDowall et al., 2017). As a result of CE's increasing popularity in industry and political agendas, recent years have also seen a proliferation of academic works on the topic.

There are also disputes about the extent to which CE can deliver on its transformative promise and the changes that will be required for this transformation (Hobson, 2020). Recent research has analyzed how CE discourse has entered into policy debates and translated into tangible public policies supporting the outcomes it recommends (Friant et al., 2020b). Others have suggested transcending the academic debate to support practitioners' proposed development pathways that can integrate CE values and practices into societal visions for the future (Ortega Alvarado et al., 2021). The significance of CE is also contested by those who perceive circularity as a new buzzword to maintain the status quo, as well as by those who wish to transform unsustainable capitalist modes of production through this concept (Friant et al., 2020a). Thus, CE is a set of discourses and imaginaries still under construction and subject to disputes, an idea explored in detail by Silva et al. (2016), Friant et al. (2020a), Fidélis et al. (2021), and Ortega Alvarado et al. (2021).

2.2. Socio-technical imaginaries understood through discourse analysis in the CE literature

The analysis presented here seeks to understand how discourses around CE can illuminate related policy choices, implementation, disputes, and framing of what CE is and can be in a given national context. Considering this aim, it makes sense to analyze policy documents as a way of examining the meanings that condition what choices are being made and how they relate to policy. In pursuing this goal, we are inspired by the concept of socio-technical imaginaries proposed by Sheila Jasanoff and colleagues, which is already well established in STS literature and analyses of CE (Bauwens et al., 2020; Kovacic et al., 2019). The concept of "imaginaries" enables us to consider how policies are framed through nation-specific technological projects that are intertwined with collectively held visions of desirable futures. Thus, this concept enables analysis of policies focusing on how nations and collectives perceive and construe sustainability and innovation in specific ways (Jasanoff and Kim, 2013). These imaginaries are powerful tools that condition and shape how policy decisions are made and how they are framed in specific national contexts; therefore, they provide a valuable theoretical guide for the proposed content analysis within this case.

We examine these imaginaries through the discourses present in our corpus of documents. Hager (1995) connected discourse theory with a practical methodological framework to understand the connection between power and environmental politics through the analysis of the ecological modernization narrative. According to Hager (2005), discursive analysis as applied to environmental politics is intrinsically linked to the reconstruction of power struggles in the search for solutions to real-world problems. The interplay among these political processes sets the stage for technological and societal change. Although some ontological tensions are evident when applying discourse analysis to the study of environmental policymaking (Leipold et al., 2019), its application to CE research is rather heterogeneous and pragmatic. Three methodological approaches to discourse analysis of CE appear in the literature. First, discourse analysis is perceived as a proxy for policy analysis to reveal CE integration in public policy. Second, it is used to present narratives that incorporate underlying assumptions and expectations regarding CE from a myriad of stakeholders. Third, it is pursued through content analysis of public official and policy documents.

The first approach, discourse as connected to policy analysis, is the most common in the literature. Through an analysis of the EU's circular

packages, Fitch-Roy et al. (2020) studied CE reframing of policy concepts, such as industrial symbiosis and closed-loop, sustainable products and consumption. They found that the temporality of conceptual recycling is manifested in public policy documents. This investigation was not explicitly called a "discourse" analysis; rather, it was presented as a policy analysis conducted through a framework of institutional change and evolution (Fitch-Roy et al., 2020). Analyzing two Swedish white papers from different time periods, Johansson and Henriksson (2020) concluded that discourses could shape policy choices, creating effects in real life and on societal decisions. Through the use of discourse analysis, they identified two opposing discourses of "strong" vs. "weak" circularity by analogy with strong vs. weak sustainable development, with "strong" circularity represented by the eco-cycle, closed-loop, stabilized focus on local consumption, despite the physical limitations of a truly circular economy (Georgescu-Roegen, 1971).

The second approach to discourse analysis of CE involves the presentation of narratives and expectations regarding CE from multiple societal actors. Ampe et al. (2020), for example, relied on Hager's concept of discourse, using discourse analysis to explore different interpretations of the significance of transitions; the researchers' main theoretical point was that "a new discourse on the wastewater system may be conditioned by the past, particularly by the established infrastructure and institutions" (Ampe et al., 2020). The narrative approach to CE discourse has also been adapted in conceptual studies. Hobson (2020) broadly discussed CE discourses in the literature, in particular those surrounding the Ellen MacArthur Foundation, and concluded that the policy interventions associated with CE were based upon incongruous assumptions and mechanisms, a situation that could worsen the very problems CE sought to address. For example, the extent to which material recirculation discouraged primary production and resource extraction was unclear. There is evidence to suggest that, in fact, without the necessary development of a new consumption culture, the CE does little more than facilitate business as usual while pretending to do otherwise (Hobson, 2020).

The third approach to discourse analysis of CE employs content analysis and computer-mediated methods. Studies of this type often consider public policy documents or websites as datasets. The text information is subsequently summarized through codes that are quantified according to keywords (Hermann et al., 2021). One Finnish study used a hyperlink analysis and also examined text associated with the metadata of webpages that referred to each hyperlink (Humalisto et al., 2020).

To summarize, analyzing policy documents allows researchers to understand victorious discourses as crystallized choices already implemented. As part of specific imaginaries, these discourses enable a better understanding of how specific frames become hegemonic and how they condition policy choices. In the case of Norway, we designed the study to see how narratives around CE are situated in specific ideas about environmental and industrial innovation (particularly with respect to what different actors mean by CE and how it can promote innovation); these ideas reinforce Norwegian imaginaries about Norway's place as a sustainability leader in Europe and the world.

3. Materials and methods

We employ a thematic analysis methodology (Saldaña, 2009) to identify socio-technical imaginaries about CE in the construction of Norwegian governmental discourse and how this construction shapes science, technology, and innovation policy. Our approach builds upon previous studies of CE discourse, as synthesized in the literature review section, e.g., at the EU level (Friant et al., 2020b). In the next section, we expand upon the context of our study, the datasets with which our thematic analyses were conducted, and our analytical approach.

3.1. Context of the study: Norway

Our dataset is embedded in the context of Norway, which offers an

extreme case for understanding certain paradoxes associated with implementing a CE policy agenda. First, Norway is both endowed with abundant natural resources and committed, at least in principle, to resource efficiency, as reflected in the rhetoric that underpins much of the CE discourse (Leipold, 2021). Second, the Norwegian economy is still heavily dependent on extractive industries; in addition to the oil and gas sector, activities such as fisheries and mining represent important contributors to export goods (Statistics Norway, 2021), which also creates ambiguities around the relationship between CE and the country's chief economic interests. In contrast to this economic profile, the country has been recognized for decades as a champion of the sustainability agenda (WCED, 1987). Specifically, regarding CE, the Ministry of the Climate and Environment produced a white paper illustrating national priorities for the implementation of CE principles (Klima- og miljødepartementet, 2015). In addition to broader considerations on waste policy, this document prominently features a strategy to address marine litter.

Historically, Norwegian firms have relied little upon in-house R&D, instead meeting their needs for new knowledge and technology by collaborating with research institutes and universities (Fagerberg et al., 2009). In this respect, the Norwegian innovation system differs from many others in the developed world (ibid.). This openness, combined with high degrees of transparency and public availability of documents and data, provided us with access to rich data on government documents.

In the political arena, Norwegians voted twice (in 1972 and 1994) against joining the European Union, which has made them more capable of autonomously establishing their own policy priorities; nonetheless, Norway is still under Brussels' sphere of influence, and its participation in the EFTA requires it to comply with decisions made by the European Parliament even though it lacks active representation in the decision-making process. As a result, the Norwegian government's priorities for CE align closely with the European Union's Circular Economy Action Plan and similar product-oriented policies (Nærings- og fiskeridepartementet, 2016). Norway's properties make it particularly well suited as a case for examining socio-technical imaginaries of CE, which are characterized by ambiguous, if not conflicting, interests. These conflicting interests have thus far been overlooked in the literature.

3.2. Thematic analysis of policy documents: a government's CE socio-technical imaginary

The first sample of texts consists of publicly available documents from the Norwegian national government dealing with CE. They were identified by searching the general term "sirkulær" ("circular") and examining the results for relevance to CE concepts. A total of 246 documents were selected, and each document was assigned metadata information: publication year, author, and document type (Appendix 1). The majority of the documents can be organized into three categories: Official Norwegian Reports (NOUs), Propositions to the Norwegian Parliament, and White Papers (Table 1).¹ This sample provides a comprehensive understanding of different stages of the policymaking process and the process of integrating the CE socio-technical imaginary within it.

At early stages, NOUs are developed when the Government or a ministry assembles a committee and/or working group to report on different societal concerns. The expert advice shared through NOUs and communicated to the government constitutes an expression of emerging ideas that can be subsequently transformed into public policy. A proposal is defined by the Stortinget (2020) as follows: "proposal from the Government for a resolution on ordinary matters and issues relating to the budget (Resolution of the Storting), which the Storting must make a decision

¹ The definition of each type of document can be accessed at <https://www.stortinget.no/en/In-English/Stottemeny/Dictionary/>.

Table 1

Source documents for the analysis of the Norwegian government's use of CE. The dataset is available through the link in Appendix 1.

Type of document	Number of documents
Official Norwegian Report (NOU)	80
Proposition to the Stortinget (resolution)	76
White paper	54
Report	20
Plan	10
Communication	2
Law	2
Principle statements	2
Total	246

on. Abbreviated in Norwegian to prop. S." White papers, abbreviated as "Meld. St.", include information the Government wishes the Storting to consider on various matters. The reviewed white papers take the form of technical reports with scientific data supporting suggested next steps on policy choices. Other informative documents include Norwegian official reports and plans. Reports, another important source of discussion on CE, are summaries of the Norwegian delegation's meetings within the EU institutions. In the sample, these reports were produced by the environmental advisers Hege Rooth Olbergsveen, Ulla Hegg, and Jonas L. Fjeldheim in collaboration with student interns at the Norwegian delegation. Reports are scientific documents commissioned by government agencies and shared on their portal. Plans, which are more formal, offer the only source of discussion for EU policies.

After gaining access to the documental data, we used the software Nvivo 12 to conduct a thematic analysis, adopting the inductive thematic coding approach proposed by Saldana (2009) and Colombo et al. (2019). First, we used the query function in Nvivo and searched for the Norwegian and English terms "sirkulær" and "circular." The resulting hits were highlighted in each document. We then completed an in-vivo coding for each sentence that included the phrase "circular economy." Next, we conducted a second-cycle coding of each sentence identified in the first stage and exported these second-cycle codes into Excel. To improve reliability during the thematic analysis, we implemented a number of measures according to Braun and Clarke (2006). The first measure (carried out by the first and second co-author) was for co-authors to discuss the coding process in pairs. A second measure implemented during this process was to bundle similar codes and eliminate repeated ones. Our analysis resulted in 62 different codes concerning the use of the term "circular economy" across official Norwegian government documents (Appendix 2). We grouped codes with similar meanings into categories, and, finally, we grouped categories sharing similar meanings into four main themes (Appendix 2). At this stage, we have certainty that the documents included in the sample addressed the understanding of CE and not the lexically similar term "circular" often used to refer to meanings other than "circular economy." The final sample of documents was thus reduced to 27 unique documents covering the period from 2014 to 2017. This means that one document could contain more than one code, as shown in the supplementary dataset (Appendix 1).²

Given the methodological ambiguity in the literature of socio-technical imaginary analysis, the thematic analysis provided a way to systematically code and identify key themes and concerns present in Norwegian policy around CE. We then interpreted these through the lens of socio-technical imaginaries to identify the tension points, since CE is a technological policy orientation "in the making" and thus incomplete

² Five documents provided more than seven coded sentences (in parentheses): the white paper *Meld. St. 45 (2016–2017). Avfall som ressurs – avfalls politikk og sirkulær økonomi* (64), the white paper *Meld. St. 27 (2016–2017). Industrien – grønnere, smartere og mer nyskapende* (17), *EUs handlingsplan for en sirkulær økonomi – regjeringen.no* (13), *Prop. 1 S (2017–2018)* (12).

and disputed. The analyzed documents enabled us to examine the disputes surrounding the meanings of CE and the different policy strategies designed to promote CE through innovation. Our final analysis will thus help illuminate how CE is enacted in both policy decisions and innovation research.

3.3. Thematic analysis of research and innovation projects: the socio-technical CE imaginaries of ST&I actors

In the second part of the analysis, we identified potential tensions between governmental socio-technical imaginaries and those of ST&I actors. The Research Council of Norway (RCN) is a government agency under the Ministry of Education and Research that funds research, development, and innovation projects in various stages of maturity. The RCN is the most important and representative national funding source for research and innovation. It offers thematically targeted programs that are open to a variety of organizations, depending on the objectives of each call and program. These thematic programs reflect the governmental strategic priorities of knowledge, competitiveness (e.g., with respect to the aquaculture industry or climate change), and research and innovation needs. Project descriptions from the RCN database offer valuable insights into the STI ecosystem in Norway.

The RCN's project database allowed us to access information about the projects the RCN has funded as well as Norwegian projects under the EU frameworks. We included the project descriptions that had been approved up to January 15th 2020 (The Research Council of Norway, 2020). As of that date, no thematic program had been designed specifically to address CE concerns, although some programs were closely related to the topic (e.g., the Miljøforsk og Bionær programs). Thus, in our sample, we avoided projects that incorporated CE in response to a targeted call. This was important because specific calls reflect, even if indirectly, policy strategic priorities that would invalidate a comparison with the datasets described in the previous section.

The database contains a brief summary and the key details of each project, including the title, coordinator, year of approval, duration, and funding amount. Analyzed texts included those categorized under the “sirkulær økonomi” (“circular economy”) tag in the database; these texts had been identified by searching for the Norwegian terms “sirkulær økonomi” and “sirkulærøkonomi” and the English term “circular economy.” The search was conducted in the RCN program, SkatteFUNN program, and EU program subsets (Horizon 2020). We perused the identified documents, reading the project titles and summaries, and included in the final sample all projects that included the term “circular economy” or its Norwegian equivalent. Table 2 summarizes the associated RCN funding programs. The identified project descriptions comprised projects starting between 2013 and 2019.

For the first-level coding, as with the previous set of documents, we extracted all sentences containing the term “circular economy,” and after eliminating repeated phrases or similar codes, we arrived at a final list of 64 different codes (Appendix 3). We grouped sentences/codes

referring to similar issues into categories and subsequently into main themes (Appendix 3). This analysis allowed some documents to emerge with more than one coded sentence.

To identify the key relationships between government sociotechnical imaginaries and those of ST&I actors, we compared the resulting themes and categories from each group of documents and identified those representing a marked contrast in terms of expectations, goals, and visions. Our findings are synthesized in the [Results](#) section.

3.4. Data analysis: tensions in socio-technical imaginaries

As described in the two previous subsections, socio-technical imaginaries were identified through a thematic analysis of government documents and RCN project descriptions. To identify tension points, we inductively read each code, category, and theme, including their presence in sentences. We then identified contrasts related to goals and expectations that could indicate potential conflicts in different actors' expectations for CE implementation.

4. Results

4.1. Overview of socio-technical CE imaginaries based on the thematic analysis of government and ST&I ecosystem actors' documents

Our analysis indicated that four predominant themes emerged from the government's dataset: “international drivers,” “multi-stakeholder alignment,” “priority areas of policy development,” and “firm-oriented strategies.” These themes are derived from eight categories, which in turn result from codes attributed to raw data, as depicted in Appendix 2.

The thematic analysis of the government documents is supported by quotes from the source documents (Table 3). From this analysis we identify four future-oriented imaginaries (GvI 1–4) on CE, which we summarize as follows:

- **GvI-1:** CE as an opportunity to align with international market access: closely aligned with EU initiatives, specifically the EU action plan on CE, plastics discussions, and compliance with sustainable consumption and Norwegian consumer protection regulations.
- **GvI-2:** CE as a potential driver for socio-technological transition, yet only slightly integrating social change while focusing more on the involvement of private players to develop new industry arenas requiring specialized training and new jobs.
- **GvI-3:** CE as going beyond enhanced waste management policy, but with a clear perception of waste as value for the future, where a circular bioeconomy comprises a scientific domain of opportunities.
- **GvI-4:** CE as an enhanced form of ecological modernization of production processes and product design in which efficiency of resource use is the key metric.

Analysis now shifts to the second dataset, namely descriptions of projects funded by the Research Council of Norway (RCN). Within this dataset (Appendix 3), four main themes emerge: “regional and local transition arenas,” “sectoral transformation,” “emerging issues in firm's strategy,” and “emerging industrial sectors.” The thematic analysis also indicates four future-oriented imaginaries associated with representations of CE in science, technology, and innovation projects (Table 4), and summarized as follows:

- **StI-1:** CE represents an opportunity for transitioning towards a sustainable society by creating circular ecosystems at regional and local levels.
- **StI-2:** CE will enable incremental sectoral transformation through circular supply chains and competences in the workforce.
- **StI-3:** CE will be increasingly embedded in corporate strategic decision processes.

Table 2

Number of documents used for the analysis of the Norwegian research and innovation system's use of CE. The dataset is available through the link in [Appendix 1](#).

RCN Program funding the project	Number of documents
BIA-User-driven innovation arena	45
SkatteFUNN	20
BIONAER (bioeconomy)	8
ENERGIX (energy)	7
EU Project development support	7
FORKOMMUNE (municipalities)	6
DIV-AKT Diverse activities	5
Haybruk (oceans)	2
FFL-JA — research funds for agriculture and food	1
NAERINGSFON (industry)	1
Total	102

Table 3

Illustrative quotes to support the thematic analysis of governmental future-oriented imaginaries around CE.

Theme	Category	Sample supporting quotes	Future-oriented imaginary about CE
International drivers	EU policies	<p>“Circular economy package builds from EU’s Europe 2020 plan for a smart, sustainable and inclusive growth, with a strong focus on resource efficiency” (<i>Meld. St. 45</i>, Ministry of Climate and Environment, 2016–2017).</p> <p>“The EU has presented an action plan on the circular economy and announced new legislation on this in the second half of 2017” (<i>Meld. St. 22</i>, Ministry of Foreign Affairs, 2016–2017).</p> <p>“Under the action plan for the circular economy, Norway will in 2017 prioritize influencing the EU’s plastics strategy” (<i>Oversikt over sentrale EU- og EOS-saker i forvaltningen – januar 2017</i>, Ministry of Foreign Affairs).</p>	<p>GVI-1: CE as an opportunity to align with international market access: closely aligned to EU initiatives, specifically the EU action plan on CE, plastics discussions, and compliance with sustainable consumption and Norwegian consumer protection regulations.</p>
	Alignment with EU initiatives	<p>“The EU is our most important export market. The EU’s investment in the circular economy is therefore of great importance for Norwegian exports of goods and services” (<i>Meld. St. 27</i>, Ministry of Trade, Industry and Fisheries, 2016–2017).</p>	<p>GVI-2: CE as a potential driver for socio-technological transition, yet only slightly integrating social change while focusing more on the involvement of private players to develop new industry arenas requiring specialized training and new jobs.</p>
Multi-stakeholder alignment	Socio-technological transition	<p>“The green shift and green competitiveness in Norway are also linked to the green shift and the work on a circular economy in Europe” (<i>Prop. 1 S.</i>, Ministry of Climate and Environment, 2017–2018).</p> <p>“Circular economy will be an important part of a broader green shift and is also part of an economy that underpins green competitiveness” (<i>Meld. St. 27</i>, Ministry of Trade, Industry and Fisheries, 2016–2017).</p> <p>“Our prosperity and a healthy environment are based on an innovative, circular economy where nothing is wasted, where natural resources are managed in a sustainable way” (<i>Meld. St. 14</i>, Ministry of Climate and Environment, 2015–2016).</p> <p>“The Research Council has several programs that</p>	<p>GVI-2: CE as a potential driver for socio-technological transition, yet only slightly integrating social change while focusing more on the involvement of private players to develop new industry arenas requiring specialized training and new jobs.</p>

Table 3 (continued)

Theme	Category	Sample supporting quotes	Future-oriented imaginary about CE
	Upgrading the national system of innovation	<p>are relevant to a circular economy. The most important are: Environmental research for a green social change (ENVIRONMENTAL RESEARCH), program for climate (KLIMAFORSK), program for energy (ENERGIX). The program for value creation within KLIMAFORSK finances many projects of relevance to a circular economy” (<i>Meld. St. 45</i>, Ministry of Climate and Environment, 2016–2017).</p> <p>“Norwegian business actors are well placed to take an important role in the development of a circular economy, both in Europe and in the rest of the world” (<i>Meld. St. 27</i>, Ministry of Trade, Industry and Fisheries, 2016–2017).</p> <p>“With new regulations and challenges from waste policy and the desire for a more circular economy, there is a great need for competence and guidance” (<i>Meld. St. 45</i>, Ministry of Climate and Environment, 2016–2017).</p>	<p>GVI-3: CE as going beyond enhanced waste management policy, but with a clear perception of waste as value for the future, where a circular bioeconomy comprises a scientific domain of opportunities.</p>
	Priority areas for policy development	<p>“Waste as a resource – waste policy and circular economy, the government presents a strategy against marine plastic waste and the spread of microplastics.” (<i>Prop. 1 S.</i>, Ministry of Climate and Environment, 2017–2018)</p> <p>“On behalf of the waste industry, calculations have been made on business development, value creation and technology development in a number of areas and in several sectors in a circular economy, in addition to calculations on reduced greenhouse gas emissions” (<i>Meld. St. 45</i>, Ministry of Climate and Environment, 2016–2017).</p>	<p>GVI-3: CE as going beyond enhanced waste management policy, but with a clear perception of waste as value for the future, where a circular bioeconomy comprises a scientific domain of opportunities.</p>
	Overlaps with the bioeconomy discourse	<p>“Bioeconomy is a central part of the circular economy, and BIONÆR emphasizes the circular perspective in the financing of both research projects and innovation projects” (<i>Meld. St. 45</i>, Ministry of Climate and Environment,</p>	<p>GVI-3: CE as going beyond enhanced waste management policy, but with a clear perception of waste as value for the future, where a circular bioeconomy comprises a scientific domain of opportunities.</p>

(continued on next page)

Table 3 (continued)

Theme	Category	Sample supporting quotes	Future-oriented imaginary about CE
Firm-oriented strategies	Ecological modernization management	2016–2017). “The Storting asks the government to discuss a goal for reducing food waste at the sales and consumer level, and to present this in the announced report on waste and the circular economy” (<i>Prop. 1 S.</i> , Ministry of Climate and Environment, 2017–2018).	
		“Increased resource efficiency is seen as a prerequisite for creating a more competitive green and circular economy and new jobs” (<i>Prop. 1 S.</i> , Ministry of Climate and Environment, 2014–2015). “A circular economy aims to preserve the value of materials and energy in the product throughout the value chain as far as possible, and thus minimize waste and resource use” (<i>Prop. 1 S.</i> , Ministry of Climate and Environment, 2015–2016). “Circular economy is about reusing resources, but also about reducing the amount of waste, utilizing the resources better and more efficiently, increasing the life of products and using more recycled materials in new products” (<i>Meld. St. 27</i> , Ministry of Trade, Industry and Fisheries, 2016–2017).	GvI-4: CE as an enhanced form of ecological modernization of production processes and product design in which efficiency of resource use is the key metric.
Product-oriented policies		“In several of the EU’s policy initiatives, green public procurement is a tool for promoting green growth, including the focus on the circular economy” (<i>Meld. St. 45</i> , Ministry of Climate and Environment, 2016–2017). “A circular economy can also be supported by policies in the various sectors in addition to product and chemicals policies” (<i>Meld. St. 45</i> , Ministry of Climate and Environment, 2016–2017).	

- **StI-4:** CE will become an integral process in new product design and development phases, specifically with bioeconomic principles and critical waste valorization.

As sketched in Fig. 1, leading partners in the projects mostly included industry and actors in the R&D system (research institutes and universities). The figures illustrate the frequency with which the term CE was

counted in the project's summary rather than the number of applications. This frequency reveals, however, that in the case of industry, the discourse on CE is closely connected to business-oriented applications. An investigation of the leading partners in these applications shows 27 different organizations from multiple sectors. Industry actors more frequently incorporating the concept of CE in their project summaries include Grønt Punkt Norge (operator of an extended producer-responsibility scheme), Nordic Comfort Products (manufacturer of furniture from reclaimed marine plastics), Biokraft (producer of bio-fuels), and Mills (producer of food products). The R&D sector includes research institutes, universities, and university colleges. The last two categories fall within the university category. A total of 11 different institutions had projects funded and included CE in their summaries.

The eight imaginaries emerging from the thematic analysis indicate some overlaps in the future expectations of adopting a CE. These overlaps notwithstanding, it is also possible to point out two points of tension between government and ST&I actors in the emerging imaginaries:

- Tension Point 1. International drivers versus regional and local transition arenas
- Tension Point 2. Ecological modernization versus sectoral transformation

In Fig. 2, these convergences and the tension points are presented via a bi-dimensional clustering according to how the imaginaries connect to the scale at which CE is implemented along a continuum from firm-oriented change to large-scale societal transformation (X-axis). In comparison, the locus of the CE imaginary is represented by the Y-axis along a continuum from prioritizing the local to addressing the concerns of international actors.

The next two sections explore in greater detail aspects of tension emerging from the imaginaries, along with the overlapping characteristics shown in Fig. 2.

4.2. Tension point: international drivers versus regional and local transition arenas

The first tension point, rooted in a spatial perspective, focuses on what primarily drives CE government policies on ST&I (GvI-1) in relation to ST&I’s actors (StI-1). The imaginary GvI-1 emerges from the first theme in the Norwegian government’s discussions of CE (Table 3). In contrast, the imaginary StI-1 is among those less frequently present in the research and innovation project applications (Table 4). In addition, StI-1 is a relatively recent theme, with the bulk of the discussion taking place after 2017.

A first sketch of the tension between imaginaries shows that in a key vision for CE in the central discussions within GvI-1, Norway’s future regulatory framework aligns with EU initiatives on CE, specifically the “EU package on CE.” This vision seems to dominate the discussions during the period 2014–2017. Given the frequency of this topic in the documents, it is clearly a central imaginary throughout those years, influenced by a close link between CE and factors such as resource efficiency (*Meld. St. 45*, Ministry of Climate and Environment, 2016–2017) and amendments to existing waste regulations (*Meld. St. 45*, 2016–2017). The “EU action plan on CE” became a common topic in the period from 2015 to 2017, which influenced reflections about plastics in Norwegian policymaking (*Meld. St. 45*, 2016–2017) and clearly prioritized EU discussions on plastic strategies (Oversikt over sentrale EU- og EØS-saker i forvaltningen – januar 2017). Additional cross-cutting topics closely related to the EU package on CE included “[the] waste directive and CE,” “stakeholder collaborations,” “smart, sustainable growth,” and issues of “material recovery targets” and the “industry strategy on digitalization and CE” (*Regjeringens arbeidsprogram for samarbeid med EU i 2017*, Ministry of Foreign Affairs). An influential discussion was centered on “alignment with EU initiatives”, in particular the Norwegian policy towards the EU. This discussion was present in two white papers

Table 4

Illustrative quotes to support the thematic analysis of government documents.

Theme	Category	Sample supporting quotes	Future-oriented imaginary about CE
Regional and local transition arenas	CE as paradigm shift in the economy	"We will make the insight available to the general public, so that more people are inspired to take part in the movement required to move us from an unhealthy linear economy to a sustainable circular economy" (project 108, firm Sandkassa Innovasjon AS, 2018).	StI-1: CE represents an opportunity for transitioning towards a sustainable society by creating circular ecosystems at regional and local levels.
	Regional development strategy	"The project will lead to changes in the organization of innovation work in the county municipality so that they will be better able to enable the business community to deliver products and services in line with circular economy principles" (project 114, Trøndelag County Government, 2017).	
	CE as an ecosystem	"Circular economy is built as an ecosystem, where all use of resources, within products, services, materials and people is part of a cycle where nothing is wasted. The circular economy links growth, business policy, the environment and environmental policy in new ways" (project 123, firm Salmar AS 2015).	
Sectoral transformation	Research and innovation system undertakings	"One of the three goals of the project has been to put together and develop a partnership that can collaborate and lift R&D projects across industries in the field of circular economy, while at the same time making the industrial weight and expertise visible to partners" (project 166, research centre SINTEF Helgeland AS, 2017).	StI-2: CE will enable incremental sectoral transformation through circular supply chains and competences in the workforce.
	Pilot implementation in supply chains	"The main objective of the Alpakka project is to establish a Norwegian flagship demonstrator for Circular Economy in practice, which will increase the aluminium packaging circularity in Norway by value-chain cooperation between collectors and food producers" (project 158, firm Norsk Hydro AS, 2019).	
	Knowledge and competence development	"Many companies need new knowledge in areas such as digitalisation, energy efficiency, renewable energy, reuse, circular economy and 'repairability'" (project 106, firm Hackstad AS, 2018).	
Emerging issue in firm's strategy	Integration of CE into product design	"A large part of the complexity within the research will also take place within the section on circular economy, material selection and how this can be baked into a high-quality product" (project 133, firm Flokk AS, 2017).	StI-3: CE will be increasingly embedded in corporate strategic decision processes.
	Upgrading business models	"A circular economy will require comprehensive business model innovation with implications for product design, manufacturing, logistics and distribution, marketing, and solutions for reuse" (Project 163, research and education, Norges Handelshøyskole, 2018).	
	Firm's strategic decision	"The project will strengthen Flokk's position as a pioneer in sustainability and help the group to maintain its position as the leading player in the furniture industry within the circular economy" (project 133, firm Flokk AS, 2017).	
Emerging industrial sectors	Critical waste valorization	"The EU has a large net import of phosphorus and has established the European Sustainable Phosphorus Platform, ESPP, as part of the circular economy. By working closely with Yara, it will facilitate the development of a full-fledged fertilizer product with better quality" (project 136, 2017).	StI-4: CE will become an integral process in new product design and development phases, specifically with bioeconomic principles and critical waste valorization.
	Interface between CE and bioeconomy	"The project will lead to good circular economy, will generally contribute to an increased degree of self-sufficiency of protein raw materials in livestock production and contribute to strengthening the local business community" (project 102, firm Felleskjøpet Forutvikling AS, 2019).	

produced in 2016, clearly marking CE as a policy strategy intended both to align with the EU export market for Norwegian products and investments (*Meld. St. 27*, 2016–2017) and as one of the five priority focus areas in the external policy towards the EU (*Meld. St. 45*, Ministry of Trade, Industry and Fisheries, 2016–2017).

In contrast, the imaginary StI-1 provides an area of discussion centered in "CE as paradigm shift in the economy" but closely connected to "regional development strategy" and the vision of "CE as an ecosystem." Here, R&D project applications use the concept of CE in a rather radical way, implying its potential as a driver for socio-technological transition (project 117, private firm, 2017). The imaginary StI-1 also prioritizes the authority of counties (Fylkeskommune) in supporting local industry implementation of CE, planning the implementation of CE at the county level or with the use of local resources (project 114, county government, 2017). These discussions take place in applications submitted to the program FORKOMMUNE (local government collaborative projects). The idea of "CE as an ecosystem" is

embedded in multiple proposals connected with the Norwegian industrial sector, in particular the mining industry. One domain that emerges as of high interest is CE in the production process and its link to industrial symbiosis (project 123, engineering professional union, 2015). In connection with the possibilities for implementing industrial symbiosis models, other research projects received funding under proposals seeking industrial district transformation towards a circular model (project 110, municipal government, 2018).

4.3. Tension point: ecological modernization versus sectoral transformation

The second tension point concerns the CE's intended scale of transformation in the continuum from firm-oriented changes at a very concrete, company-level scale to medium- and large-scale societal change focused on industrial sectors. We defined this tension as occurring between a clearly marked ecological modernization imaginary

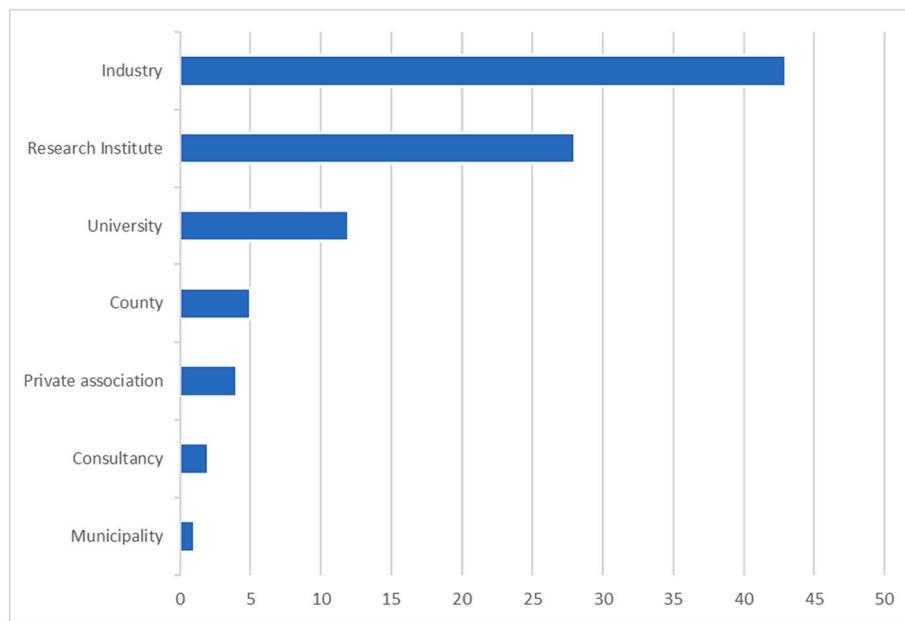


Fig. 1. Frequency of CE mentions per type of organization in applications to the Research Council of Norway.

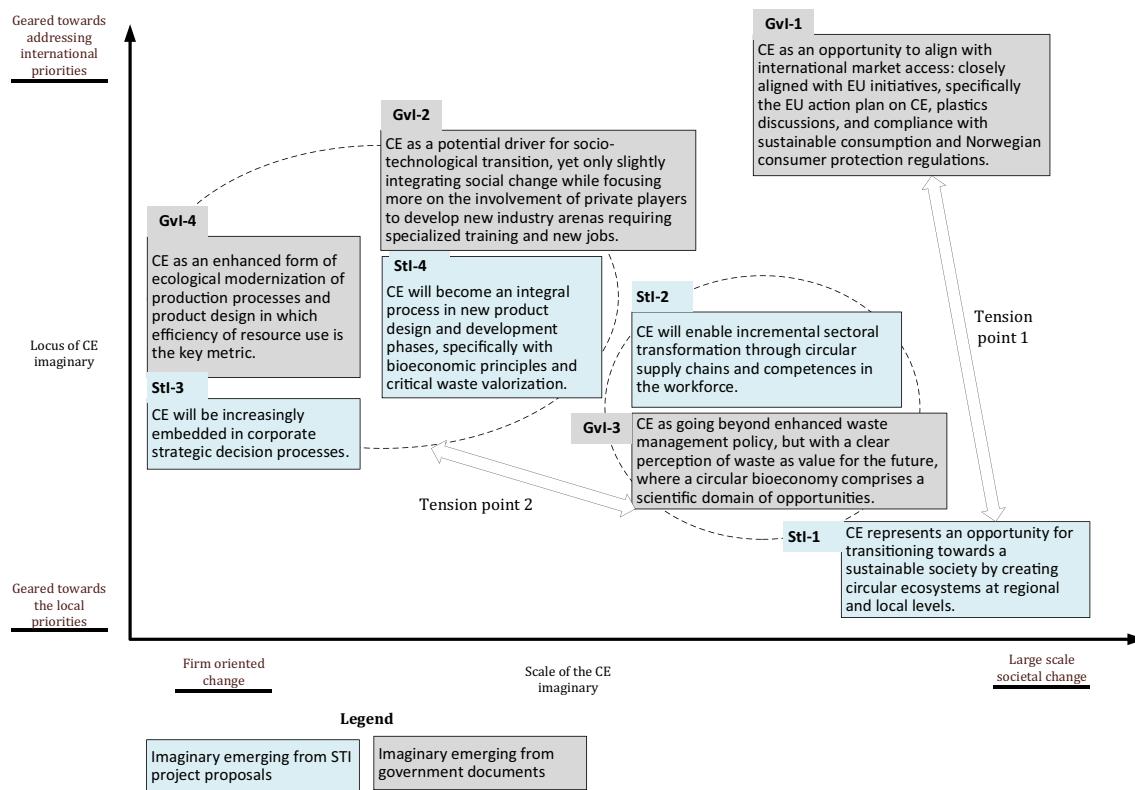


Fig. 2. Mapping tensions in Norwegian CE socio-technical imaginaries revealed by thematic analysis of government documents and R&D projects.

(imaginaries StI-3, StI-4, Gvi-4, and Gvi-2) and the sectoral transformation theme implicit in the imaginaries StI-2 and Gvi-3.

In the first group, “clearly marked ecological modernization,” we find four imaginaries that emerged from the thematic analysis. In this case, the pair of imaginaries Gvi-4 and StI-3 are clearly marked as leaning towards firm and corporate application of management principles to integrate CE into production and strategy. The pair of imaginaries Gvi-2 and StI-4 go a slight step forward by claiming the possibility of moving the CE discussion beyond the focal company boundary towards

their suppliers and organizations within the same branch of industry.

The imaginary Gvi-4 represents the more extreme case of a vision of CE connected to “firm-oriented strategies.” In terms of coding frequency, this is the theme appearing the most throughout the years and across multiple documents and public agencies. The discourse on firm-oriented strategies revolves around two categories: “ecological modernization management” and “product-oriented policies.” These two categories generally reflect attempts to engage the private sector in CE initiatives by highlighting the potential gains in an organization’s competitiveness

resulting from integrating a CE strategy into its plans. In the category “ecological modernization management,” the discussions are dominated by resource efficiency, technological aspects of CE, and the reference to reuse, repair, and improvement principles. In addition, we identified 11 further codes linked to this category, including, among others, materials use in a CE, partnerships for CE, low-emission technologies, and business models and CE. One public document, stresses the relevance of CE for a firm’s strategies (*Meld. St. 18*, Ministry of Local Government and Modernization, 2016–2017). The frequent mention of “resource efficiency” as closely related to CE is evident throughout the years. This idea also connects with the idea of CE as a driver for job creation (*Prop. 1 S.*, Ministry of Climate and Environment, 2014–2015). A similar point is the overly positive estimation of CE’s effects on the environmental and societal aspects of supply chains, in particular due to the recovery of materials and energy preservation throughout value chains (*Prop. 1 S.*, Ministry of Climate and Environment, 2015–2016). The result is an official definition of CE that targets resource reuse, reduction of waste, and better and more efficient use of resources (*Meld. St. 27*, Ministry of Trade, Industry and Fisheries, 2016–2017).

The imaginary StI-3 aligns well with the government imaginary GVI-4, as presented previously. StI-3 also represents an imaginary anchored in “CE as an emerging issue in firm’s strategy.” The thematic analysis within this theme highlights four issues, which have in common that the action takes place at a level within the organization, specifically in the private sector: “integration of CE into product design,” “upgrading business models,” “firm strategic decisions,” and “focal firm’s stakeholder management.” The first issue, “integration of CE into product design,” involves a number of technical discussions of how CE principles can actually translate into concrete products: with 11 mentions throughout the last three years, “product design principles of material reuse” is a key concern for companies, and project proposals emerge from multiple types of companies and with regard to multiple types of end products (e.g., furniture, packaging, and construction). It is interesting to note the type of technical discussions brought forward at this product level of integration, such as the commercial project “ALLOC: A new method to produce floor and wall products” (project 133, private firm, 2017). Companies also mentioned “product life extension” as a second concern in relation to the integration of CE principles into product design. “Integrated product innovation management” reflects some companies’ interest in looking beyond the tangible individual product and approaching the complexities of global supply chains, one example being the project “NEWMAT – New Value Creation based on Global Circular Material Streams,” which aims to align suppliers along the supply chain through circular guidelines (project 162, industrial cluster organization, 2018).

GVI-2 and StI-4 follow a trend similar to that of the corporate imaginaries, yet they incorporate visions of CE extending slightly beyond the boundaries of the focal firm. In StI-4, for example, one concept that emerges from the fourth theme arising from the analysis of R&D and innovation projects is “emerging industrial sectors,” which highlights three areas: “critical waste valorization,” “oceans and agriculture resource valorization,” and “interface between CE and bioeconomy.” The discourse connected to these categories shows the Norwegian industry actors’ ideas around areas with potential to generate business value from emerging sectors. The central issue in this discourse is “critical waste valorization,” which among its other aspects focuses on plastics and CE, food waste reduction, hazardous waste, new materials innovations, marine plastics, and feedstock valorization. In connection with CE, all these project summaries imply that the suggested technology or product will directly contribute to higher-level societal efforts (project 165, research institute, 2018).

The tension emerges in the contrast with the imaginaries StI-2 and GVI-3, which share an ideal of CE enabling sectoral transformations – that is, transformations of not just the focal company or the product but entire value chains. For example, in the case of the imaginary StI-2, four key discussions emerged from our analysis: research and innovation

system undertakings, industry sector initiatives, pilot implementation in supply chains, and knowledge and competence development. The nature of these discussions illustrates more pragmatic projects within different sectors, contrasting with the local-government–driven approach of the first theme. A closer look at the first category, “research and innovation system undertakings,” highlights five topics often associated with CE. The most common was research and development partnerships for the sake of CE. It was characteristic of these types of proposals to indicate the creation of multiple forums to discuss and nurture new CE spin-off projects, thus qualifying for funding from the RCN. Some examples include the “forum for circular economy solutions in Norwegian wastewater management” promoted by the university NMBU (project 160, university, 2019). A second topic was the internationalization of competences related to CE implementation. This topic was connected with previously funded EU projects and the need to continue these collaborations. The above-listed forum, for example, had a side goal of further enhancing these competences while internationalizing collaboration on circular economy (project 160, 2019). In terms of frequency, other categories within the theme of “sectoral transformation” were marginal over the years, but it is worth illustrating how they sketch the concerns of the industry. For example, stakeholders mentioned concerns about the “pilot implementation in supply chains.” Projects of this type connected CE with smart production, and the overall focus was demonstration aspects ahead of full implementation (project 158, public–private consortium Norsk Hydro AS, 2019). Pilot projects also included elements of developing competences for CE at a firm level as well as how university and industry could enhance their collaboration (project 106, private firm 2018).

Aligned with the ST&I actors’ imaginaries, GVI-3 indicates priority areas for policy development on CE (third theme), in particular a focus on “waste policy” and “bioeconomy,” which indicates the close connections between all three themes for politicians and how different plans aim to bridge goals that cut across all three. We identified the idea of “waste as a resource” as very often portrayed in the titles of publications; for example, one of the key public policy documents produced by the Ministry of Climate and Environment has the title of “Waste as a resource” (*Meld. St. 45*, 2016–2017). “Waste as a resource” closely matches discussions of “CE as waste valorization,” which is closely connected to new ways of integrating waste products into supply chains and identifying new industrial processes to increase the value recoverable from various waste streams (*Meld. St. 45*, 2016–2017). However, some criticism of the idea of “CE as waste valorization” is evident, implying that a sustainable circular economy should go beyond the domain of waste (*Meld. St. 45*, 2016–2017). The second priority area for CE policy development overlaps with the discourse on bioeconomy. In the government documents, both discourses are represented, if not closely connected, through publicly funded science programs (*Meld. St. 45*, 2016–2017). The idea also includes reducing biological waste streams; hence the connection with CE conceptualization (*Meld. St. 45*, 2016–2017). Food waste reduction and frequently mentioned biological resources are framed as a mechanism to facilitate CE and seen in addition as part of an overall policy effort closely connecting waste policy and CE (*Prop. 1 S.*, 2016–2017).

5. Discussion

Our analysis identified four distinct themes in the Norwegian public policy discourse on CE: international drivers, multi-stakeholder alignment, priority areas for policy development, and firm-oriented strategies. These four themes act upon different levels of socio-technological organization and constitute a framing of environmental problems that calls for a specific solution: namely, CE. In short, the assumption underlying these four themes is that state-funded research and innovation programs comprise an important tool for enhancing the international competitiveness of national industries. Technological innovation can thus allow the decoupling of economic growth from environmental

degradation (especially in relation to climate change and natural resources). The goal of this narrative convergence is the international competitiveness of national industry. In support of this discourse, the Norwegian government responds to external pressures, particularly from the European Commission, by implementing policies to valorize waste and new material streams. These policies seek to align with EU action plans on CE, thus moving the agenda towards the redesign of products to reduce waste and the integration of closed production loops to reduce material use. Interestingly, this case provides insights into the strength of EU soft power in setting its neighbors' agendas in the field of sustainability. This dynamic also represents a gap in the literature, which has extensively focused on CE discourses where EU policy has formal powers of action (Fidélis et al., 2021; Leipold, 2021; Silva et al., 2016).

Our findings also illustrate the nature of discourse on CE on the part of ST&I actors through the lens of project summaries funded by the RCN. In contrast to state discourse surrounding CE, the four themes presented in these summaries manifest in two broad approaches: one associating CE with "regional and local transition arenas" and one concerned with "sectoral transformation." In the former discourse, which primarily assumes a locally driven (i.e., regional or municipal) development pathway, sustainability questions focus on the improvement of local industries and human well-being. The underlying goal is local prosperity, while interconnections with overall global supply chains are overlooked. This theme connects several project ideas that include public-private platforms for intersectoral cooperation (industry-local, government-academia). The second broad issue includes project applications, reflected in the themes of "sectoral transformation," "emerging industrial sectors," and "emerging issues in firm strategies." This discourse assumes that incremental improvements will lead to the sector-wide integration of CE in business models and metrics that are not exclusively linked to one organization. The goal for any given sector is to improve its environmental and social performance through technological innovations, improved methodologies, and strategies for coordination across organizations. Our findings are aligned with earlier research showing that national imaginaries are modified when reproduced in local contexts and that the legitimacy of "official" imaginaries depends on the past experiences of distributed stakeholders (Eaton et al., 2014). At the same time, despite conflicts between local and national imaginaries, there is potential to establish synergies and complementarities between bottom-up and top-down imaginaries (Trencher and van der Heijden, 2019). The mechanisms by which tensions can be overcome and transformed into complementarities constitute a crucial theme for future research.

One aspect of the CE imaginaries we identified is the potential of these technologies to help transform Norway into an innovative economy that is fully aligned with the EU Green New Deal and less dependent on commodity exports. Conversely, the data also suggest that the framing of ideas such as sustainability and circularity does not substantially differ from previous conceptualizations, namely eco-efficiency and sustainable development. Norwegian policy *de facto* frames the challenge of sustainability in terms of improving the efficiency of its industry, which in turn suggests that the political and industrial elites of the country interpret CE as a rehashed version of ecoefficiency.

Norway was already successful once in using public policy to avoid the "Dutch disease," effectively channeling its oil and gas bonanza to benefit its manufacturing sector (Fagerberg et al., 2009). Key elements of Norway's national innovation system include few large firms, many small firms with limited investment in R&D, and a large and active public sector (Fagerberg et al., 2009). Not surprisingly, important natural-resource endowments are also at the center of the country's industrial base and the way its national innovation system developed. While most extractive industries are considered to be low in technological sophistication, this is not the case for the oil and gas sector. The growth of this sector since the 1970s shaped decades of knowledge and skills development (e.g., geological knowledge and competences in

marine environments) for workers, firms, and research and education institutions. Tax revenues from the oil sector have also enabled the public sector to invest directly in R&D, expand programs for technology development, and promote and sustain regional development (Smith et al., 1996). Lastly, the dominance of oil and gas in the economy has also led to path dependence; for instance, Norway has been limited to incremental innovations in renewable energy, while Denmark has managed to engage in a more radical and rapid transition (Algers and Kattel, 2021).

In this article, we employed the idea of socio-technical imaginaries to understand how meanings or imaginaries are also material and institutional enactments of specific forms of CE, pertinent to and situated in the national context of Norway. This approach adds to earlier discourse analyses, as it enables a better understanding of which dominant discourses have established themselves, how they relate to competing imaginaries around CE, and how these tensions reveal the processes through which specific forms of CE emerge and stabilize in a given context. Our inductive content-analysis approach contrasts with previous research, which employs a more deductive methodology. Although in academic debates discourses are seen as "battling," as discussed extensively in Friant et al. (2020a), institutional boundary-making allows different imaginaries to co-exist relatively harmoniously, as these potentially contrasting perspectives are not forced to interact. To illustrate this point, the case of Norway highlights the government's development of a socio-technical CE imaginary that supports the idea of adopting "CE" as a "buzzword" while retaining the old paradigm of eco-innovation. This imaginary aligns with a technocentric CE discourse (Friant et al., 2020a). The two tension points highlighted above also call into question how academic discourses of CE unfold in real-world politics, thus reflecting the co-existence of discourse typologies. For instance, the discourse coalition around "local transition arenas" contains elements of the so-called "reformist circular society" discourse while also prioritizing the local (e.g., certain elements of the "fortress circular economy" discourse) on behalf of global solutions (Friant et al., 2020a). We argue that although discourse typologies are practical heuristic tools to engage actors in planning, such typologies should be combined with a consideration of the discourse's institutional context.

Our findings also allowed us to point out parallels to and differences from other nation states' framings of CE in the context of ST&I policies. First, we identified parallels with Norway's translation of CE into ST&I policies at the national level; this process does not represent a novel, groundbreaking paradigm shift. Rather, it is in line with previous research highlighting CE's incremental development at the EU level, a development that largely involves recycling concepts and ideas already present in policymaking and presenting them as novel (Fitch-Roy et al., 2020). Similarly, the authors of a study within the Swedish context called for a more critical approach to CE, one that acknowledges that CE is not a new concept, as several of its ideas have been portrayed with different names and definitions in the past (Johansson and Henriksson, 2020). Our findings expand Johansson and Henriksson's argument, suggesting that a shift is needed from a general national plan to more concrete development to critically portray the way that understandings of circularity influence CE policies in ST&I.

The identification of socio-technical imaginaries also leads to certain parallels with research in Finland that highlights how societal actors respond to CE funding calls (Humalisto et al., 2020). We thus emphasize that identifying socio-technical imaginaries can serve the interests of both decision-makers and potential beneficiaries of CE policies aimed at enhancing R&D and innovation. This approach can contribute to a better understanding of how broad CE policies and bottom-up initiatives complement each other.

Our results indicate that tensions represent a starting point of the policymaking process and reflect the evolving priorities of ST&I actors. These findings suggest that official CE policy programs tend to minimize or overtly ignore criticisms and contestation that are increasingly evident in academic literature about circularity. For example, Fitch-Roy

et al. (2020) applied institutional theory to the study of institutional practices, rules, processes, and actors. However, their results did not indicate particular tensions between these aspects. Instead, they found that institutional change was manifested through bricolage or translation that tended to conceal academic dissent on CE instead of engaging with it. Thus, they concluded that “new” policy packages representing and framing new regulations were rarely new. Instead, they represented an approach of repackaging extant regulations through new combinations and forms (Fitch-Roy et al., 2020).

Indeed, we can contribute evidence supporting Fitch-Roy et al.’s (2021) follow-up study on policy coherence (complementarity across the policy environment) and institutional layering (adoption of new tools alongside existing instruments). Policy packages are considered optimal when they combine a low degree of layering (i.e., “brand new” policies that challenge path-dependency) with a high degree of coherence. Policy packages with high layering and low coherence are non-optimal, while the remaining two combinations (high layering and high coherence; low layering and low coherence) are considered to be sub-optimal (Fitch-Roy et al., 2021). When we conducted the sampling to compile our dataset, the Norwegian government had not established a clear policy package on CE. Instead, the imaginary on CE had been constructed from a number of official documents that included a high degree of “layering,” e.g., building on existing policies. This situation demonstrates that CE policy is still a work in progress even in “green” leading countries, underscoring the limitations of using typologies to analyze CE policies and their effects.

This article also contributes, more broadly, to research on contested imaginaries in sustainability transitions (Birch, 2016; Eaton et al., 2014; Trencher and van der Heijden, 2019). For instance, our findings are aligned with Birch (2016), who points out that imaginaries of a bioeconomy can be related at the same time both to existing structures that accommodate the status quo (e.g., biodiesel, ethanol) and to radically new scenarios. In addition, both in the case of CE (as shown in the present study) and in that of the bioeconomy (as depicted by Birch (2016)), imaginaries appear to function as powerful drivers of change, despite mismatches between political-economic ambitions and the techno-scientific reality. However, our findings have several limitations. First, the use of a single case study limits external validity. We addressed this issue by selecting an extreme case (Flyvbjerg, 2006); such an approach can help researchers obtain more detailed information on an issue, thus assisting in creating a “school of thought” or theorizing from an understudied phenomenon. Second, because our document analysis focused on a selection from RCN research projects and official government documents, our analysis was based on the representations of the documents agreed upon by government agencies or parliament. Thus, we were limited in the scope of our analysis, particularly in our ability to examine underlying negotiations or policy-making processes. Similarly, the RCN data represented successfully funded project applications; these generally described the visions and research interests of ST&I actors, yet they did not necessarily portray visions of broader civil society actors. Finally, we are aware that a new research agenda is currently emerging around the topics of societal justice and the circular economy transition, e.g., Jaeger-Erben et al. (2021).

6. Conclusions

The connections between CE and the transition towards environmental sustainability are increasingly clarified by the burgeoning literature on the subject. Nonetheless, a knowledge gap still exists concerning the relationship between how transitions to a circular economy are imagined and enacted in research and policy agendas and how such imaginaries around CE interact with those from ST&I actors, systems, and policies.

Our paper provides an analysis of socio-technical CE imaginaries emerging from both policy documents and funded research applications in Norway, a country with very specific characteristics that occupies a

unique place in the global and European arenas. Through that analysis, we were able to identify specific ways through which ideas of CE are helping to organize ST&I agendas in Norway. Although the pursuit of circularity through innovation and market tools enjoys broad support, we can also identify tension points around which the broader imaginaries of CE emerge in Norway. These tension points refer to (i) how CE is produced locally versus in relation to the EU and (ii) how CE functions as a driver for social transformation as opposed to reinforcing current socioeconomic patterns of production and consumption.

Tension Point 1 discussed above refers to the contradiction inherent in Norway’s status as a nation fueled by a predominantly extractive economy that values its independence from the EU and values its autonomy while at the same time striving to reorient its insertion into the regional European space, aligning itself with the broader Green New Deal being constructed in the EU. This tension also refers to Norway’s ideals of being a leader in sustainability, an image it projects to the outside world, while its economy benefits from oil and gas and the old economy that CE and the Green New Deal are trying to surpass. Tension Point 2 refers to the contradiction between CE as a driver of social change (changing consumption patterns and questioning the infinite growth and social values associated with a thriving capitalist economy) and CE as enabling a critical adjustment or reorientation of current socio-technical arrangements, which would mean some sort of questioning of the country’s dependence on an extractive economy, growing consumption, and living standards that place enormous pressure on resources. If CE is as suggested within Tension Point 1 emerging as a way to “greenwash” business-as-usual practices, this can make it harder for social change to become a policy agenda in itself.

These contradictions are latent in the documents and have emerged from our coding of differing ideas of CE and differing strategies that are seen as adequate for reaching such transformative goals. They show that CE is a very open concept, still a cloud of conflicting ideas that have not stabilized into agreed-upon practices, technologies, or policies. Also, it becomes clear that Norway’s case, while unique in its specific configurations, can help shed light on contradictions that could also be present in other national or regional contexts, where CE transitions are also in the making and presumably also embed tensions.

Further research could identify the relationship between “CE policy packages” and innovation policies at the implementation stage, including the impact of the former on the latter. Such research could illustrate the relationship between socio-technical visions and the effects of these policies on ST&I actors’ research and innovation output. This could take the form of a longitudinal analysis of companies participating in publicly funded programs. It would also be important to further explore imaginaries using a broader spectrum of sources—media articles, public debates, interviews with stakeholders—comparing them with ideas identified in funded research in order to enrich analysis of national socio-technical imaginaries around CE. Finally, research contrasting imaginaries that converge on the vision of a sustainable future but use distinct labels to frame that vision (circular economy, bioeconomy, low carbon economies, etc.) also constitutes an avenue for further investigation.

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CRediT authorship contribution statement

Roberto Rivas Hermann: Methodology, formal analysis, data curation, writing original draft, visualization, Writing - review & editing.

Mario Pansera: Conceptualization, writing original draft, methodology.

Leticia Antunes Nogueira: Writing original draft; Writing - review & editing.

Marko Monteiro: Writing original draft, Writing - review & editing.

Declaration of competing interest

No potential competing interest was reported by the authors.

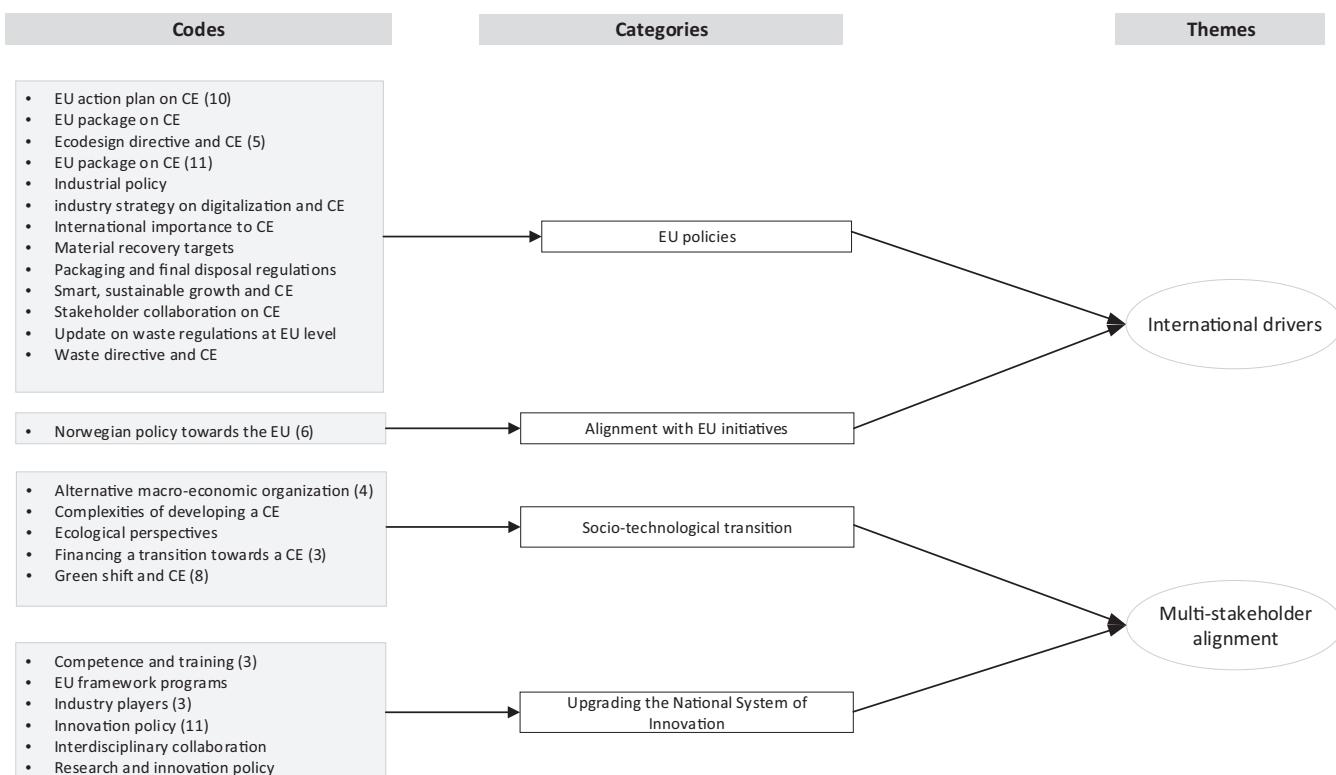
Acknowledgments

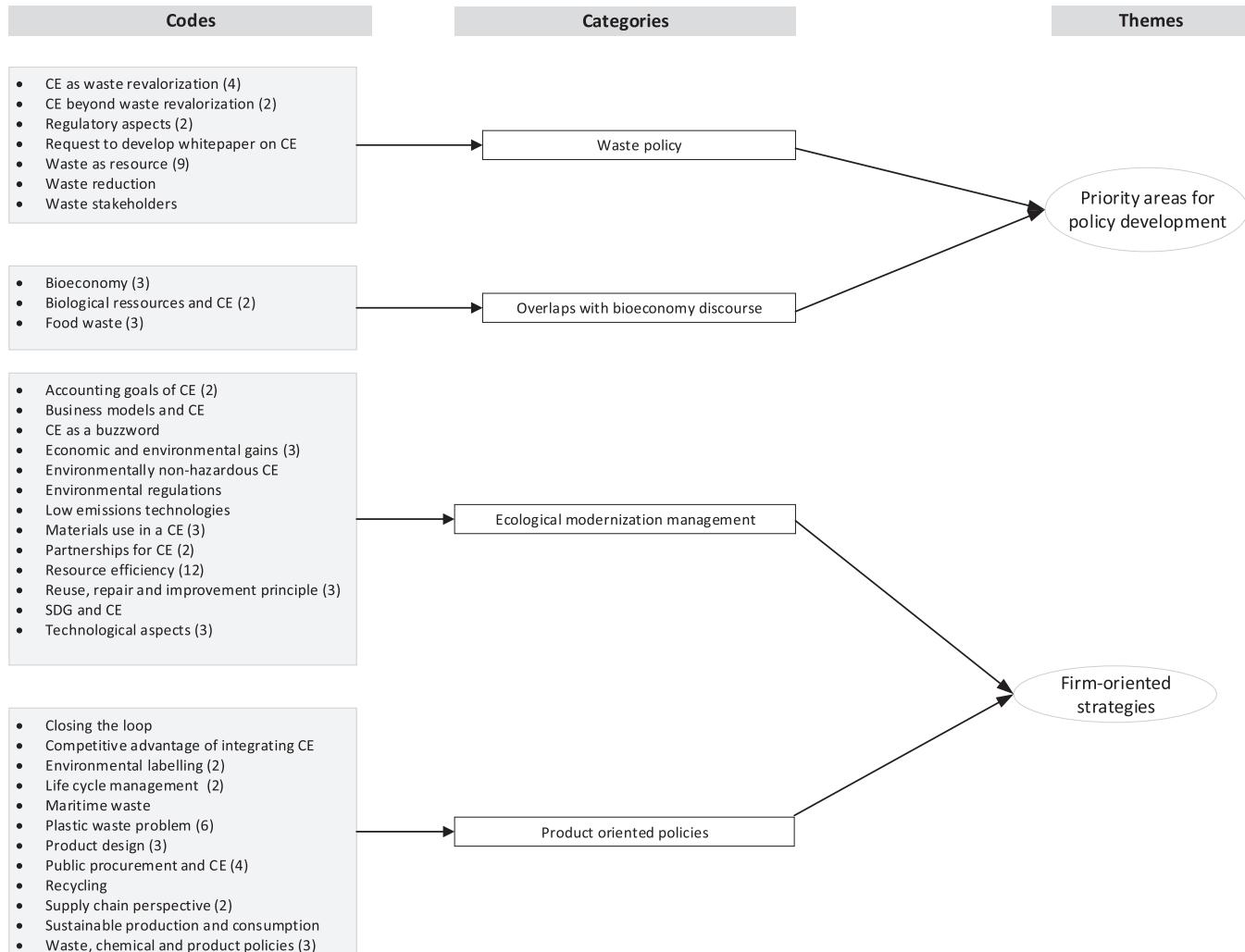
This research is based on a dataset co-authored with Dr. Are Jensen (Nordland Research Institute, Norway) (Hermann and Jensen, 2020). The authors thank him for his support in the compilation of governmental documents. The manuscript's quality improved substantially following the insights of two anonymous reviewers, as well as the proofreading of Sarah Freire-Gibb and her colleagues at The Golden Pen.

Appendix 1. Documents and dataset

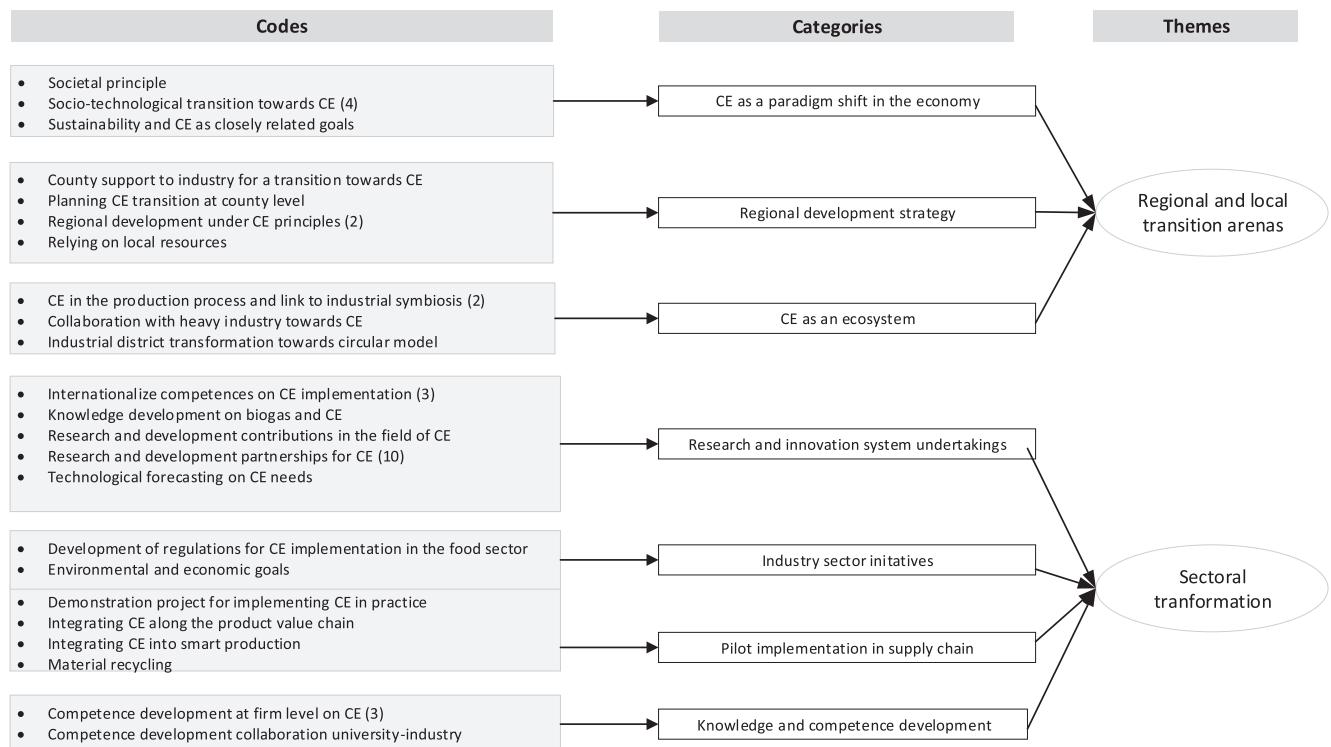
The original dataset used for the thematic analysis on circular economy can be accessed at the repository Dataverse: <https://doi.org/10.18710/CZRKNZ>.

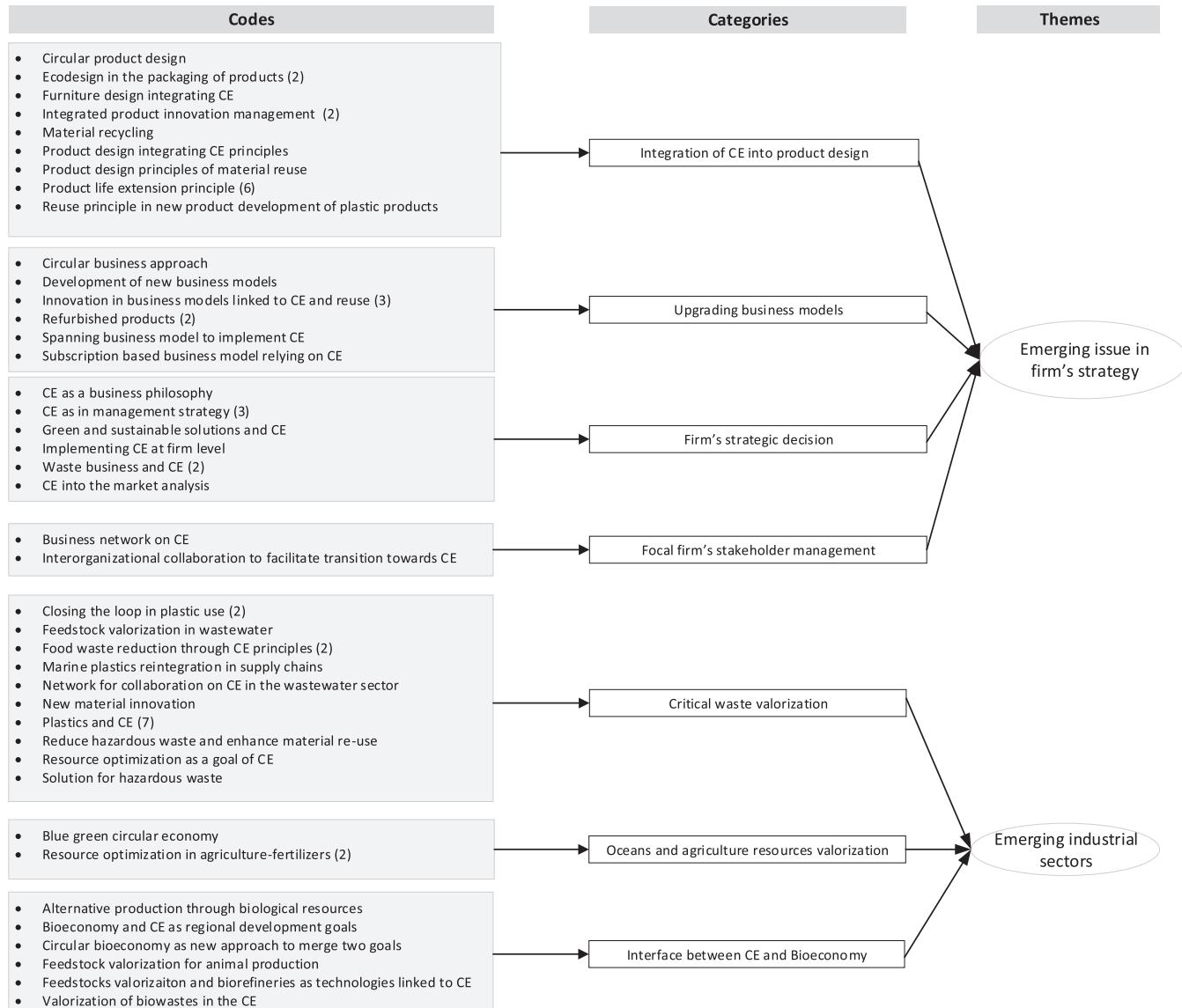
Appendix 2. Data structure for the Norwegian government documents on the circular economy





Appendix 3. Data structure for the Norwegian research and innovation system documents on the circular economy





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