

# Managing Innovation Ecosystems For Net-Zero Targets

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## Extended abstract

Ecosystem approach has been increasingly used as a theoretical frame for phenomena where multiple actors pursue system-level transition to sustainability (Aarikka-Stenroos et al. 2021; Linde et al., 2021, Parida et al. 2021). The concept of ecosystem represents organizational collectives of interacting actors whose activities are interdependent but can be linked in the processes of both collaboration and competition (Jacobides et al., 2018; Pattinson et al., 2023). Transition to sustainability-oriented business processes, that embraces radical shift of the existing system to another that concerns all actors and processes in the system (Geels & Kemp, 2007), oftentimes regards development and implementation of innovations. Joint effort of the ecosystem actors aimed to create value of the innovations may require their mutual adaptation of resources and activities, and involvement of societal and institutional actors that contribute to innovation development and commercialization (Aarikka-Stenroos & Ritala, 2017; Ritala et al., 2013). Thus, innovation ecosystem can be characterized as multiple actors' collaboration following customer-oriented goals, focal innovations, their development, and commercialization (Kapoor & Lee, 2013; Jacobides et al., 2018). Innovations play the key role in address sustainability issues such as tackling challenges of anthropogenic emissions in persuasion of net-zero targets. Generally, net-zero assumes decarbonization of the economy through policies aimed at climate change mitigation and utilization of technologies that allow reshaping industrial processes to decrease carbon dioxide emissions (Bouckaert et al., 2021; Bataille et al., 2021). Principles of decarbonization across industries are promoted and triggered by regulatory changes in the EU and at the local level (European Commission, 2023; Kujanpää et al., 2023). European Commission has adopted Sustainable Carbon Cycles communication that currently bears recommendations to increase carbon removal in farming and industries (European Commission, 2021), which makes companies, especially engaged in energy sector, waste management, wood and pulp production, to collaborate searching for innovative solutions of carbon capturing and its following utilization.

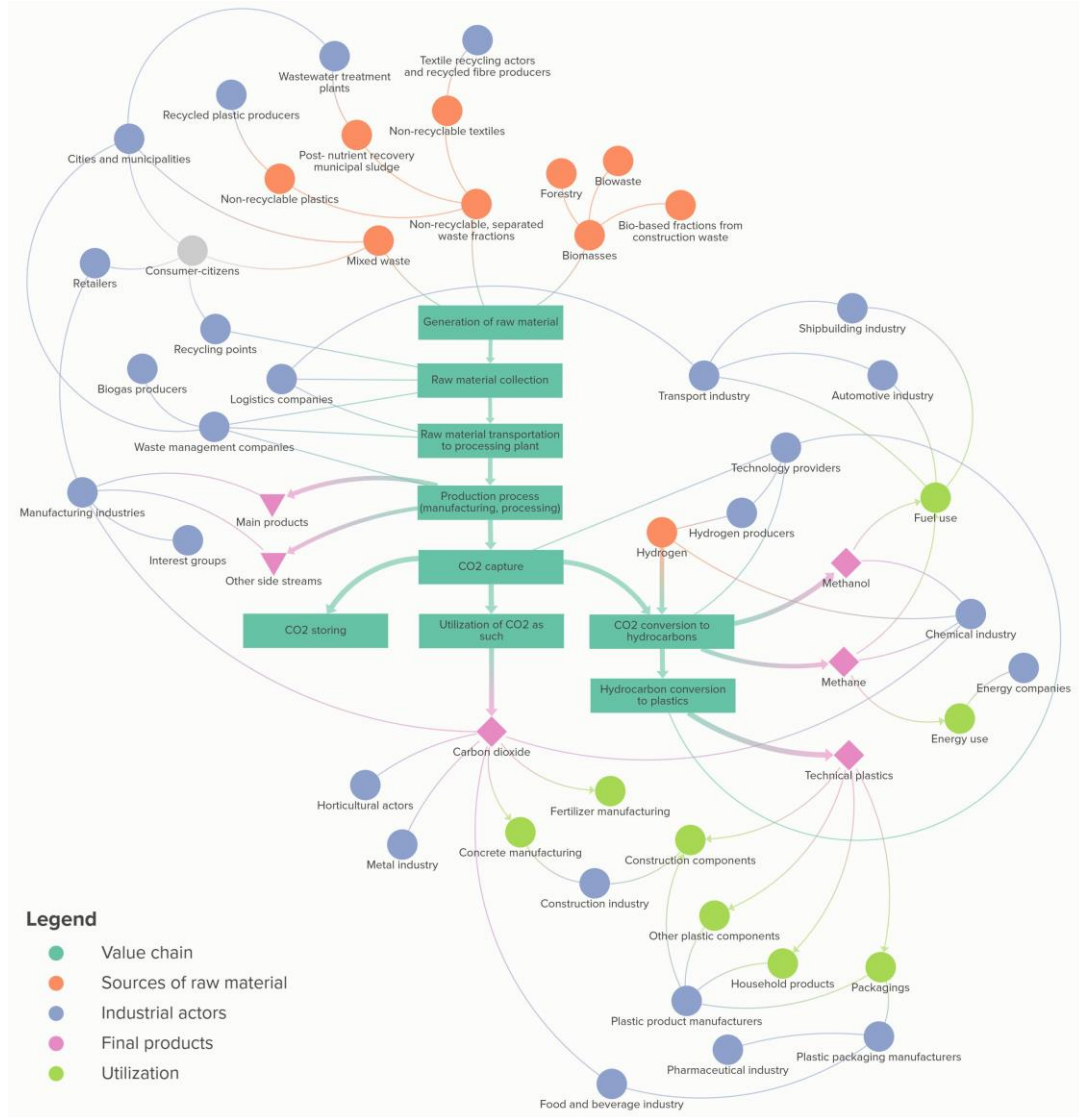
Thus, carbon capture and utilization (CCU) innovations are developed in response to the environmental regulations change and technological advancement allowing to capture, store and transform the emission into “sustainable” gases or chemicals and to utilize them in the industrial processes for production of plastics, energy, or biofuel (Araújo et al., 2017; Zhaurova et al., 2021). Despite CCU technology has been known for decades, it is still considered pre-commercial due to rare implementation in the industrial scale (Pratama & Mac Dowell, 2022). Along recent regulatory-driven changes in the business, the CCU innovations have commercial potential through development of novel business models, recovering carbohydrate raw materials for production of e.g., methane, methanol, ammonium, high demand for decarbonization of production processes (Ryu et al., 2022; Zhaurova et al., 2021). Bringing recovering of resources closer to the industrial value chains aid to security of raw material access (Aldaco et al., 2019) that may be interrupted as it is evident from recent global challenges of COVID19 and geopolitical turmoil. Utilization of CO<sub>2</sub> as waste transformed into raw materials, also contributes to Circular Economy (CE) principles, and allows reducing industrial consumption of fossil-based raw materials and recovering chemicals as resources (Naims, 2020; Tcvetkov et al., 2019).

Business perspectives of CCU remain little addressed in management (Naims, 2016; Naims, 2020). Despite technological advancement of carbon utilization, companies generally unable to implement this technology without clear identification of business models, understanding how CCU fits to the existing value chains and relying to the interaction of ecosystem actors supporting innovations. Against this background, *this study explores how managerial interaction in innovation ecosystems can support novel business models and value chains development aimed at net-zero targets?*

Empirically, this qualitative study is grounded on i) primary data obtained through interviewing in period of Aug 2022 - Dec 2023 from 10 companies operating in Finland that implement CCU technologies in their value chains or engaged in technologies development; ii) secondary data collected through notes taking during seminars organized between ecosystem actors and researchers (n=7), publicly available data of the companies websites, marketing outlets and press releases (n=10), related governmental directives, acts and reports (n=4). Despite contextual delimitation to Finland, this country makes an interesting research case, since its political and industrial context creates catalyzing conditions for CCU implementation due to policies focused on negative climate change effects mitigation and support for innovations development (Rodriguez et al., 2021; Kujanpää et al., 2023). The data was analyzed through content analysis with help of Atlas analytical software (Mayring, 2014).

The current findings allow us to map a generalized value chain and ecosystem that are illustrated in Figure 1. The figure shows the key elements of the materials flow in the value chain from the waste generation stage (e.g., industrial or household waste for incineration, or waste of wood reprocessing) to the stage where carbon dioxide is captured, purified and

either supplied for storing or transformed into hydrocarbons for production of plastic, or as other chemical components used in other industries.



**Figure 1.** Generalized CCU value chain and ecosystem.

In this study, the focus of business models regarding CCU is on the utilization of recycled carbon dioxide instead of storing it since the companies of this research aim to close the loop of emission circulation to maximize its CE value and pursue sustainability goals. For the companies that implement CCU in their waste incineration value chain, profit generation of CO<sub>2</sub> circulation is derived from sales of chemical products resulted after the emission transformation. Industrial actors who are potentially interested in the raw materials of the emission circulation, in our case, represent mostly producers of plastics, but also produces of synthetic fuels. Companies engaged in development CCU innovations

and related industrial solutions maintain their business models by offering these innovations and technical support to industrial customers that can embed them into the existing industrial value chains. Carbon capturing also can be offered as a service for other companies representing emitting industries such as cement industry.

Ecosystem approach to the innovations management is vital to support the business models functioning as well as material, knowledge, and financial flow in the value chains. The business models remain immature due to emerging stage of the carbon capturing as business. The main driving catalysts for CCU innovations are not only regulation-driven but also rooted in the companies' strategies for decarbonization and exploitation of business opportunities out of this novel business activities. The forming an innovation ecosystem helps the transition of industrial value chains to sustainability which efficient management require close interaction of the value chain actors and communication including internally to the companies and with business partners. The main challenge of the value creation in this ecosystem includes identification of the potential business customers across industries both - interested in CCU technologies and recovered raw materials. CCU technology remains expensive a risky investment that polluting industrial players can still escape by paying fines for emission. Growing business interest to CCU makes companies engage in R&D projects with institutional actors to solve the key challenges in innovations and business domains.

This study contributes to the management literature by exploring managerial activities and challenges of organizing within innovation ecosystems (Jacobides et al., 2018). This study also contributes to sustainable ecosystem research (Theodoraki et al., 2017) by exploring carbon capturing processes aimed at net-zero (Bataille et al., 2021) and development of new business models contributing to environmental sustainability.

## Keywords

Carbon capturing, sustainability, industrial ecosystem, value chain, business models

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