6. From vision to commercialization of a circular economy innovation: a longitudinal study of overcoming challenges throughout the full innovation process[1]

Jenni Kaipainen and Leena Aarikka-Stenroos

INTRODUCTION

Although circular economy (CE) is expected to drive sustainable development (Ghisellini et al. 2016), to date it remains unclear how real-life firms can realize CE's promises (Brown et al. 2021; De Jesus and Mendonça 2018). What we know by far is that minor adjustments are not enough; we crucially need innovation to fuel CE (De Jesus and Mendonça 2018; Jakobsen et al., Chapter 1 in this volume) and sustainable business (Goodman et al. 2017; Seebode et al. 2012). Yet, more research is needed under the particular lens of innovation management (De Jesus and Mendonça 2018) to overcome the challenges of circularity (Geissdoerfer et al. 2017). In this chapter, we address this need by investigating firm-level CE innovation as a longitudinal process requiring support from diverse actors.

With innovation, we emphasize process perspective over outcome, and refer to a novel technology, product or service that involves marketing and/or technological discontinuity, is diffused beyond the innovator firm, and provides economic value (Garcia and Calantone 2002). Firms' innovation strategy focuses on creating this value, allocating resources, and managing trade-offs (Pisano 2015) while innovator firms execute innovation process activities from visioning to commercialization. As both the innovation process and innovation strategy involve continual processes of experimentation, learning, and adaptation (Pisano 2015), a process perspective is essential in innovating. Firms need to rethink their innovation processes particularly when implementing CE (Aarikka-Stenroos et al. 2021), as sustainable innovating goes beyond firms' core activities (Mousavi and Bossink 2017) and challenges them to abandon old practices (Seebode et al. 2012). However, processes of sustainable (Seebode et al. 2012; Wicki and Hansen 2019) and CE innovating (Brown et al. 2021) remain underexplored. Therefore, we consider a processual approach necessary for capturing the challenges and needed actions throughout overarching CE innovating.

Innovating challenges are not limited to the innovator firm, but often relate to managing diverse actors in the encompassing innovation ecosystem (Adner 2006). For CE innovating, expertise needs to be compiled from various actors (Ghisellini et al. 2016), which is why identifying and involving them is critical (Brown et al. 2021). To understand how actor diversity and their engagement (Driessen and Hillebrand 2013) can support the full innovating process, particularly for CE (Brown et al. 2021; De Jesus and Mendonça 2018; Jakobsen et al., Chapter 1 in this volume) and sustainability (Goodman et al. 2017; Wicki and Hansen 2019), more empirical evidence is needed (Aarikka-Stenroos et al. 2014). When innovating for sustainability in complex environments – such as CE ecosystems (Aarikka-Stenroos et al. 2021) – par-

ticipating actors may co-evolve during the process (Seebode et al. 2012). Investigating such actor dynamics over time calls for processual (Brown et al. 2021) and longitudinal (Phillips and Ritala 2019) research approaches, which remain currently underexplored.

Addressing the gaps and firms' pragmatic need to realize sustainable CE business, this chapter examines from a firm perspective a longitudinal CE innovation strategy and process, occurring from early vision to global commercialization with support from diverse actors. Our research goal is to learn "How can a firm, together with its ecosystem actors, realize sustainable innovating despite the challenges of the CE innovation process?"

To best respond, we take a critical forerunner case that allows a longitudinal investigation of diverse actors and actions in CE innovating. The selected case, Neste Oyj, demonstrates a radical, even disruptive innovation process for renewable energy production, a field considered particularly challenging for CE (Ghisellini et al. 2016). Radical innovation refers to novelties that – from the customer and market perspectives – change behaviours and consumption patterns and require learning on the part of the target market, value chain and customers (Chiesa and Frattini 2011). From the innovator firm perspective, radical innovations are challenging to manage, as they create new business lines, requiring the firm to face unfamiliar product categories and infrastructures (Aarikka-Stenroos et al. 2014). Our case displays these features over an innovating period of 25 years, which required both the markets and the firm to learn and adapt for successful, radical CE innovation.

The chapter is structured as follows. First, we discuss innovation processes in the light of innovation, technology, and business management research. Then, we provide an illustrative analysis of the case study's 25-year CE innovation strategy and process. Last, we discuss the findings, and sum up the contributions for CE and innovation management literature as well as pragmatic implications, and provide avenues for future research.

THEORETICAL BACKGROUND ON INNOVATION PROCESSES AND ACTORS

Diverse conceptualizations and theoretical models illustrate how innovation and innovating occur as a process. Conventionally conceptualized, linear process models, comprise front-end or ideation and visioning, research and technical development and commercialization (including launching, facing markets, and disseminating the innovation) (see, e.g., Chiesa and Frattini 2011). In contrast, more iterative models have also been suggested, which consider commercialization and technical development/R&D as parallel and complementary processes (O'Connor and Rice 2013). Because of this parallel nature, what might initially be considered a good solution can later lead to unintended problems. Hence, the process typically entails regressions and loops. In general, key characteristics of successful innovation processes are innovation and commercialization strategy and its implementation, which explain the iteration mechanism. An innovator firm takes a strategic direction with the potential innovation, refines the activities and decisions described above based on experience and then modifies the innovation strategy and implementation for the next iteration (Lynn et al. 1996).

The process for radical innovation often begins with a vision, which drives both the innovation's technical and commercial development (O'Connor and Veryzer 2001), followed by a techno-market match analysis to define commercializability (Jolly 1997). Finally, the process moves to market learning and commercialization activities, aiming to convert the

radical novelty into a commercial success (Siegel et al. 1995). For the innovator firm, radical innovation often requires learning and experimentation about the driving forces impacting innovation success, particularly in specific market contexts (Chiesa and Frattini 2011; Lynn et al. 1996). Moreover, radical innovation can develop completely new operations and value propositions along the industry and its actors (see Möller and Svahn 2009). Consequently, radical innovations have the power to expand firms' strategic frames (O'Connor and Rice 2013).

However, instead of limiting to the innovator firm's boundaries, innovating should also involve stakeholders from the surrounding multi-actor networks and ecosystems. Researchers in the field of ecosystem, network, and stakeholder research have acknowledged that engaging and involving diverse actors from the business, innovation, and knowledge ecosystems is essential for successful innovating (Aarikka-Stenroos et al. 2014). These may include other complementary and competing firms, public organizations, regulators and policymakers, experts, universities, research organizations, user communities, and associations (see Aarikka-Stenroos et al. 2014; Driessen and Hillebrand 2013). Managing the involvement of these actors throughout innovating is important as it is found to partly improve and partly complicate the process. On one hand, stakeholder diversity expands the breadth of available resources and increases learning and creativity (Driessen and Hillebrand 2013). On the other hand, actor diversity increases heterogeneity in knowledge, logics, competences, and power, and thus increases mismatches between actors' goals, understandings, and technologies, leading to risks and conflicts (Aarikka-Stenroos et al. 2017).

METHODOLOGY

Research Design and Case Selection

To best cover the overarching CE innovation process and its challenges, we follow a qualitative research design with an illustrative, extreme, and critical single-case study (Stake 1995, p. 3). Studying a single-case allows deep-diving to the *collaborative process phases and practices within a circular-oriented innovation context* (Brown et al. 2021, p. 6). Adding a longitudinal approach, we unfold the diverse incidents, activities, and stages during the studied process (Van de Ven 1992).

Having accumulated technical competences since 1948, Finnish oil refiner Neste invented a technology (NExBTL) that expands and creates new lifecycles for renewable feedstocks, waste, and residue by transforming them into renewable fuels (Neste Oil 2011). Such biomass-based fuels are considered clean, environment-friendly, and efficient renewable energy resources (Yilmaz and Atmanli 2017), advancing a major CE challenge (Ghisellini et al. 2016) by converting biowaste into energy (Vanhamäki et al. 2020). Calculated in compliance with the EU Renewable Energy Directive, NExBTL-based fuel results in 90 per cent lower greenhouse gas emissions over its lifecycle compared to fossil fuels (Neste Oil 2011).

In contrast to Neste having started with sourcing Russian raw oil and processing it in Finland, Neste nowadays collects and processes more than ten types of renewable feedstocks globally. Ensuring that the feedstocks are certified and the production complies with the EU's sustainability requirements, all NExBTL refineries have acquired third-party audited International Sustainability & Carbon Certification (ISCC) (Neste Oil 2011), governed by an

association of over 140 members, including research institutes and NGOs (ISCC website). Having expanded from Northern European fossil fuel markets, Neste-branded renewable fuel is nowadays distributed to business and customer markets in Europe and Northern America. Next to road transportation fuels, the same technology is nowadays being applied to jet fuel production and adapted to research in renewable plastics. With its 25-year NExBTL-based innovation strategy, Neste has transformed from a traditional oil refiner to the world's largest renewable fuel producer, with operations in 14 countries and an approximate 40 per cent share of the world's total renewable diesel production. Such an extreme case satisfies our selection criteria by allowing investigating how a longitudinal, full CE innovation process unfolds over time.

Data Gathering, Analysis and Assuring Quality

To illustrate an in-depth, longitudinal case and creating a retrospective case history over time (Van de Ven 1992), we multisource primary data from seven semi-structured interviews of top managers, two focus groups and 16 annual reports published between 2006 and 2021. We interviewed top managers across departments to fully understand the managerial perspective in change processes (Van de Ven 1992), covering research and technology, new feedstock, marketing, sustainability, public affairs, regulation, communications, and sales departments. The interviews were followed by focus groups, one for the interviewed managers, another for the strategy team. Primary data insights were complemented and validated by diverse secondary data from trade journals, magazine and newspaper articles, firm-related presentations and lectures, news releases, blog posts, and stakeholder websites.

Following an iterative, discovery-allowing research process with abductive logics (Dubois and Gadde 2002), our analysis evolved between rich empirical findings and theory-based innovating activities. Supported by the literature review on innovation processes and actors, we mapped the case firm's innovation process and innovation ecosystem using critical incident technique and Kumu.io ecosystem software. After mapping the events, actions, and actors with year-level detail onto a timeline, we classified them according to the theory-driven key innovation process activities the incident principally contributed to: visioning and ideation, research and development, and acceleration and commercialization (see Figure 6.1), to study the emerging process patterns.

Research quality is improved with various strategies: data and informant triangulation allowed reaching data saturation and developing a critical viewpoint to the case; researcher triangulation enhanced interpreting findings with objectivity; and carefully describing the methods and context improved methodological transparency. We also validated the initial findings in focus groups and interviewee commentary rounds.

FINDINGS

We first provide an overview of the case firm's full innovation process. Then, we elaborate the process activities in more detail, explaining the key challenges, actions and supporting actors throughout the process.

NExBTL technology was invented already in 1996 but not advanced until markets and regulators showed growing interest for sustainability in early 2000s. Reacting quickly to early

signals, Neste ramped up NExBTL production in 2005, yet the investment become profitable only in 2011. During the non-linear process with overlapping critical incidents (see Figure 6.1), Neste has overcome many challenges, supported by diverse actors (see Table 6.1). Although the technology has remained fairly unchanged over time, it has launched business model innovation to meet the new, sustainable value proposition (follow for example the vision updates in Figure 6.1), extend supply chain operations globally (follow feedstocks in Figure 6.1), and serve new customers and markets (follow external commercialization activities in Figure 6.1).

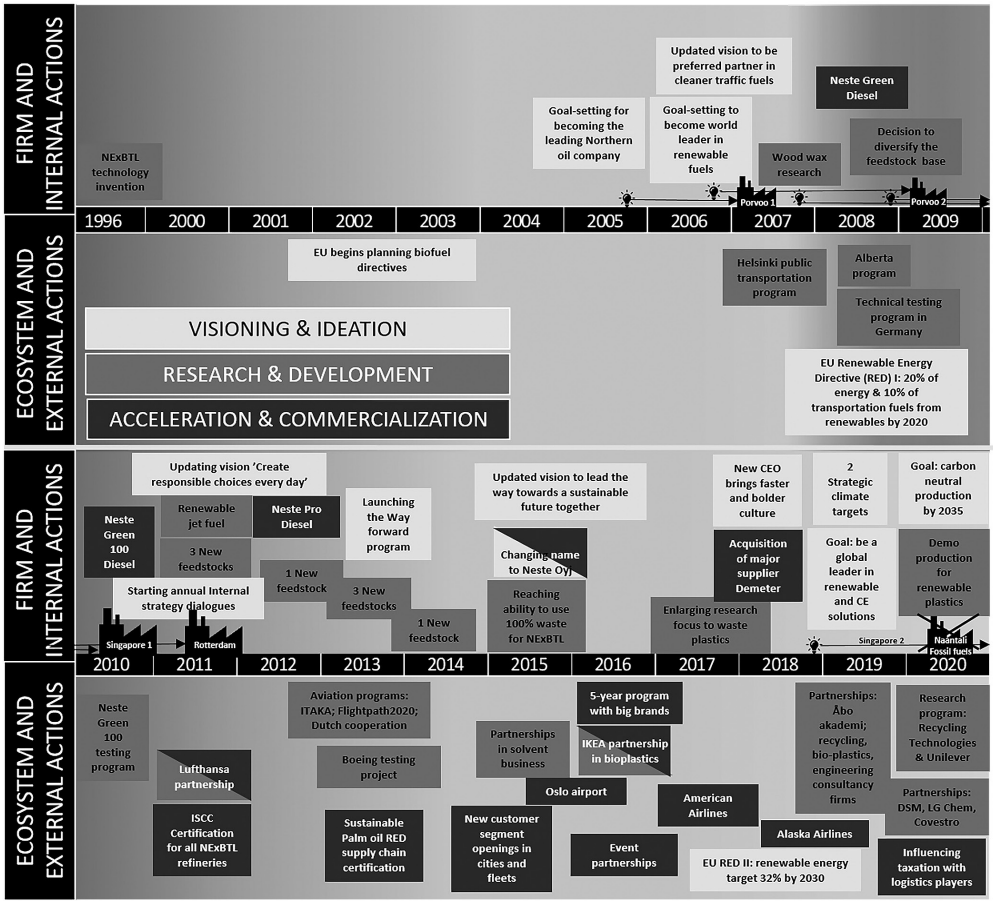

Figure 6.1 *Overview of the full CE innovation process and its critical incidents involving internal and external actions*

In *visioning and ideation*, the key challenges were inventing the technology and gaining internal support for it, while the key ecosystem actors were competitors, public audience, markets, and policymakers. To *invent the technology*, technically skilled individuals were needed and encouraged by the innovation-supporting organizational culture, originating from both experiment-encouraging leadership and Neste's technological pioneer heritage.

Regarding ecosystem actors, experimentation was motivated for maintaining competitive advantage while competitors worked with similar bio-based fuel technologies.

For ensuring *internal support for the CE invention*, sustainability-oriented strategizing and bold visioning was crucial when Neste top management evaluated future potential of the new CE-based business idea. From 2000s onwards, early signals from public, markets, and policymakers gave internal faith towards renewable fuels' future. Later in the innovation process, internal support was sealed through firm-wide strategy dialogues.

In *research and development*, the key challenges were in production scaling, answering the external concerns and maintaining continuous innovation, while the needed key actors were research-oriented partners, suppliers, regulators, industry, non-governmental organizations (NGOs), and a subsidiary. To *scale up production*, Neste was not too small in terms of not having enough resources for exploring, but not too large to neglect NExBTL because of its early marginal revenue stream. Later, extending the feedstock variety to various vegetable oils, waste and residue supported access to the feedstock volumes needed for industrial production. As one example of using residue feedstocks, Neste uses McDonald's cooking oil to produce renewable fuel, which is circulated to transport the cooking oil feedstock to Neste's production site. Scaling up was also facilitated by learning by doing, multidisciplinary competences, and cross-functional teams, as well as external competences of Neste's subsidiary.

To address the *ecosystem actors' concerns* on NExBTL's sustainability and safety, Neste discussed actively with regulators, industry, and NGOs, for which NExBTL was new. To advance the discussion and relieve concerns, Neste built credibility through third-party certifications, technical testing and research-oriented partnerships, and established supplier contracts to expand feedstocks from palm oil, questioned particularly by NGOs. By remaining open and providing their viewpoints on sustainability issues, collaborating actors supported Neste in overcoming the external concerns regarding its business sustainability.

As for *continuous innovation*, Neste maintained innovation-encouraging culture, supported by co-evolving innovation and sustainable business strategies. With the multidisciplinary and cross-functional teams as well as existing competences and technology, advancing sustainable CE accelerates new business openings in renewable jet fuels and plastics. Continuous innovation is supported particularly by collaborating with suppliers, customers, and research-oriented partners.

Challenges in *acceleration and commercialization* relate to hindering regulation, adopting launched products, and ensuring business sustainment, and are supported by regulators, industry players, competitors, NGOs, media, public discussion, customers, and research partners. To address *regulation prohibiting commercialization*, Neste keeps discussing with regulators and industry players. While regulation, standardization and product safety statements were not existing, concerns remained; as an extreme example, some even wondered if animal fat-based fuels could transmit mad cow disease. Credibility-building from the R&D stage assures ecosystem actors of product safety and influences regulation for commercialization. Additionally, competitors help in pressuring regulators along with NGOs, media, and public discussion.

Adoption of new products was facilitated by innovating emotional brand marketing and communications, a radical move for a traditional oil refiner to target new sustainability-valuing customers and public. Meanwhile, facts-based arguments were still needed for demonstrating NExBTL products' safety, technological advantages and credibility compared to fossil fuels. Additionally, feedstock expansion in the R&D stage allowed large customers to choose from different feedstocks, facilitating their adoption.

Finally, Neste *ensured its sustained business* with risky refinery investments, which in turn required securing sufficient feedstock volumes, resulting in not only establishing new supplier networks, but also supplier acquisitions. Lastly, partnering with both customers and research partners sustains long-term business.

Neste's story illustrates the challenges, overcoming actions and diverse actors needed during the CE innovation process activities. Our full findings are presented in Table 6.1 with illustrative quotations.

DISCUSSION AND LESSONS FROM THE CASE

This chapter illustrated through an extreme case how a CE innovation process can occur from an innovator firm perspective, from visioning a CE-based solution to commercializing it globally. We next discuss the lessons learnt from the case.

The concluding actor column (Table 6.1) evidently demonstrates ecosystem actors' importance for innovating activities, supporting prior literature findings (Aarikka-Stenroos et al. 2014; Driessen and Hillebrand 2013). As radical innovation develops new operations and value propositions along encompassing actors (see Möller and Svahn 2009), our findings highlight that both the importance and number of innovation-supporting actors increases along CE innovating process. Yet, even sustainability-valuing actors, particularly NGOs and regulators, can hinder the process if the credibility and value of new CE innovation is not properly communicated to them early on. Therefore, the innovator firm needs to seek for collaborations already in R&D, or even visioning. This is because most key actors in R&D activities accelerate commercializing activities later in the process: for example, suppliers expand renewable feedstocks both for R&D resources and new offerings. Similarly, research partners, NGOs, and strategic customers not only facilitate competence-building for R&D, but also build adoption-facilitating credibility. Then again, NGOs and pioneer customers accelerate the public sustainability demand, pressuring regulators to permit market openings and encouraging diffusion to customers.

The complexity of inherently challenging sustainable innovating (Wicki and Hansen 2019) manifests in the case through parallel-role actors; for example, an actor being both a customer and research partner simultaneously. When parallel roles result from the limited partner candidates in the innovation ecosystem, as we estimate to be the case here, the innovator firm needs to establish strategic partnerships with the limited partner candidates, meanwhile seeking partnerships beyond traditional ecosystem boundaries. Developing innovation ecosystem and CE innovation process seem interlinked; accordingly, accelerating the process through innovation ecosystem development is important since visioning. Despite the complexity and collaborator diversity of CE ecosystems (Aarikka-Stenroos et al. 2021), the case displays that determined ecosystem development is the key for successful CE innovating.

Our critical incident mapping shows how innovating activities overlap (see O'Connor and Rice 2013) meanwhile developing new business model innovation from technology innovation, as these innovation types can be interlinked (see Engez et al., Chapter 17 in this volume). This demonstrates also how sustainable CE requires reconfiguring innovation approaches as a major strategic undertaking (see Seebode et al. 2012), for which both innovation and business strategies need to co-develop. The found overlapping process structure also supports

Table 6.1 *Challenges, overcoming actions, and diverse actors needed during CE innovation process activities*

	Challenges in CE innovating	How can the firm respond to overcome the challenge?	Which ecosystem actors support overcoming the challenge; how?	Illustrative quotation from the case data
Visioning & Ideation	Inventing the technology innovation	– Innovative individuals with technical skills – Explore-encouraging organizational culture & leadership – R&D sector resourcing – Cherishing technological pioneer heritage	*Competitors* – Signalling interest in biofuels, encouraging to follow the trend and secure competitiveness via technological experiments	Young researchers in late 90s were encouraged to *"look beyond and do their thing"* – Strategy Team
	Gaining internal support for the CE idea	– Visionary individuals in top management – Courageous and ambitious goal setting aligned with sustainable business strategy – Unifying the vision with internal dialogue, value programmes and branding	*Regulators, potential customers* – Providing early signals of emerging markets and regulation that encourage taking strategic risks with the CE innovation	*"We did not have much else than the vision that the product is good, and markets are developing, but regulation did not properly exist"* – Sustainability and Public Affairs, Senior Vice President

	Challenges in CE innovating	How can the firm respond to overcome the challenge?	Which ecosystem actors support overcoming the challenge; how?	Illustrative quotation from the case data
Research & Development	Scaling the invention to industrial production	– Firm size is suitable for allowing experimentation – Learning by doing – Building multidisciplinary competences – Cross-functional cooperation – Feedstock expansion to ensure sufficient supply	*Subsidiary* – Subsidiary's complementary competences allowed building first refineries without building first a conventional demo plant	*"When opening the world scale refineries, we went forward quite boldly even if there were big question marks in feedstock supply and markets."* – Renewables Platform, Top Manager
	Ecosystem actors questioning the product	– Active participation in ongoing discussions to learn and interact – Feedstock expansion to meet external requirements and worries related to some of the existing feedstocks – Ensuring that own operations and processes meet the requirements for third-party certification	*Third-party auditors, research-oriented partners, technical testing programmes, NGOs, customers, regulators* – Build credibility for innovation and innovator firm's competency through collaborating – Remaining open and active in ongoing discussions with the innovator to allow learning from others who value sustainability	*"The firm cooperates with local NGOs in Southeast Asia and actively supports work in the areas of legislation and certification aimed at preventing the irresponsible production of palm oil."* – Neste Annual Report 2011
	Continuous innovation	– Experiment-encouraging culture and leadership as part of sustainable strategizing – Feedstock expansion for incremental innovation – Multidisciplinary competences & cross-functional teams – Developing tech innovation into business model innovation	*Research partners, customers, suppliers* – Building technical and sustainability-related competences together – Customer cooperation for new solutions with NExBTL technology – Supplying new feedstocks to allow expanding the scope of CE innovation	*"If you want to stand out, you need to do a bit differently from others."* – Marketing, Top Manager

	Challenges in CE innovating	How can the firm respond to overcome the challenge?	Which ecosystem actors support overcoming the challenge; how?	Illustrative quotation from the case data
Acceleration & Commercialization	Regulation prohibits commercialization	– Active participation in industry discussions – Gaining particularly technical credibility through actions taken in research and development activities	*Industry associations, regulators, competitors, NGOs, media, public* – Collaborating with industry associations for awareness of regulative progress and to stay ahead of competition – Increase in the number of competitors can pressure regulators for allowing the products in new markets – NGOs, media, and public discussion increase regulator attention	*"Implementing the directive can be very different in different countries, sometimes purpose-directed, or even protectionist."* – Public Affairs & Feedstock Regulation, Top Manager
	Facilitating the adoption of launched products	– Emotional and sustainable brand marketing for new, sustainable value proposition – Product launches in new geographic areas increase diffusing the innovation – Feedstock expansion to meet customer requirements	*Customers, suppliers, public, media* – Innovation adoption through direct customer transactions – Suppliers provide feedstock variety from which big customers can choose their orders to be produced – Public audience and media share experiences and information that encourages looking for sustainable products such as NExBTL	*"We won't tell people to do anything. We wake them to think and inspire them."* – Marketing, Top Manager
	Ensuring the business sustainment	– Risk-taking in investments – Strategic acquisitions for ensuring supply – Maintaining the strategic sustainability orientation	*Customers, public; research partners, suppliers* – Strategic collaborations with customers, research partners and suppliers to expand existing business and explore new business openings over time – Increasing public interest in sustainability mega trends supports regulative development, customer acquisition, and finding suppliers	*"CE has an important role in our new strategy. Now it is the right time to advance circular solutions, like replacing raw oil with waste plastic in oil products."* – Neste Annual Report 2018

Brown et al.'s (2021) idea of involving actors in a dynamic process, engaging new partners over time for collaborative CE innovating.

CONCLUSIONS AND IMPLICATIONS

Theoretical Contributions

We enrich innovation management and CE literature with understanding of the CE innovating process, showing how firms can overcome challenges with diverse actors to implement and accelerate CE innovation over time. This culminates in two key contributions.

First, by taking the innovation management lens (De Jesus and Mendonça 2018) to study CE innovation, we build new understanding of the innovation process from a new perspective (Aarikka-Stenroos et al. 2014; O'Connor and Veryzer 2001). By taking a longitudinal approach (Phillips and Ritala 2019) to investigate the lacking yet fruitful process perspective (Wicki and Hansen 2019), we provide evidence of the looping and iterative innovation process structure (O'Connor and Rice 2013), which has remained unclear particularly regarding sustainable (Seebode et al. 2012; Wicki and Hansen 2019) and CE-oriented innovating (Brown et al. 2021).

Second, we contribute to innovation management and CE literature with understanding how and when ecosystem actors support innovating activities. Aligned with prior innovation studies (Aarikka-Stenroos et al. 2014; Phillips and Ritala 2019; Seebode et al. 2012), our findings support the view that CE innovation makes no exception among innovations that critically need collaboration over time (Brown et al. 2021), both to provide needed competences and resources for R&D (Driessen and Hillebrand 2013) and to radically switch the value proposition in commercializing (Möller and Svahn 2009). Extending prior CE research, our findings display that CE innovating requires firms to establish strategic partnerships, seek collaboration beyond traditional boundaries (as noted previously with sustainable innovations; e.g., Seebode et al. 2012), and actively engage in public discussion involving encompassing actors, such as NGOs and regulators, early in innovating.

Practical Implications

Table 6.1 supports technology and business managers in identifying the main challenges and choosing what actions to take and when in CE innovating. It also advises who to involve and when to overcome the emerging challenges during CE innovating. Three key managerial implications give pragmatic advice as follows:

1. Strengthen innovative organizational culture with experimentation-encouraging leadership and sufficient resourcing to proactively initiate and accelerate new CE innovation processes.
2. Build multidisciplinary competences, also across firm boundaries, and facilitate their use with cross-functional teams already in early CE innovating to allow new, parallel business opportunities to emerge.
3. Establish strategic partnerships with sustainability-valuing actors and seek collaboration beyond traditional boundaries early on to facilitate both R&D and commercialization activities.

This chapter demonstrates how instead of choosing between them, managers can pursue both sustainability and economic gains through executing CE innovation strategies and processes, meanwhile strategically renewing for sustainability with aligned innovation and business strategies. Moreover, the advantages of successful CE innovation are not limited to benefits from the firm perspective; sustaining future production and consumption with firms' sustainable practices and solutions is societally crucial. Consequently, contributing to ensure success of firms' full CE innovation processes is of great interest for many, including regulators, NGOs, and customers.

Limitations and Future Research

Many firm features, such as size, innovation, or market features (e.g., industry and stakeholder conservatism; Möller and Svahn 2009) can shape CE innovation processes. As actions and actors crucial throughout innovation processes may vary based on firm features, as well as innovation types, further research is needed to complement our findings on a primarily technological CE innovation case with business model innovation features. Further, as the processual view to CE innovating remains new and underexplored (Brown et al. 2021), more examinations are needed on diverse sustainable/CE innovation processes, across industries in ecosystem and market creation settings. Lastly, seeing the power of sustainable/CE innovating to strategically transform the way firms do business, we encourage investigating the impact of sustainable/CE innovating under a strategic management lens.

ACKNOWLEDGEMENTS

The data generation and writing of this chapter were supported by the Strategic Research Council, Academy of Finland, through the research project "Circular Economy Catalysts: From Innovation to Business Ecosystems" (CICAT2025) (grant ID 320194). We also thank Erkki Paasikivi Foundation, Tampere Foundation for Economic Education, and Kansan Sivistysrahasto for supporting Kaipainen's work.

NOTE

1.

REFERENCES

Aarikka-Stenroos, L., Jaakkola, E., Harrison, D., & Mäkitalo-Keinonen, T. (2017). How to manage innovation processes in extensive networks: A longitudinal study. *Industrial Marketing Management*, 67, 88–105.

Aarikka-Stenroos, L., Ritala, P., & Thomas, L. (2021). Circular economy ecosystems: A typology, definitions and implications. In S. Teerikangas, T. Onkila, M. Mäkelä, & K. Koistinen (eds), *Research Handbook of Sustainability Agency*. Cheltenham, UK: Edward Elgar Publishing.

Aarikka-Stenroos, L., Sandberg, B., & Lehtimäki, T. (2014). Networks for the commercialization of innovations: A review of how divergent network actors contribute. *Industrial Marketing Management*, 43(3), 365–381.

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review*, 84(4), 98–107.

Brown, P., Von Daniels, C., Bocken, N. M. P., & Balkenende, A. R. (2021). A process model for collaboration in circular oriented innovation. *Journal of Cleaner Production*, 286, 125499.

Chiesa, V., & Frattini, F. (2011). Commercializing technological innovation: Learning from failures in high-tech markets. *Journal of Product Innovation Management*, 28(4), 437–454.

De Jesus, A., & Mendonça, S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecological Economics*, 145, 75–89.

Driessen, P. H., & Hillebrand, B. (2013). Integrating multiple stakeholder issues in new product development: An exploration. *Journal of Product Innovation Management*, 30(2), 364–379.

Dubois, A., & Gadde, L. E. (2002). Systematic combining: An abductive approach to case research. *Journal of Business Research*, 55(7), 553–560.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: A literature review. *Journal of Product Innovation Management*, 19(2), 110–132.

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy: A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768.

Ghisellini, P., Cialani, C., & Ulgiati, S. (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.

Goodman, J., Korsunova, A., & Halme, M. (2017). Our collaborative future: Activities and roles of stakeholders in sustainability-oriented innovation. *Business Strategy and the Environment*, 26, 731–753.

Jolly, V. K. (1997). *Commercializing New Technologies*. Boston: Harvard Business School Press.

Lynn, G. S., Morone, J. G., & Paulson, A. S. (1996). Marketing and discontinuous innovation: The probe and learn process. *California Management Review*, 38(3), 8–37.

Möller, K., & Svahn, S. (2009). How to influence the birth of new business fields: Network perspective. *Industrial Marketing Management*, 38(4), 450–458.

Mousavi, S., & Bossink, B. A. G. (2017). Firms' capabilities for sustainable innovation: The case of biofuel for aviation. *Journal of Cleaner Production*, 167, 1263–1275.

Neste Oil (2011). *Annual Report*. https://www.neste.com/sites/default/files/attachments/corporate/investors/agm/review_by_the_board_of_directors_2011.pdf.

O'Connor, G. C., & Rice, M. P. (2013). New market creation for breakthrough innovations: Enabling and constraining mechanisms. *Journal of Product Innovation Management*, 30(2), 209–227.

O'Connor, G. C., & Veryzer, R. W. (2001). The nature of market visioning for technology-based radical innovation. *Journal of Product Innovation Management*, 18(4), 231–246.

Phillips, M. A., & Ritala, P. (2019). A complex adaptive systems agenda for ecosystem research methodology. *Technological Forecasting and Social Change*, 148, 119739.

Pisano, G. (2015). You need an innovation strategy. *Harvard Business Review*, 93(6), 44–54.

Seebode, D., Jeanrenaud, S., & Bessant, J. (2012). Managing innovation for sustainability. *R&D Management*, 42(3), 195–206.

Siegel, R. A., Hansén, S.-O., & Pellas, L. H. (1995). Accelerating the commercialisation of technology: Commercialisation through co-operation. *Industrial Management & Data Systems*, 95(1), 18–26.

Stake, R. E. (1995). *The Art of Case Study Research*. Thousand Oaks, CA: Sage Publications.

Van de Ven, A. H. (1992). Suggestions for studying strategy process: A research note. *Strategic Management Journal*, 13(S1), 169–188.

Vanhamäki, S., Virtanen, M., Luste, S., & Manskinen, K. (2020). Transition towards a circular economy at a regional level: A case study on closing biological loops. *Resources, Conservation & Recycling*, 156, 104716.

Wicki, S., & Hansen, E. G. (2019). Green technology innovation: Anatomy of exploration processes from a learning perspective. *Business Strategy and the Environment*, 28(6), 970–988.

Yilmaz, N., & Atmanli, A. (2017). Sustainable alternative fuels in aviation. *Energy*, 140, 1378–1386.