

Mapping the European innovation ecosystems for renewable energy: the role and impact of MNCs

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Abstract—Ecosystem-based entrepreneurship is essential for accelerating the global transition toward sustainability and renewable energy. Among the various actors, multinational corporations (MNCs) play a pivotal role in the genesis and growth of resilient innovative ecosystems. This study examines the character of their interplay and impact on European innovation ecosystems for renewable energy and suggests an ecosystem-based perspective on strategic innovations and global sustainability at the MNC level. The research is based on a multi-step approach involving qualitative methods and social network analysis. By triangulating data from direct observations of MNCs' practices and their reported ties to corresponding European renewable energy nonprofit organizations, we collect a sample for social network analysis from a global perspective. The findings enhance an understanding of collaboration among actors in innovation ecosystems for renewable energy and evaluate the catalytic role of MNCs. The study provides managers, policymakers, and researchers with insights and an understanding of how large-scale actors, such as MNCs, can be leveraged to support the transition toward renewable energy through their participation in innovation ecosystems.

Keywords— *innovation ecosystem, strategic innovations, renewable energy, multinational corporations, international business, strategic management, nonprofit organizations, sustainability, corporate social responsibility*

I. INTRODUCTION

Recent studies have confirmed that innovation ecosystem theory plays a big role in advancing technology and creating value in a competitive business environment [1]–[3]. Simultaneously, ecosystem-based entrepreneurship has become essential for accelerating the global transition toward renewable energy [4], [5]. This is crucial for preventing climate change by reducing greenhouse gas emissions and pollution, ensuring long-term energy security and independence, and promoting a healthier and more sustainable future. These challenges create new opportunities for the research, development, and implementation of clean technologies and involve many innovative incumbents.

Multinational corporations (MNCs) play a pivotal role in the genesis and growth of resilient innovation ecosystems [2], [6], [7]. In particular, international firms that participate in innovation ecosystems acquire ecosystem-specific

advantages vital to their long-term resilience and competitiveness [8], [9]. On the one hand, they possess significant financial and technical resources; on the other hand, they have already gained solid project management expertise and are ready to share it with smaller innovators. These capabilities allow MNCs to invest in and develop renewable energy projects on a large, even global, scale, and thus form a renewable energy market. As the largest energy consumers, they are motivated to improve operational efficiency by reducing energy costs and accelerating renewable energy innovations. Embracing renewable energy not only aligns with their corporate social responsibility goals but also enhances their reputation and global influence.

While the involvement of MNCs in innovation ecosystems is theoretically reasonable and valuable, empirical evidence of their impact is scarce and predominantly regional [10], [11]. The modes of MNCs' engagement in the development of innovation ecosystems in the renewable energy sector also remain unclear.

This research gap highlights the need to provide a comprehensive understanding of MNCs' roles and activities within these ecosystems, ultimately contributing to a better understanding of the dynamics and potential for collaboration in the renewable energy innovation landscape.

II. THEORY AND RESEARCH QUESTION

The central theoretical concepts that inform our research stem from both ecosystem and innovation ecosystem theories, which underscore the vital interactions and knowledge exchange between diverse actors to generate new value. Integral to this theoretical backdrop is the sustainability framework, specifically its emphasis on renewable energy, which guided our sector selection for this study. To understand their contribution to the structure and patterns of collaboration in the renewable energy sector, we primarily consider Adner's approaches to ecosystem construction [2]. The assumption of viewing the ecosystem as an 'affiliation' (a network of collaborative actors) helps to explore the internal modes of actors' structure and the links between them. Simultaneously, the assumption that the ecosystem is a combination of interrelated activities ('ecosystem as structure') could be helpful in explaining the roles these actors play in shifting the system toward its goals.

Although the term ‘innovation ecosystem’ does not have a rigorously defined analogy to natural ecosystems [12], we use it to highlight the similarity in terms of complex relationships, dependencies, and interactions among the various actors and resources involved in fostering innovation. Existing literature supports the idea of the evolving nature of innovation ecosystems [13]. However, when considering the context of sustainability or its dimensions, the theoretical basis narrows noticeably.

Based on the affiliation approach, we can argue that the key difference lies in the networking actors involved. Traditional innovation ecosystems primarily focus on the triple-helix framework, which involves various collaboration patterns between the government, businesses, and the research and development (R&D) entities, driven by the resource flows required to create new products or services and bring them to the market [14]–[16]. However, this structure of actors does not inherently support ideas that go beyond market purposes and embrace sustainable innovation. Considering sustainability dimensions, businesses rarely prioritize them naturally. This is why these innovation initiatives must be actively promoted. The UN addresses this task by establishing Sustainable Development Goal (SDG) 17, ‘Partnerships for the Goals,’ and identifying nine major groups from civil society that are expected to actively engage in sustainable development initiatives [17], [18]. Along with traditional businesses ranging from small and medium-sized enterprises to MNCs, R&D organizations, governments, and financial institutions, as well as specific innovative actors such as start-ups or inventors, the affiliation of actors in the innovation ecosystem toward sustainability includes various nongovernmental organizations (NGOs) or nonprofit organizations (NPOs). Given that their collaborative patterns and roles are influenced by sustainability dimensions, we now focus our theoretical considerations on the research field of the renewable energy sector.

We used the Scopus database, widely regarded as a trusted resource, to establish a strong theoretical foundation and identify the research gap. Our search employed the keywords ‘renewable,’ ‘energy,’ ‘ecosystem,’ and ‘innovation’ with the search criteria set to TITLE-ABS-KEY. Furthermore, we limited the search to publications in relevant subject areas including business, management, social sciences, environmental sciences, decision sciences, and economics. The initial sample consisted of 142 documents. Upon studying the abstract papers, we were able to narrow our focus to 14 relevant papers that made valuable contributions to the exploration of ecosystems as affiliations or structures.

The theoretical findings show that the research landscape in the field is quite young and covers the period of 2018–2023. The selected publications encompass mostly regional qualitative studies, particularly those based on interviews, document analysis, and case studies. This methodology allowed the authors to explore the composition of actors and their dynamics between niche, system (industrial), and landscape levels in specific regional renewable energy ecosystems in China, the Netherlands, Israel, and Iran. Some studies have examined niche-level actors [19]–[22] to understand their motivation to compete rather than

collaborate in engineering processes. Other authors have focused on local community-based ecosystems and tried to explain the benefits of the interactions between focal actors and other stakeholders [23]–[25].

As the ‘focal actor’ concept is central to the affiliation approach [2], certain studies have investigated the ecosystems built around institutional (landscape) actors (governments or other public authorities) or corporations and proved their pivotal role in promoting and coordinating renewable energy transitions [10], [11], [26], [27].

The structural approach to innovation ecosystems for renewable energy is used mostly to understand the behavioral dynamics and interactions between different actors within the ecosystem. It examines how institutional, community, or niche actors engage with each other, form partnerships, exchange resources, and jointly create value (interests, motivation, collaborative patterns) [10], [11], [19], [20], [23], [28], [29].

It is worth mentioning that the authors often pay limited attention to civil society, NGOs, or NPOs which are considered influential major groups according to the UN approach [17], [18].

Thus, to summarize the results of previous studies, we can argue that the key contributions cover the pivotal role of institutional actors and interactions within the ecosystem at different levels, including niche and local community-based ecosystems. Simultaneously, a gap emerges regarding the role and impact of MNCs in innovation ecosystems for renewable energy. Our study aims to address this gap by investigating the involvement of MNCs and understanding the collaborative patterns, influence, and implications of MNCs in shaping the transition toward sustainable energy practices in ecosystems built around such major groups as NPOs, including particular associations or platforms.

Therefore, we address the following research question: What are the roles and impacts of MNCs in European innovation ecosystems for renewable energy affiliated with NPOs, including associations and platforms?

III. METHODS

To answer the research questions regarding the role and impact of MNCs in the European renewable energy innovation ecosystem, we employed a multi-step approach involving qualitative methods (data sampling and observation) and social network analysis (SNA).

First, we identified and analyzed the reported ties between MNCs and European renewable energy NPOs. These NPOs serve as key players in the innovation ecosystem and represent collaborative networks of actors with complementary interests and activities. By examining MNCs’ engagement with these NPOs, we gained insights into their involvement in the ecosystem.

We adopted the definition of an ecosystem by Jacobides et al., considering it as a set of actors with varying degrees of multilateral, non-generic complementarities, which are not fully hierarchically controlled [3]. Within this

framework, we recognized relevant business associations and other related NPOs as mechanisms through which players in the ecosystem engaged in cooperation and competition [30]. Consequently, we focused on identifying and studying European renewable energy NPOs that had significant involvement and engagement with MNCs. This approach allowed us to capture six key organizations that played a central role in shaping the European renewable energy innovation ecosystem.

To confirm that the identified NPOs construct an ecosystem, we applied SNA to map the network of affiliations among these entities. By examining the internal structure of the actors and the links between them, we could visualize and analyze the collaborative relationships and interactions within the ecosystem. This network analysis provided empirical evidence of the interconnectedness and interdependencies among identified NPOs, further supporting the notion of an ecosystem.

Further, using frequency analysis, we determined the extent of MNCs' membership in these selected NPOs. By identifying MNCs with the highest frequency of membership across different NPOs, we designated them as the focal actors in the European innovation ecosystem for renewable energy. This analysis allowed us to understand which MNCs were actively engaged and had a prominent presence within the ecosystem.

Lastly, we applied SNA to investigate mutual collaborative connections among focal MNCs. By examining their interconnectedness, we gained insights into their roles, collaborations, and potential impacts within the European innovation ecosystem for renewable energy. This analysis enabled us to assess the dynamics and influence of these focal MNCs in shaping the ecosystem.

IV. RESEARCH RESULTS

In our initial mapping of the European renewable energy innovation ecosystem as an 'affiliation,' we identified six influential NPOs that play a crucial role in driving Europe-wide corporate collaborations and advancements in the renewable energy sector. These NPOs include SolarPower

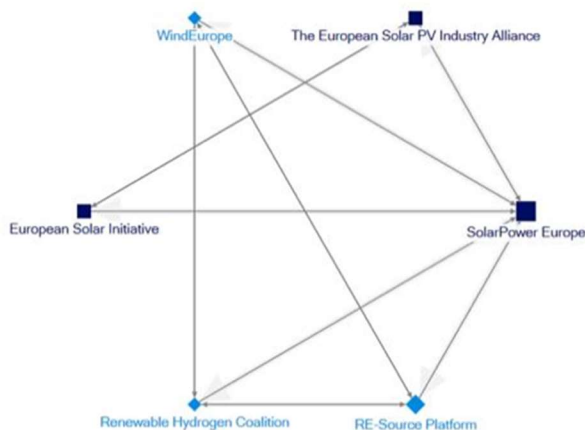


Fig. 1. Network of affiliations among the observed European renewable energy NPOs

Europe, the RE-Source Platform, the Renewable Hydrogen Coalition, the European Solar Initiative, WindEurope, and the European Solar PV Industry Alliance. Among these organizations, SolarPower Europe has 18 MNCs as members, while the RE-Source Platform, the Renewable Hydrogen Coalition, the European Solar Initiative, WindEurope, and the European Solar PV Industry Alliance have 8, 7, 17, 11, and 5 MNCs respectively.

Our network analysis confirmed the high interconnectedness and interdependencies among the identified NPOs, supporting the notion of an ecosystem in the European renewable energy sector. Figure 1 presents the network of affiliations among the observed European renewable energy NPOs and illustrates the connections and collaborations between them.

The distribution of MNCs' membership intensity in the observed NPOs provides insights into the extent of their participation and engagement within the European renewable energy innovation ecosystem (Figure 2).

Of the 27 identified MNCs that participated in the observed NPOs, the distribution revealed varying levels of membership intensity. Among them, seven MNCs are members of only one NPO, indicating a relatively lower level of engagement focused on a specific organization. On the other hand, 12 MNCs are involved in two NPOs, indicating broader engagement across multiple organizations. This finding suggests a higher level of participation and interest in collaborating within a larger network of NPOs.

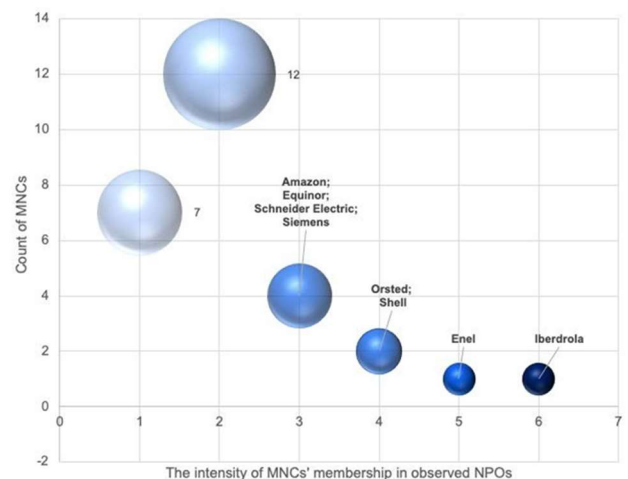


Fig. 2. Distribution of MNCs' membership intensity in the observed NPOs

Furthermore, four multinational corporations—Amazon, Equinor, Schneider Electric, and Siemens—demonstrate an elevated level of engagement by participating in three of the aforementioned NPOs. These MNCs demonstrate a stronger commitment to collaboration and active involvement in multiple NPOs within the renewable energy sector. Notably, two MNCs, Orsted and Shell, stand out with membership in four NPOs. This indicates their significant presence and active participation across a wider range of organizations, highlighting their strategic positioning within the European renewable energy innovation ecosystem. As a prominent player, Enel is a member of five NPOs, demonstrating a high

level of engagement and involvement in shaping the renewable energy sector through collaborative efforts. Finally, Iberdrola stands out as the most extensively engaged MNC as it is a member of all six observed NPOs. This shows its comprehensive involvement and strategic positioning as a key focal actor within the European renewable energy innovation ecosystem.

Further network mapping of MNCs' participation in the observed NPOs provides valuable insights into the screening of focal MNCs within the European renewable energy innovation ecosystem (Figure 3).

This analysis confirms the binding role of several prominent MNCs in shaping and driving the ecosystem forward. Specifically, Iberdrola, Enel, Orsted, Shell, Amazon, Equinor, Schneider Electric, and Siemens emerged as key connectors within the ecosystem.

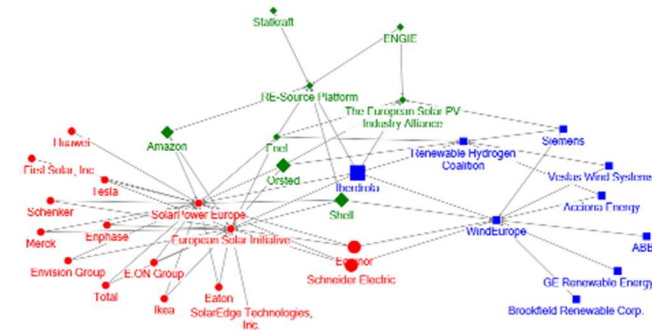


Fig. 3. Social network analysis of MNCs' participation in observed NPOs

Among the focal MNCs, namely Amazon, Schneider Electric, Siemens, Enel, Iberdrola, Orsted, Shell, and Equinor, strong partnerships and collaborations have emerged as crucial factors in the evolution of the ecosystem (Figure 4). Notably, Enel, Iberdrola, Orsted, Shell, and Equinor are energy companies, and their collaborations with each other as well as with Amazon, Schneider Electric, and Siemens highlight their significance as cornerstones within the ecosystem.

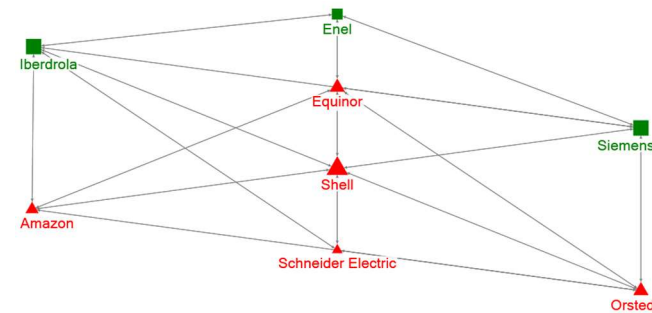


Fig. 4. Social network analysis of focal MNCs' mutual collaborative connections

The absence of direct collaborations between Amazon, Schneider Electric, and Siemens suggests that their interactions and contributions are more focused on specific areas or aspects of the renewable energy sector. However, their involvement in collaborations with energy companies underscores their valuable contributions to the ecosystem.

The extensive joint collaborations between Enel, Iberdrola, Orsted, Shell, and Equinor further reinforce their central roles within the ecosystem. SNA revealed that Shell exhibits the highest degree of centrality within the network. Additionally, two distinct fractions emerge: 1) Orsted, Amazon, Equinor, Schneider Electric and 2) Iberdrola, Siemens, and Enel. This finding suggests that Iberdrola and Shell play slightly different leading roles in the ecosystem.

Iberdrola, being the most extensively engaged MNC as a member of all six observed NPOs, assumes the role of an ecosystem networker, facilitating connections and collaborations among various actors. On the other hand, Shell emerges as the leader in value exploration orchestration, driving initiatives and strategic activities within the ecosystem.

V. THEORETICAL AND MANAGERIAL IMPLICATIONS

From the perspective of ecosystem and innovation ecosystem theories, our mapping of the European renewable energy innovation ecosystem as an 'affiliation' reveals the presence of influential NPOs that drive corporate collaborations and advancements in the sector. These findings support the collaborative nature of networking within renewable energy ecosystems [24], [28]. Additionally, our contribution aligns with Adner's structural approach by providing a clear understanding that NPOs, as facilitators and coordinators, bring together diverse actors, including multinational corporations, and serve as platforms for communication, knowledge exchange, and resource sharing. The role of NPOs in this context is crucial for fostering innovation and addressing complex sustainability challenges.

On the other hand, the structural approach to explaining ecosystem dynamics allows us to contribute to strategic management theory. The results obtained from the analysis of MNCs' engagement in multiple NPOs demonstrate their strategic intention to collaborate and their recognition of the importance of network participation in driving innovation and competitiveness. The findings provide insights into their strategies, internationalization modes, and ecosystem-specific advantages.

Based on the level of engagement and centrality within the ecosystem, we identified two distinct types of corporate actors in the renewable energy sector: focal and participating MNCs. They play different strategic roles in the ecosystem. Focal MNCs acting as cornerstones and connectors have a significant impact, setting and orchestrating trends, and driving sustainable transitions as supported by Shen [10] and Elset [11]. Participating MNCs leverage resources and expertise in the renewable energy sector.

Furthermore, these research results have broader theoretical implications that contribute to various domains, including international business theory, global strategic corporate social responsibility (CSR), sustainable business transformation, shared value theory, and technological innovation management.

In terms of international business theory, the research results provide an understanding of how MNCs operate globally in the context of sustainable energy, characterized by

high turbulence. The analysis of MNCs' roles and impacts within the renewable energy innovation ecosystem suggests the development of dynamic capabilities, such as future awareness, agility, flexibility, learning, and strategic innovation, in alignment with Teece's theory [31].

In addition, this study has implications for the evolution of strategic CSR in a global context. It emphasizes the need for MNCs to engage with NPOs and collaborate on initiatives that drive advancements in the renewable energy sector, aligning with the concept of global strategic CSR described in [32] and the integration of social and environmental considerations into corporate strategies.

The research also sheds light on sustainable business transformation, highlighting the importance of collaboration, innovation, and leveraging ecosystem resources for sustainable practices in the renewable energy sector. Additionally, it supports the concept of shared value creation [1], [21], [23] by promoting sustainable development, addressing climate change, improving energy access, and driving sectoral progress through engagement with NPOs.

The key managerial implications emphasize the value of ecosystem engagement, collaboration, and leveraging ecosystem resources for strategic innovation, sustainable supply chains, internationalization, and the integration of global corporate social responsibility. Managers might consider the benefits of participating in relevant innovation ecosystems, identify influential NPOs, and actively leverage ecosystem partnerships to drive innovation, competitiveness, and sustainable development within future growth sectors.

By participating in innovation ecosystems, firms gain access to diverse actors, knowledge-sharing platforms, and opportunities for co-innovation. This enables them to remain informed about emerging trends, access new markets, and form strategic collaborations that drive technological advancements and market growth. Therefore, managers can build on that by prioritizing engagement in relevant ecosystems to reap these benefits and remain competitive in the dynamic competitive sectors.

Furthermore, ecosystem-based strategy development is crucial for firms to effectively leverage available resources, foster collaborations, and drive innovation. By aligning their innovation strategies with ecosystem participation, managers can secure firm's competitive advantages and contribute to the sector's sustainable development. This strategic alignment ensures that firms are well-positioned to capitalize on the opportunities present within innovation ecosystems.

For firms seeking international expansion, global innovation ecosystems provide valuable entry points into new markets. By strategically engaging with influential NPOs and relevant innovation ecosystems, firms can establish networks, access local expertise, and navigate regulatory frameworks more effectively.

An essential managerial implication of this study is the integration of global CSR into corporate strategies. For instance, companies can engage with NPOs by supporting renewable energy projects in underprivileged communities, contributing to environmental conservation efforts, or

sponsoring educational programs. These actions not only demonstrate a commitment to addressing societal and environmental challenges but also strengthen a company's reputation, foster stakeholder trust, and contribute to sustainable development on a global scale.

Finally, by exploring partnership models and leveraging shared resources, knowledge, and expertise within an ecosystem, companies can develop more effective and sustainable supply chains.

VI. CONCLUSIONS

Innovation ecosystems are pivotal in expediting the global transition toward renewable energy. Our study has revealed the presence of various incumbents operating within this sector, each contributing distinctively to the transition. Particularly noteworthy is the significant role played by MNCs in shaping and nurturing resilient renewable energy innovation ecosystems. It is worth also noting that limited attention has been paid to civil society, NGOs, or NPOs within the ecosystems context which are considered the influential major groups according to the UN approach. These NPOs serve as key players in the innovation ecosystem and represent collaborative networks of actors with complementary interests and activities.

Our network analysis has confirmed the high interconnectedness and interdependencies among the identified NPOs, supporting the notion of an ecosystem in the European renewable energy sector. Out of the 27 identified MNCs that participate in the observed NPOs, the distribution reveals varying levels of membership intensity. The analysis confirms the binding role of several prominent MNCs in shaping and driving the ecosystem forward.

The research results have several theoretical implications that contribute to various domains, including international business theory, global strategic CSR, sustainable business transformation, strategic management theory, creating shared value theory, ecosystem and innovation ecosystem theory, and technological innovation management.

From the perspective of ecosystem and innovation ecosystem theories, the mapping of the European renewable energy innovation ecosystem and the identification of influential NPOs highlight the collaborative nature of networking within the sector. NPOs play a crucial role as facilitators and coordinators, bringing together diverse actors, including MNCs, and fostering innovation and sustainability. This aligns with Adner's structural approach, emphasizing the importance of NPOs as platforms for communication, knowledge exchange, and resource sharing.

The research also contributes to strategic management theory by exploring MNCs' engagement in multiple NPOs and their strategic intention to collaborate. The findings shed light on MNCs' recognition of the value of network participation in driving innovation and competitiveness, providing insights into their strategies, internationalization modes, and ecosystem-specific advantages.

These results provide useful insights into the evolving international firm theories under the conditions of

sustainability crisis and increasing technological dynamism with particular managerial implications for facilitating strategic innovations, ecosystem-based strategy development, global sustainability strategy development, and sustainable supply chain management.

Within strategic management and international business theory, several potential research areas can be derived to understand better the behavior of both focal and participating MNCs within renewable energy innovation ecosystems. Some areas to explore include the motivation driving collaboration among MNCs, their innovation strategies and modes, and the mechanisms through which MNCs shape policy development and implementation in the renewable energy sector. Delving into these areas will enhance our comprehension of the intricate dynamics within these ecosystems.

REFERENCES

- [1] B. Clarysse, M. Wright, J. Bruneel, and A. Mahajan, 'Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems', *Research Policy*, vol. 43, no. 7, pp. 1164–1176, Sep. 2014, doi: 10.1016/j.respol.2014.04.014.
- [2] R. Adner, 'Ecosystem as structure: An actionable construct for strategy', *Journal of management*, vol. 43, no. 1, pp. 39–58, 2017.
- [3] M. G. Jacobides, C. Cennamo, and A. Gawer, 'Towards a theory of ecosystems', *Strategic management journal*, vol. 39, no. 8, pp. 2255–2276, 2018.
- [4] G. Surie, 'Creating the innovation ecosystem for renewable energy via social entrepreneurship: Insights from India', *Technological Forecasting and Social Change*, vol. 121, pp. 184–195, Aug. 2017, doi: 10.1016/j.techfore.2017.03.006.
- [5] G. Surie, 'Scaling the Innovation Ecosystem for Renewable Energy: The Case of India', *International Journal of Global Business and Competitiveness*, vol. 17, no. 1, pp. 89–103, 2022.
- [6] M. Iansiti and R. Levien, 'Keystones and dominators: Framing operating and technology strategy in a business ecosystem', *Harvard Business School, Boston*, vol. 3, pp. 1–82, 2004.
- [7] P. Ryan, M. Giblin, G. Buciuni, and D. F. Kogler, 'The role of MNEs in the genesis and growth of a resilient entrepreneurial ecosystem', *Entrepreneurship & Regional Development*, vol. 33, no. 1–2, pp. 36–53, Jan. 2021, doi: 10.1080/08985626.2020.1734260.
- [8] S. A. Zahra and S. Nambisan, 'Entrepreneurship in global innovation ecosystems', *AMS review*, vol. 1, no. 1, pp. 4–17, 2011.
- [9] S. Nambisan, S. A. Zahra, and Y. Luo, 'Global platforms and ecosystems: Implications for international business theories', *J Int Bus Stud*, vol. 50, no. 9, pp. 1464–1486, Dec. 2019, doi: 10.1057/s41267-019-00262-4.
- [10] W. Shen, 'Who drives China's renewable energy policies? Understanding the role of industrial corporations', *Environmental Development*, vol. 21, pp. 87–97, 2017.
- [11] D. F. Elset, 'Corporations and the renewable energy transition in the Arctic', in *Renewable Energy for the Arctic*, Routledge, 2018, pp. 136–154.
- [12] D.-S. Oh, F. Phillips, S. Park, and E. Lee, 'Innovation ecosystems: A critical examination', *Technovation*, vol. 54, pp. 1–6, 2016.
- [13] L. A. de Vasconcelos Gomes, A. L. F. Facin, M. S. Salerno, and R. K. Ikenami, 'Unpacking the innovation ecosystem construct: Evolution, gaps and trends', *Technological Forecasting and Social Change*, vol. 136, pp. 30–48, Nov. 2018, doi: 10.1016/j.techfore.2016.11.009.
- [14] D. Arthur, J. Moizer, and J. Lean, 'A systems approach to mapping UK regional innovation ecosystems for policy insight', *Industry and Higher Education*, vol. 37, no. 2, pp. 193–207, 2023.
- [15] H. Etzkowitz and C. Zhou, *The triple helix: University–industry–government innovation and entrepreneurship*. Routledge, 2017.
- [16] Y. Cai, 'Neo-Triple Helix model of innovation ecosystems: integrating Triple, Quadruple and Quintuple Helix models', *Triple Helix*, vol. 1, no. aop, pp. 1–31, 2022.
- [17] B. Adams and L. Pingeot, 'Strengthening public participation at the United Nations for sustainable development: Dialogue, debate, dissent, deliberation', Study for UN DESA/DSD Major Groups Programme. Available: <http://sustainabledevelopment.un.org/index.php>, 2013.
- [18] L. Oliveira-Duarte et al., 'Innovation Ecosystem framework directed to Sustainable Development Goal# 17 partnerships implementation', *Sustainable Development*, vol. 29, no. 5, pp. 1018–1036, 2021.
- [19] N. Odake and K. Hayase, 'Efforts to promote renewable energy: Ecosystem and regional perspectives', in *Japanese Business Operations in an Uncertain World*, Routledge, 2021, pp. 33–46.
- [20] M. Ebrahimi, 'A system dynamics approach to strategy planning by small and medium-sized enterprises in the renewable energy sector', *International Journal of Business and Systems Research*, vol. 17, no. 2, pp. 172–202, 2023.
- [21] P. Hansen, 'Optimising shared renewable energy systems: An institutional approach', *Energy Research & Social Science*, vol. 73, p. 101953, 2021.
- [22] A. Proka, D. Loorbach, and M. Hisschemöller, 'Leading from the Niche: Insights from a strategic dialogue of renewable energy cooperatives in the Netherlands', *Sustainability*, vol. 10, no. 11, p. 4106, 2018.
- [23] T. Joensuu, M. Norvasuo, and H. Edelman, 'Stakeholders' Interests in Developing an Energy Ecosystem for the Superblock—Case Hiedanranta', *Sustainability*, vol. 12, no. 1, p. 327, 2019.
- [24] K. O. Adu-Kankam and L. M. Camarinha-Matos, 'Renewable energy communities or ecosystems: An analysis of selected cases', *Heliyon*, p. e12617, 2022.
- [25] C. D'Alpaos and F. Andreolli, 'Renewable Energy Communities: The challenge for new policy and regulatory frameworks design', in *New Metropolitan Perspectives: Knowledge Dynamics and Innovation-driven Policies Towards Urban and Regional Transition Volume 2*, Springer, 2021, pp. 500–509.
- [26] A. A. Khalifa, A.-J. Ibrahim, A. I. Amhamed, and M. H. El-Naas, 'Accelerating the Transition to a Circular Economy for Net-Zero Emissions by 2050: A Systematic Review', *Sustainability*, vol. 14, no. 18, p. 11656, 2022.
- [27] T. Zohar, Y. Parag, and O. Ayalon, 'Weaving an innovation network from the middle-out: the case of the renewable energy ecosystem', *Energy, Sustainability and Society*, vol. 12, no. 1, pp. 1–15, 2022.
- [28] S. Kilpeläinen, P. Aalto, and J. Kiviluoma, 'Renewable Energy in Finland: From a Production-Centric to a Consumption-Centric System', *New Challenges and Solutions for Renewable Energy: Japan, East Asia and Northern Europe*, pp. 349–376, 2021.
- [29] C. D. Diale, M. G. Kanakana-Katumba, and R. W. Maladzhi, 'Ecosystem of Renewable Energy Enterprises for Sustainable Development: A Systematic Review', *Advances in Science, Technology and Engineering Systems Journal*, vol. 6, no. 1, pp. 401–408, 2021.
- [30] R. J. Wieringa, W. Engelsman, J. Gordijn, and D. Ionita, 'A Business Ecosystem Architecture Modeling Framework', in *2019 IEEE 21st Conference on Business Informatics (CBI)*, Jul. 2019, pp. 147–156. doi: 10.1109/CBI.2019.00024.
- [31] D. J. Teece, G. Pisano, and A. Shuen, 'Dynamic capabilities and strategic management', *Strategic management journal*, vol. 18, no. 7, pp. 509–533, 1997.
- [32] N. Krasnokutskaya and T. Danko, 'Corporate social responsibility and countries' reputation: A study from a global strategic management perspective', in *Comparative CSR and Sustainability*, Routledge, pp. 364–379, 2022.