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Business Model Innovation in Green Startups in the Energy Transition Era

Nofiatun Rahmadhaningtyas[1*]

[1] Universitas Negeri Yogyakarta, Yogyakarta, Indonesia

Abstract

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The global energy transition is driving the growth of green startups that rely on business model innovation to develop sustainable solutions. This study aims to analyze how business model innovation serves as a key enabler for the adaptation and growth of green startups in responding to both challenges and opportunities presented by the energy transition. Through a systematic literature review of international journals published between, this research finds that the success of green startups is highly determined by their ability to integrate technological innovation, sustainability principles, and adaptability to dynamic energy policies. Business model innovation enables these startups to design value creation systems that align with economic, environmental, and social goals. The study provides a conceptual framework to better understand the role of innovative and sustainable business strategies in the context of emerging clean energy landscapes. It also offers insight into how green startups position themselves as key actors in accelerating the global shift towards sustainable energy systems.

*Corresponding author:
nofiatunrahmadhaningtyas.2022@student.uny.ac.id (Nofiatun Rahmadhaningtyas)

1. Introduction

Global climate change and the urgent need to significantly reduce carbon emissions have accelerated the transition towards cleaner, more efficient, and sustainable energy systems. In the context of this major transformation, the presence of green startups is crucial and strategic as key players in developing, implementing, and disseminating environmentally friendly technologies and business models that support decarbonization efforts and overall energy efficiency improvements. Green startups not only focus on technological innovation but also actively update and adjust their business models to generate a dual impact that encompasses economic, social, and environmental dimensions simultaneously and balancedly. Energy transition itself generally refers to the process of shifting energy systems from those previously based on fossil fuels to energy systems supported by renewable energy sources such as solar power, wind energy, and bioenergy.

This process is not simple because it demands complex and comprehensive structural changes in the energy sector, including aspects of regulation, technology, market behavior, and consumer preferences. Amidst the complexity and dynamics of these changes, green startups emerge and play an important role as catalysts for transformation by presenting innovative and visionary business approaches that combine economic value creation with a commitment to environmental sustainability. One of the most vital elements in driving the success of green startups is their success in designing and implementing the right business model innovation (BMI) (Tohanean & Weiss, 2019). Business Model Innovation (BMI) is understood as a strategic process of redesigning the basic logic of a business, encompassing three

main aspects: how the business creates value, delivers that value to users, and captures value as a result (Geissdoerfer et al., 2018). In the context of green startups operating in a fast and uncertain energy transition era, BMI becomes a key element to enable them to adapt dynamically to market challenges, policy changes, and ongoing technological evolution.

Green startups generally face various structural and non-structural barriers, including limitations in access to financing, regulatory uncertainty that hinders business certainty, and market resistance to the adoption of innovative solutions they offer. Therefore, it is very important for green startups to have the ability to create business models that are flexible, adaptive, and able to respond to various external environmental changes quickly and accurately. Innovation in various aspects of business models, such as unique value propositions, innovative revenue structures, smart partnership strategies, and high consumer engagement, becomes an important element to ensure business continuity and long-term growth (Teece, 2018). Furthermore, the global urgency regarding the sustainability agenda has encouraged investors, regulators, and consumers to be more selective in supporting businesses that adhere to sustainability principles. Startups that are able to integrate ESG (Environmental, Social, Governance) principles into their business models not only gain competitive advantages but also obtain social legitimacy and access to wider resources.

The business models they run are not only required to be financially profitable but also must have a real contribution to improving environmental quality and community welfare (Geissdoerfer et al., 2018). Through this literature study

approach, the author aims to comprehensively explore how the concept of business model innovation is applied by green startups in order to support and accelerate the ongoing global energy transition process. The main focus of this study includes the mechanisms of business model innovation adopted by green startups, the main challenges they face in the sustainable energy business ecosystem, and various strategic opportunities that can be utilized in supporting operational sustainability. This study is expected to provide relevant theoretical and practical contributions for business developers, academics, and policymakers involved in the development of the green startup ecosystem in supporting the sustainable energy transition agenda in the future.

2. Literature Review

2.1. The Concept of Business Model Innovation and its Relevance in Energy Transition

Business model innovation is defined as a systematic and structured form of change in how an organization designs, creates, delivers, and captures the value that forms the core of their business operations. Teece (2018) explicitly explains that Business Model Innovation (BMI) is not merely a form of technical product or process innovation, but rather a comprehensive change to the entire value ecosystem run by an organization or company. In the context of green startups, BMI becomes a very important, strategic, and relevant instrument for creating real sustainability impacts on an economic, social, and environmental scale. Startups operating in the renewable energy, energy efficiency, and circular economy sectors have widely

applied various business models that explicitly emphasize the importance of co-creation value.

Namely through active involvement with various stakeholders and direct participation from end-users in the innovation and product or service development process (Geissdoerfer et al., 2018). Sustainable Business Models successfully implemented by green startups generally include a combination of several important elements: the integration of environmentally friendly technologies, inclusive and adaptive market penetration strategies, and the use of data-driven and analytical approaches to support more accurate and responsive decision-making processes to evolving dynamics. With this approach, startups can adapt more effectively to the latest energy policies and rapidly changing market dynamics (Nosratabadi et al., 2019).

2.2. Dynamics and Challenges Faced by Green Startups

Green startups often operate in a business ecosystem that is still in its early stages of development and not yet fully mature, both in terms of available supporting infrastructure, a clear and stable regulatory framework, and access to adequate and sustainable funding (Bouncken et al., 2021). This condition creates various complex challenges, where regulatory uncertainty in the energy transition process is one of the main factors most frequently faced by green startup actors. Such uncertainty can hinder business continuity and expansion because fluctuating policies make long-term planning difficult. However, on the other hand, various forms of government incentives and increasing support from investors have a positive impact in

accelerating the adoption of new, more sustainable, and environmentally friendly business models.

This support becomes a strategic opportunity for startups to continue innovating in perfecting their business models. In addition to external challenges, there are also significant internal constraints, such as limited human resources with competence and deep understanding of green technology, as well as limited capacity in terms of small production scale. Nevertheless, some green startups are able to overcome these obstacles by adopting collaboration-based business models and using resource-sharing platforms that allow cost efficiency and increased capacity (Bocken et al., 2019). Furthermore, digitalization also plays a very important role in supporting transparency, automation, and overall operational efficiency in the green startup ecosystem.

2.3. Business Model Innovation Strategies in Supporting Energy Transition

Effective Business Model Innovation (BMI) strategies in the operational context of green startups usually involve a combination of several important elements: sustainable technological innovation, adaptation to changing market needs and behaviors, and high sensitivity to the development of energy regulations applicable locally and globally (Bidmon & Knab, 2018). One strategic approach widely adopted by green startups today is the concept of servitization, which is the shift in focus from selling physical products to providing solution-based services. One concrete form is the energy-as-a-service (EaaS) model, which allows startups to provide comprehensive energy solutions without having to sell products directly, but rather through subscription schemes or results-based systems (Teece, 2018).

This approach is considered capable of increasing the accessibility of green energy services while strengthening long-term relationships with customers. In addition, the open innovation strategy is also an important part of developing green startup business models. Through this approach, startups involve end-users, industry partners, and research institutions in the process of developing and refining innovative solutions. With this multi-party involvement, the process of knowledge transfer and technology adoption becomes faster, more efficient, and more targeted. No less important, the application of the circular economy model also provides a strategic foundation in designing sustainable green business models. This model emphasizes waste reduction, resource reuse, and overall energy efficiency improvement (Geissdoerfer et al., 2018).

3. Method

This research uses a systematic literature review method to explore and understand various findings from international scientific publications discussing business model innovation (BMI) within the scope of green startups, especially those engaged in the energy transition sector. The main focus is directed at academic works published, with strong relevance to issues of business innovation, sustainability, and the transformation of energy systems based on renewable resources. Data collection was carried out through the Google Scholar platform using specific keywords such as: "Business Model Innovation", "Green Startups", "Energy Transition", "Sustainable Business Model", and "Clean Energy Entrepreneurship". From the search results, a number of inclusion criteria were applied to select documents

worthy of analysis, including: articles originating from peer-reviewed scientific journals published, articles explicitly discussing business models in startups in the field of renewable energy or sustainable practices, and containing direct studies related to the relationship between business model innovation and the energy transition process.

Non-academic documents, such as opinions, popular articles, or those not directly related to the main topic of the study, were systematically excluded from the analysis stage. After the initial screening process, articles were obtained that met all selection criteria. These articles were then analyzed using a qualitative approach with a thematic method. This analysis was conducted to identify common patterns in the literature, including the business model innovation strategies applied, the obstacles faced by green startups, and the extent to which their approaches impacted the achievement of energy transition targets. All data obtained were then categorized into three major themes: key components in business model innovation, dynamics and challenges faced by green startups in their operations, and adaptation strategies undertaken to respond to changes in the global energy landscape. The results of the analysis were then compared with the theoretical framework developed by previous researchers to compile a more comprehensive conceptual understanding.

4. Results

The results of the study of 12 international journal articles show that business model innovation in green startups in the era of energy transition has distinct characteristics that are fundamentally different compared to conventional startups

generally operating in traditional sectors. In general, green startups tend to adopt business models that are more dynamic, flexible, collaborative, and highly integrated with sustainability principles as their core strategy. Various studies analyzed in this study reveal that there are several elements considered most crucial and determining in the business model innovation process carried out by green startups. These elements include a sustainability-based value proposition, a business approach based on the utilization of clean technology, and an adaptive and flexible revenue structure in facing market changes.

Generally, green startups consciously and strategically design their business models with the aim of addressing two main challenges simultaneously: creating sustainable economic value while simultaneously minimizing negative environmental impacts. In an in-depth study conducted by Geissdoerfer et al. (2018), it is explained that green startups actively redefine the value creation process by explicitly incorporating social and environmental value elements into their business model design from the early stages. As a concrete example, many renewable energy companies are starting to offer their products not as disposable consumer goods, but in the form of sustainable services (such as Energy-as-a-Service or EaaS), which allows customers to more easily switch to using green energy without having to make large initial investments or purchase assets directly.

The study by Bidmon and Knab (2018) also highlights that business model innovation in green startups tends to integrate digital technology intensively, such as the use of Internet of Things (IoT), big data technology, and blockchain, to increase operational efficiency and transparency throughout the entire value chain they

manage. The implementation of these technologies has proven capable of increasing trust from both investors and consumers, especially in the context of real-time and verifiable data-based environmental impact measurement and reporting. This provides added value in building the credibility of green businesses in the eyes of the public and strategic partners.

In addition to technological aspects, the adoption of a circular economy approach also becomes a very important foundation in the design of green startup business model innovation. Circular business models allow for the reuse of raw materials, reduction of generated waste, and optimization of existing resource utilization to the maximum. In the operational context of green startups, this strategy not only provides cost efficiency in the long term but also becomes a strong selling point for consumer segments who are increasingly aware and concerned about environmental and sustainability issues (Bocken et al., 2019).

Furthermore, a study by Nosratabadi et al., (2019) places special emphasis on the importance of active involvement of stakeholder engagement in the entire business model innovation process. Successful and long-term sustainable green startups are generally those that build an inclusive business ecosystem that includes various strategic partners such as technology providers, user communities, impact investors, research institutions, and regulatory bodies. This participatory approach is considered to accelerate the adoption of green solutions more broadly and increase the social legitimacy needed for market expansion.

Although various potential advantages have been identified, the reality still shows that significant challenges continue to be faced by many green startups. One

of the most significant challenges is the barrier in obtaining financial support and sustainable financing, given that green business models are often considered high-risk by conventional financial institutions. To overcome this problem, a number of startups implement a hybrid financing approach that combines traditional funding with alternative methods such as crowdfunding, green bonds, or collaboration with impact investors (Bouncken et al., 2021). This approach has proven capable of bridging the initial funding gap while building broader community support.

In addition to financing, the regulatory aspect is also an important determinant of the success and continuity of green startup business model innovation. Studies by Teece (2018) show that policies and regulations that actively encourage decarbonization and carbon emission limits contribute directly to creating very potential new market opportunities for green startups. Conversely, uncertainty or frequent changes in energy policies in many countries often pose a challenge for startups that must quickly adjust their business models to regulatory changes. This situation demands green startups to have a high level of flexibility, strong organizational resilience, and good strategic adaptability to remain relevant amidst dynamic policy changes.

Furthermore, innovative business models such as peer-to-peer (P2P) energy trading and energy sharing platforms are gaining widespread adoption among green startups. A study by Bryant et al. (2018) states that these business models allow for the direct distribution of renewable energy between producers and consumers, utilizing technologies such as blockchain and smart contracts to ensure transparency, efficiency, and security of energy transactions. This model not only disrupts the

conventional energy market but also encourages the creation of a more democratic and decentralized energy market.

In addition, digital platform business models also show rapid development in the green startup sector. This approach allows startups to reach a wider market without requiring large investments in physical infrastructure. Examples of this model include sustainable mobility platforms (such as electric vehicle-based ride-sharing), digital platforms for waste management, and specialized marketplaces for green energy products and services. This approach has proven effective in accelerating business scale and simultaneously building loyal and sustainable user communities (Sjödin et al., 2020).

From a financial performance perspective, green startups that adopt innovative business models generally show more stable and promising performance in the long term. Although their initial growth phase is often slow due to financing and market education challenges, the competitive advantages offered by sustainability principles, energy efficiency, and technological innovation provide a strong foundation for consistent business growth. This makes green business models not just a temporary trend, but a future business strategy that is increasingly relevant amidst the climate crisis and global sustainability demands.

Finally, the results of this literature study also emphasize that success in implementing business model innovation is highly influenced by internal factors within the organization. Some key determining factors include an organizational culture that supports innovation, adaptive and strategic managerial capacity, and the team's ability to learn quickly and adapt to external dynamics. Green startups that

are able to foster a culture of collaboration and continuous learning will have a greater chance of success in a highly dynamic, competitive, and challenging business environment such as the current energy transition era. Considering all the findings from the 15 analyzed scientific articles, it can be concluded that business model innovation is not only a tool for survival in a competitive market but also a main strategy in driving the transformation of energy systems towards a more sustainable and inclusive direction. The strategic role of green startups in this context is highly dependent on their ability to continuously experiment, innovate, and collaborate across sectors to create solutions that have a real impact on the future of global energy.

5. Discussion

The findings of this literature review clearly demonstrate that business model innovation is a crucial element in supporting and strengthening the strategic role of green startups in the global energy transition process. Green startups not only function as business entities that create new products and services in the energy sector, but they also perform a transformational function in changing how economic, social, and environmental value is created, delivered, and captured in a sustainable and low-emission energy system. In the context of climate change and pressure on conventional energy systems, business models are no longer just ordinary economic instruments, but have become strategic tools to generate real positive impacts on the environment and wider society.

One important and highly relevant implication of this study's results is the importance of a close and integrated integration between innovative technology and sustainability principles in the overall design of business models adopted by green startups (Juntunen et al., 2019). Successful and competitive green startups are those that are able to combine high-tech approaches such as digitalization, AI, IoT, or blockchain with environmental sustainability principles and social values. This integration can create dual value, namely on one hand increasing operational efficiency and on the other hand strengthening social legitimacy and attractiveness in the eyes of stakeholders. However, to achieve this integration, a deep understanding of various aspects is needed, ranging from the structure of the energy system, consumer and industry market behavior, to the dynamics of energy regulations and policies that continue to evolve dynamically.

This discussion also emphasizes the importance of a collaborative approach in business model innovation strategies. Strategic partnerships with various parties such as government, investors, green financial institutions, and consumers can help startups reduce business risks, overcome resource limitations, and expand market reach more efficiently. This collaborative approach is in line with the concept of triple helix innovation, which is a model of cooperation between the public, private, and academic sectors to create more impactful and widely sustainable systemic innovation (Galvao et al., 2019). Nevertheless, significant challenges still loom over green startups, especially related to business scale and long-term sustainability. Many startups have a big vision in the field of sustainable energy but are still constrained by limited access to financing, markets, or supporting policies. Therefore, the

designed business models must accommodate flexible growth strategies, including diversification of revenue sources and continuous adaptation to changes in energy and climate policies.

On the other hand, there is also strong external pressure on green startups to be able to demonstrate concrete and measurable sustainability impacts. For this, transparent and credible evaluation models, reporting, and verification systems are needed. Technologies such as blockchain have the potential to be a solution to increase transparency, accountability, and impact tracking in the green energy supply chain and other sustainable products. Considering all aspects outlined above, it can be concluded that business model innovation is not a linear or one-time process. Instead, this innovation is an evolutive, dynamic, and continuous process that requires continuous iteration based on market feedback, new technological developments, and changing regulatory pressures (Lianto et al., 2018). The ability of green startups to continuously learn, adapt quickly, and respond to external dynamics is a key determining factor in their success amidst the complex challenges of the energy transition era.

6. Conclusion

This literature study confirms that business model innovation is a fundamental and crucial foundation for green startups to survive, grow, and create real impact in the increasingly complex and competitive era of energy transition. By combining sustainability principles, the application of innovative clean technology, and a cross-sector collaborative approach, green startups have the capacity to present

business solutions that are not only financially profitable but also provide long-term and sustainable social and environmental impacts. The global energy transition today demands a paradigm shift in running businesses, from previously relying on natural resource exploitation to an approach that emphasizes efficiency, circularity, and co-creation of value throughout the supply chain.

Business model innovation provides strategic space for green startups to leverage the momentum of policy changes, shifts in consumer behavior, and technological acceleration as new growth opportunities. Although many challenges are faced, such as market uncertainty, limited financing, and regulatory unpredictability, startups can overcome them by building a resilient, responsive, and data-driven business ecosystem. This research also makes a significant conceptual contribution to stakeholders in the public and private sectors in designing more effective support for the development of green startups. In the future, more in-depth empirical studies are needed to explore best practices in business model innovation and its contribution to achieving global sustainable development targets.

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