
SUSTAINABLE BUSINESS MODELS IN THE GREEN ENERGY SECTOR: CREATING GREEN JOBS THROUGH RENEWABLE ENERGY TECHNOLOGY INNOVATION

Benediktus Rolando^{1*}, Alberta Ingriana²

^{1,2}Department of Management, Faculty of Business Management, Universitas Dinamika Bangsa, Jambi, Indonesia

E-mail: ^{1*}benediktus@unama.ac.id, ²alberta.ingriana@unama.ac.id

Abstract

The transition to a low-carbon economy presents significant opportunities for creating sustainable business models that generate environmental benefits while simultaneously creating new employment opportunities. This research examines how innovation in renewable energy technologies—specifically solar, wind, and biomass—drives the development of green jobs and supports sustainable business practices. Through a systematic literature review of 50 high-impact studies published between 2020-2024, we analyze how renewable energy adoption creates value across economic, environmental, and social dimensions. Our findings demonstrate that technology innovation in the green energy sector not only reduces environmental impacts but also stimulates job creation across multiple segments of the value chain, from research and development to installation and maintenance. The study identifies critical barriers to implementation, including high initial investment costs, infrastructure limitations, and workforce skill gaps. We further explore how strategic collaboration between public and private sectors can accelerate renewable energy adoption through targeted policies, financial incentives, and workforce development programs. These findings provide valuable insights for policymakers, business leaders, and researchers seeking to maximize both employment and environmental benefits during the energy transition. The study contributes to the growing body of knowledge on how sustainable business models can align profit motivation with positive societal impact through the creation of green jobs.

Keywords: *Sustainable Business Model, Green Energy, Green Jobs, Renewable Energy Technology, Innovation, Sustainable Economy, Energy Transition*

1, INTRODUCTION

The green energy sector has emerged as a key pillar in *global* efforts to address the challenges of climate change and dependence on fossil energy. With increasing awareness of the importance of sustainability, the transition to renewable energy is now an urgent need in many countries. This transition not only focuses on reducing environmental impacts but also creates new opportunities in the economic sphere. One of the significant opportunities is the creation of *green jobs* through the application of renewable energy technology innovations.

Technologies such as solar, wind, and biomass have the potential to not only provide cleaner energy sources but also create jobs that support a sustainable economy. Several studies show that the switch to renewable energy not only reduces greenhouse gas emissions but also facilitates new economic growth by creating sustainability-focused jobs. Therefore, it is important to examine more

deeply how this green energy sector can be used as a business model that is not only economically profitable, but also environmentally and socially friendly(Simbolon & Simbolon, 2024;Rafi, 2022)

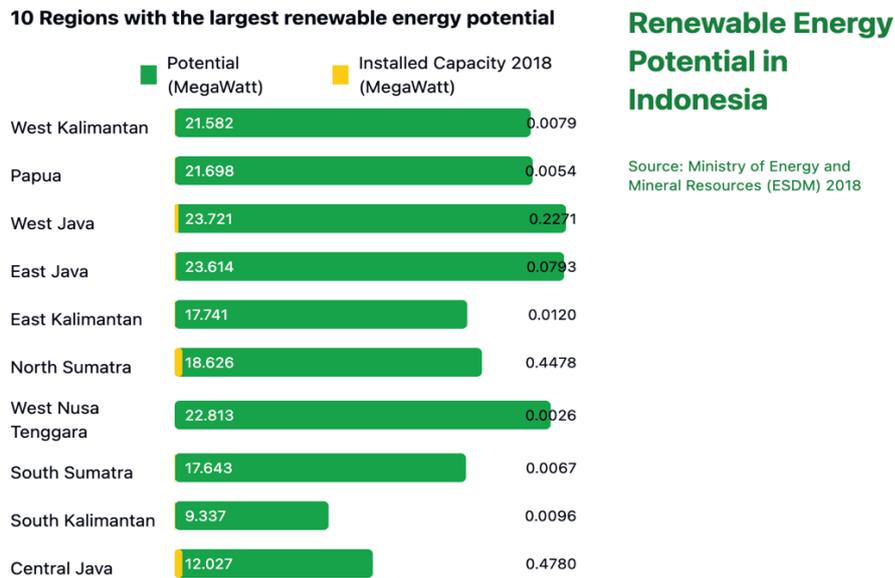


Figure 1 Data on the distribution of renewable energy potential in Indonesia

The green energy sector in Indonesia faces unique challenges and opportunities. With abundant natural resources, Indonesia has great potential to develop renewable energy, such as solar, wind, and biogas energy. Rumbayan (2020) emphasized the importance of biogas technology as a renewable energy solution that can be implemented in rural communities, providing better and sustainable energy access. In addition, Huda pointed out that fiscal incentives from the government can play an important role in funding research and development in the renewable energy sector, which in turn can accelerate innovation and the application of new technologies(Rumbayan, 2020;Huda, 2020).

Technological innovation is the key to creating a sustainable business model. Research by Belva & Raspati, (2024) shows that the development of renewable energy technologies in cities, such as in the context of the *Smart City* program, can support sustainable development goals by creating an inclusive and safe environment (Belva & Raspati, 2024). In addition, training and public education on renewable energy technologies, such as those carried out by Kastawan et al., (2024) and Anugrah, et al., (2022) show that increasing people's knowledge and skills is essential to support this energy transition. Thus, education and training are integral to creating sustainable green jobs.

The importance of collaboration between the public and private sectors cannot be ignored either. Simbolon & Simbolon (2024) emphasized that the success of the energy transition in Indonesia requires synergy between government policies and sustainable business initiatives, where social and environmental considerations are important factors in decision-making, adding that the use of various renewable energy sources can strengthen the business environment and reduce resource scarcity in the global market. Therefore, a sustainable business model must consider social, economic, and environmental aspects holistically.

In this context, the development of renewable energy not only serves as an alternative to meet energy needs, but also as a driver of inclusive economic growth. Research by Sumarni et al. shows that innovations in education and training can improve the capabilities of the workforce, which in turn supports the creation of new jobs in the green energy sector This is in line with findings by Indravati et al. which show that the application of renewable energy-based technologies in the agriculture and livestock sectors can increase efficiency and productivity, and create new job opportunities (Sumarni et al., 2020;Indrawati et al., 2021)

With all these aspects in mind, it is clear that the sustainable business model in the green energy sector depends not only on technology, but also on human capacity building and cross-sector collaboration. This research aims to provide deeper insights into how technological innovation can drive green job creation, as well as how policies and best practices can be implemented to support this transition. Thus, it is hoped that the results of this research can make a significant contribution to the development of sustainable energy policies in Indonesia and around the world.

Problem Formulation:

1. How can a sustainable business model in the green energy sector create green jobs?
2. How can renewable energy technology support the development of environmentally friendly sustainable business models?
3. What are the challenges and opportunities that exist in the application of renewable energy technology to create green jobs?

Research Objectives:

1. To answer how a sustainable business model in the green energy sector can create green jobs.
2. To answer how renewable energy technology can support the development of sustainable business models that are environmentally friendly.
3. To identify challenges and opportunities in the application of renewable energy technology to create green jobs.

2. METHODOLOGY

This research employs a systematic literature review (SLR) approach to comprehensively analyze sustainable business models in the green energy sector and their role in creating green jobs through renewable energy technology innovation. The SLR methodology was chosen as it provides a structured, transparent, and reproducible process for identifying, evaluating, and synthesizing relevant research evidence.

2.1 Search Strategy and Selection Criteria

The literature search was conducted using the Publish or Perish application, which primarily indexes Google Scholar along with other academic databases. This tool was selected for its comprehensive coverage and ability to analyze citation metrics. The search terms included combinations of keywords such as "sustainable business model," "green energy," "renewable energy technology," "green jobs," "innovation," "sustainable economy," and "energy transition."

Initial searches through Google Scholar via the Publish or Perish application yielded 60 relevant journals, which were subsequently filtered down to 50 based on relevance to our research objectives. The selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and

Meta-Analyses) framework, as illustrated in Figure 2.0. Studies published in peer-reviewed journals between 2020-2024 were prioritized to ensure relevance to current market conditions. The focus was on articles addressing sustainable business models, green energy sector, or renewable energy technologies with particular attention to those discussing job creation, economic impacts, or sustainability dimensions. Only studies available in full text and in English or Indonesian language were included. Studies focusing solely on technical aspects of renewable energy without business model implications or those not addressing sustainability, economic, or social dimensions were excluded from the analysis.

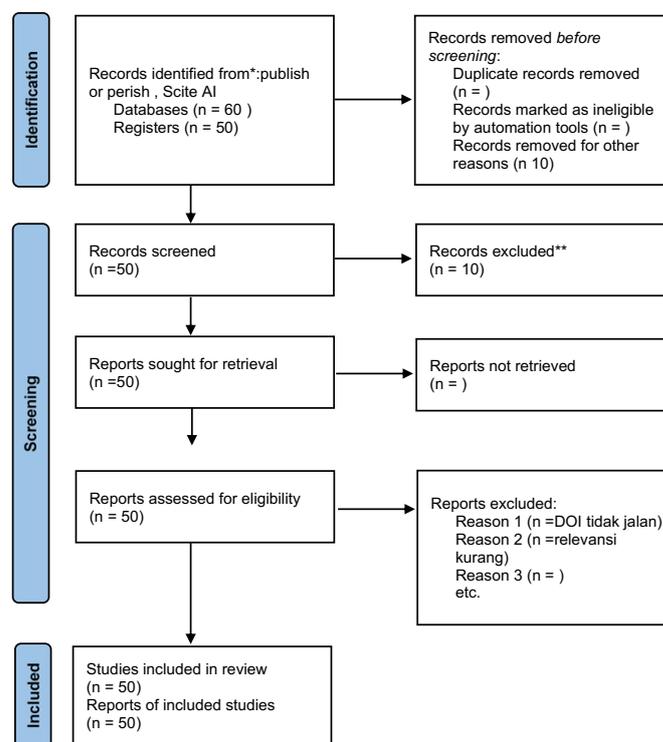


Figure 2. PRISMA Table

2.2 Data Extraction and Analysis

Data extraction concentrated on identifying sustainable business models in the green energy sector, the relationship between renewable energy technology and green job creation, challenges and opportunities in implementing renewable energy technologies, economic, social, and environmental impacts of renewable energy adoption, and policy recommendations and best practices. The analysis followed a qualitative synthesis approach, with thematic analysis used to identify patterns and relationships across studies. Table 1.0 presents the most cited journals in our dataset, which provided foundational insights for our analysis. The quality of selected studies was evaluated based on methodological rigor, relevance to research questions, citation impact, and contribution to theoretical and practical knowledge. The Google Scholar citation metrics extracted through Publish or Perish

allowed us to identify the most influential works in the field, such as Dell'Anna et al. (2021) with 106 citations and Izam et al. (2022) with 59 citations, which received particular attention in our analysis due to their significant impact.

TOTAL CITED	JOURNAL NAME	RESEARCHERS	JOURNAL YEAR
106	<i>Green jobs and energy efficiency as strategies for economic growth and the reduction of environmental impacts</i>	Dell'Anna et al.	2021
59	<i>Sustainable Development Perspectives of Solar Energy Technologies with Focus on Solar Photovoltaic—A Review</i>	Izam et al.	2022
33	<i>How does renewable energy technology innovation affect manufacturing carbon intensity in China?</i>	Xin et al.	2022
9	<i>Comparison of Knowledge Management Implementations in Various Industries</i>	Sagala et al.	2020
8	<i>The Employment Impact of a Green Fiscal Push: Evidence from the American Recovery and Reinvestment Act</i>	Poop et al.	2022

Table 1. The Most Citations from Journals Obtained by Cites Authors Title Year

2.3 Supplementary Analysis and Limitations

While our primary methodology is a systematic literature review, we also examined secondary data from annual reports and sustainability reports from companies in the renewable energy sector. This supplementary analysis provided practical insights into how technological innovations influence environmental and economic performance in real-world contexts. The integration of theoretical frameworks from the literature with practical examples from industry reports allowed for a more comprehensive understanding of sustainable business models in the green energy sector and their contribution to green job creation. Limitations of this methodology include potential publication bias toward positive outcomes, limited access to proprietary industry data, geographic concentration of studies in certain regions, and variability in how "green jobs" are defined across studies. Despite these limitations, the systematic literature review using Google Scholar through the Publish or Perish application provides a robust foundation for understanding the relationship between sustainable business models, renewable energy technology, and green job creation.

Through this methodological approach, the research aims to address the specified research objectives and contribute valuable insights to both academic literature and practical policy formulation in the renewable energy sector. The comprehensive nature of Google Scholar, coupled with the analytical capabilities of the Publish or Perish application, enabled us to capture a broad spectrum of relevant literature while maintaining focus on high-quality, impactful research contributions to the field.

3. RESULTS AND DISCUSSION

As is known, the green energy sector and renewable technology innovation have a significant impact on sustainable development, including the creation of green jobs. The transition to renewable energy not only reduces dependence on fossil energy sources but also opens new opportunities in a more environmentally friendly and sustainable world of work. This section will present the results of the research that has been conducted, focusing on how sustainable business models in the green energy sector can create green jobs. In addition, the discussion will include the important role of renewable energy technology in supporting the achievement of these goals. To provide a deeper understanding, the discussion will be divided into several sub-sections detailed below. Each sub-section will outline various related aspects, such as the impact of technology on the energy sector, the challenges faced, and the opportunities that can be leveraged in efforts to create sustainable jobs.

3.1 Sustainable Business Model and Green Jobs

Sustainable business models in the green energy sector have significant potential to create green jobs, which are jobs that contribute positively to the environment and are sustainable. In this context, it is important to understand how this business model operates and its impact on job creation. Sustainable business models focus not only on financial gains, but also on social and environmental impacts, which are key in creating environmentally friendly jobs (Aurel, 2023; Hutahuruk et al., 2023).

One of the ways in which sustainable business models can create green jobs is through the application of green technology and innovation (Mulyono & Rolando, 2025; Rolando, 2025b; Rolando & Mulyono, 2025). Green technologies, such as renewable energy and energy efficiency, require skilled labor for development, installation, and maintenance. According to research, the adoption of the circular economy and innovation in business models can increase the contribution of the MSME sector to the achievement of the Sustainable Development Goals (SDGs). Thus, the MSME sector that implements a sustainable business model can create new job opportunities that focus on environmental sustainability (Alfarizi, 2023; Poerwanto et al., 2021).

In addition, the importance of collaboration between various stakeholders, including government, the private sector, and society, cannot be ignored. This collaboration can strengthen green initiatives and create an ecosystem that supports green job growth (Mulyono, 2024; Rolando, 2025c, 2025f, 2025d, 2025a). Research shows that the involvement of various parties in creating sustainable business models can improve business performance and its social impact; With support from various parties, companies can more easily implement sustainable practices which in turn will create more jobs (Hutahuruk et al., 2023; Vinata Wisnu Saputra et al., 2023).

The application of green business practices can also increase the competitiveness of companies. In this context, companies that implement sustainable practices will not only benefit from reduced operational costs through energy efficiency but can also attract consumers who are increasingly concerned about environmental issues. Research shows that companies that integrate sustainability into their business strategies tend to perform better and can create more jobs; This

shows that sustainability is not only a social responsibility, but also a smart business strategy (Fachrozi et al., 2024; Mattunruang & Asmirawati, 2023).

Furthermore, education and training in the field of green skills are becoming very important to support the transition to a green economy. With the increasing demand for skilled labor in green technology, green-skills-focused education can help create a workforce that is ready to meet market needs. Research shows that training to boost the spirit of green entrepreneurship among the younger generation can be an important step in creating green jobs; Thus, proper education and training can accelerate the transition to a green economy and create new job opportunities. (Etni Marlina et al., 2021; Erwinsyah, 2021)

In a broader context, the implementation of sustainable business models in the green energy sector can also contribute to the reduction of greenhouse gas emissions and negative impacts on the environment. By shifting the focus from conventional business practices that damage the environment to more sustainable practices, companies can contribute to the achievement of *global* goals to address climate change. Research shows that business models that focus on sustainability can help reduce environmental impact and create better jobs. Therefore, it is important for companies to consider the sustainability aspect in every business decision taken (Fathihani et al., 2024).

Overall, sustainable business models in the green energy sector have great potential to create green jobs. Through the application of green technologies, collaboration between stakeholders, increased corporate competitiveness, green skills education and training, as well as contributions to emission reduction, the sector can be a key driver in sustainable and environmentally friendly job creation. As such, it is important for all parties to support and invest in sustainable business models to achieve these goals.

3.2 The Role of Renewable Energy Technology

Renewable energy technologies play a crucial role in supporting the development of environmentally friendly sustainable business models. In this context, renewable energy technologies not only serve as an alternative energy source, but also as a driver of innovation in sustainable business practices. With increasing awareness of environmental issues, companies around the world are starting to adopt more sustainable business models, which integrate sustainability principles into their strategies. This is in line with the view that sustainable business models (SBM) must be able to generate long-term profits while still taking into account the social and environmental impacts of their operations; (Aurel, 2023; Royandi et al., 2023; Sari et al., 2023)

One of the ways in which renewable energy technologies support sustainable business models is through reduced operational costs. The use of renewable energy sources such as solar, wind, and biomass can reduce reliance on expensive and non-renewable fossil fuels. For example, companies that adopt solar panels to meet their energy needs can significantly reduce electricity costs, which in turn increases their profitability. In addition, by switching to renewable energy, companies can also reduce their carbon footprint, which is becoming increasingly important in the context of strict environmental regulations and increasing consumer demand for environmentally friendly products; (Alfarizi, 2023; Nathaniela et al., 2022; Poerwanto et al., 2021)

Innovation in sustainable business models is also often fueled by advances in renewable energy technology. For example, the application of smart grid technology allows companies to manage their energy consumption more efficiently, make optimal use of renewable energy, and reduce energy waste. This creates opportunities for companies to develop new products and services that are more sustainable, as well as increase their competitiveness in the market; Thus, renewable energy technology serves not only as a source of energy, but also as a catalyst for innovation in more sustainable business models (Midisen et al., 2024; Wahyu & Pinardi, 2022; Sovei, 2020)

Furthermore, the integration of renewable energy technologies in sustainable business models can strengthen the relationship between companies and their stakeholders. Companies that commit

to using renewable energy often get support from environmentally conscious consumers, as well as from governments that provide incentives for sustainable business practices. This creates a mutually beneficial ecosystem, where companies can improve their reputation and attract more customers, while consumers get more environmentally friendly products. In this context, sustainable business models focus not only on financial gains, but also on the creation of greater social and environmental value. (Alfarizi, 2023; Jonathan & Nuringsih, 2022)

The implementation of the circular economy is also one of the important aspects in the development of sustainable business models supported by renewable energy technology. The circular economy focuses on waste reduction and resource reuse, which is in line with sustainability principles. By adopting renewable energy technologies, companies can reduce energy waste and utilize resources more efficiently, which in turn supports the goals of the circular economy; For example, companies that use recycling technology to turn waste into energy can create more sustainable production cycles and reduce negative impacts on the environment. (Alfarizi, 2023; Sari et al., 2023; Kusmaningtyas & Nugroho, 2022)

In the context of MSMEs, the application of renewable energy technology can also increase business competitiveness and sustainability. Many MSMEs operating in energy-intensive sectors can reduce their operational costs by switching to renewable energy sources. In addition, by adopting more sustainable business practices, MSMEs can attract the attention of consumers who are increasingly concerned about environmental issues, thereby increasing their market share; Therefore, support for MSMEs in adopting renewable energy technology is very important in creating a sustainable business ecosystem. (Alfarizi, 2023; Azhar & Evanthi, 2024; Yulianto et al., 2024)

However, challenges in adopting renewable energy technologies remain, especially in terms of the initial costs and lack of knowledge about the technology. Therefore, it is important for the government and relevant institutions to provide support through policies and incentives that encourage the adoption of renewable energy technology among companies, especially MSMEs. Training and mentoring programs can also help companies understand the benefits and how to implement renewable energy technologies in their business models; Thus, this support can accelerate the transition to a more sustainable and environmentally friendly business model. (Mutamimah et al., 2022; Sabilla & Tiara, 2024; Sagala et al., 2020)

Overall, renewable energy technology has great potential to support the development of environmentally friendly sustainable business models. Through reduced operational costs, innovation in products and services, and improved relationships with stakeholders, these technologies can help companies achieve their sustainability goals. In addition, by integrating circular economy principles and providing support to MSMEs, we can create a more sustainable and highly competitive business ecosystem in the future. Therefore, it is important to continue to explore and develop renewable energy technologies as part of a sustainable business strategy.

3.3 CHALLENGES AND OPPORTUNITIES IN GREENJOBS

The application of renewable energy technology in creating *green jobs* faces various significant challenges and opportunities. The main challenge faced is the high start-up costs for investments in renewable energy technologies, such as solar panels, wind turbines, and biogas systems. Although the cost of capital for these technologies has decreased along with technological advancements, there are still significant barriers in terms of accessibility and public acceptance of these new technologies (Rolando, 2025e; Rolando & Mulyono, 2024a, 2024b) In Indonesia, for example, the cost of installing renewable technologies is still a major inhibiting factor in the deployment of renewable energy, although electricity demand is projected to grow by an average of 8.3% per year. (Yana et al., 2022).

On the other hand, the opportunity to create *green jobs* is huge, especially in the renewable energy sector. The growth of this sector is driven by increasing public awareness of the importance of environmental sustainability and reducing carbon emissions. With increasing investment in renewable energy technologies, such as solar, wind, and biomass energy, there is great potential to create new jobs focused on sustainability; For example, research shows that the renewable energy sector can create significant jobs, especially in rural areas that have limited access to conventional energy sources.(Riswano & Acep Rachmat, 2023;Dell'Anna, 2021)

Another challenge is the lack of suitable skills among today's workforces. Many jobs related to renewable energy require specific technical skills, and there are skills gaps that need to be addressed in order for the workforce to adapt to the needs of the new industry; Therefore, proper training and education are essential to prepare the workforce to enter the sector. Training programs focused on renewable energy technologies can help reduce these skills gaps and prepare individuals for jobs in this growing sector (Popp et al., 2022;Wang, 2024)

In addition, government policies also play an important role in creating opportunities for *green jobs*. Policies that support renewable energy, such as tax incentives and regulations that promote the use of clean energy, can encourage investment and create jobs. For example, in the United States, economic recovery programs focused on clean energy have proven successful in creating new jobs in the sector. Policies that support the development of renewable energy infrastructure can also help create jobs in various sectors, including construction and maintenance (Popp et al., 2022;Woods et al., 2023).

Another opportunity that arises from the application of renewable energy technologies is the potential to create jobs in related sectors, such as sustainable transportation and green development. These sectors not only create new jobs but also contribute to the reduction of carbon emissions and the improvement of environmental quality. For example, the development of environmentally friendly transportation infrastructure can create jobs in various fields, from construction to maintenance and operations.

The renewable energy sector also has the potential to increase energy security and reduce dependence on fossil fuels. By leveraging local resources, such as solar and wind energy, countries can reduce their dependence on energy imports and improve national energy security. This not only creates new jobs but also contributes to long-term economic stability (Dell'Anna, 2021). However, the challenges in the application of renewable energy technology cannot be ignored. One of the biggest challenges is the resistance from established industries, such as the fossil fuel industry, which may see the transition to renewable energy as a threat to the sustainability of their businesses. Therefore, it is important to involve all stakeholders in this transition process, including government, industry, and civil society, to ensure that this transition is done in a fair and sustainable manner.

In the *global* context, climate change and increasingly stringent environmental policies are also encouraging countries to invest in renewable energy technologies and create *green jobs*. Countries in the European Union, for example, have adopted policies that support the development of renewable energy as part of their strategies to address climate change. This shows that there is a growing *global* awareness of the importance of shifting to a more sustainable and environmentally friendly economy. Overall, the application of renewable energy technology to create *green jobs* offers significant challenges and opportunities. While there are barriers to overcome, such as start-up costs and skills gaps, the potential to create new jobs and improve environmental sustainability is enormous. With the right policy support and investment in education and training, the renewable energy sector can be a key driver for sustainable economic growth and future job creation.

4. CONCLUSION

This study demonstrates that sustainable business models in the green energy sector serve as powerful catalysts for green job creation while advancing environmental sustainability goals. The research findings reveal that renewable energy technology innovations are not merely alternative energy solutions, but transformative forces that reshape economic landscapes by generating employment opportunities across multiple sectors. Solar, wind, and biomass energy technologies create diverse job prospects throughout their value chains—from research and development to manufacturing, installation, maintenance, and system management. These technologies simultaneously address pressing environmental challenges while fostering sustainable economic growth.

The implementation of renewable energy technologies underpins environmentally responsible business models by reducing fossil fuel dependence, decreasing harmful emissions, and improving overall energy efficiency. Our analysis confirms that the green energy sector possesses significant potential to drive cleaner, more sustainable economic development. However, several key challenges persist in the widespread adoption of renewable energy technologies and subsequent green job creation. These barriers include substantial initial investment requirements, infrastructure limitations, and gaps in workforce skills and technical knowledge necessary to support the evolving renewable energy landscape.

Workforce development emerges as a critical factor in maximizing the employment potential of the green energy sector. Targeted training programs and education initiatives are essential to equip workers with specialized skills required to support technological advancements in renewable energy. Without adequate investment in human capital development, the full job creation potential of the sector cannot be realized. Conversely, substantial opportunities exist for job creation across diverse sectors including manufacturing, installation, research, and energy management. With strategic policy support and targeted investments, the green energy sector can function as a powerful economic driver while advancing environmental objectives.

The research further indicates that effective implementation of sustainable business models leveraging renewable energy technologies delivers a triple benefit: creating meaningful employment opportunities, reducing environmental impacts, and supporting broader economic sustainability. While challenges exist, they can be addressed through coordinated policy interventions, infrastructure investments, and comprehensive workforce development programs. The potential for green job creation is particularly significant in regions with abundant renewable resources and limited access to conventional energy, suggesting important implications for regional development strategies.

In conclusion, the transition toward renewable energy represents not only an environmental imperative but also an economic opportunity. By embracing sustainable business models powered by renewable energy innovations, societies can simultaneously address climate challenges, create quality employment, and build more resilient economic systems. Future research should focus on quantifying employment impacts across different renewable technologies, developing standardized frameworks for measuring green job creation, and designing policy interventions that maximize both environmental and employment benefits in the expanding green energy sector.

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