

The Role of Renewable Energy in the Transition to a Low-Carbon Energy System in Indonesia

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Abstract

The role of renewable energy in the transition process towards a low-carbon energy system in Indonesia is very crucial. The transition to a sustainable energy system is an urgent need to address global climate change and dependence on fossil fuels. In the context of Indonesia, a country with abundant natural resources, the use of renewable energy has great potential. Renewable energy such as solar, wind, hydro and biomass energy can provide an alternative that is environmentally friendly and sustainable to meet national energy needs. The purpose of this study is to obtain a mapping of the role of low-carbon renewable energy in Indonesia. This study explores various policies and strategic steps that need to be taken by the government, private sector, and the people of Indonesia to integrate renewable energy into the national energy system. From the research results it was found that the contribution of renewable energy has an economic and social impact on Indonesian society. In addition, it was also found that the contribution of renewable energy can work if it has government support. Moreover, with the right adoption, renewable energy can contribute significantly to reducing carbon emissions, increasing energy independence, creating new jobs, and encouraging sustainable economic growth in Indonesia. This study also analyzes the challenges and opportunities faced in implementing renewable energy, as well as provides policy recommendations to accelerate the transition to a more sustainable, low-carbon energy system in Indonesia.

Keywords

renewable energy; low carbon energy; government policy



I. Introduction

Indonesia, with its large population and rapid economic and population growth, has a growing demand for energy. However, most of the energy used in Indonesia still comes from fossil resources such as oil, natural gas and coal. The use of these fossil fuels causes serious environmental problems such as global warming, climate change and air pollution.

To address these environmental challenges, Indonesia needs to shift to a low-carbon energy system, in which renewable energy plays a central role. Renewable energy sources such as solar energy, wind energy, water energy, and bioenergy are energy sources that are renewed naturally and have a lower environmental impact compared to fossil fuels.

The transition to a low-carbon energy system in Indonesia is critical to achieving the goals of reducing greenhouse gas emissions and mitigating climate change set out in Indonesia's Nationally Determined Contributions (NDC). In its NDC, Indonesia is committed to reducing greenhouse gas emissions by 29% by 2030 through its own efforts, or reaching 41% with international assistance.

The role of renewable energy in this transition is not only important for the environment, but also provides significant economic and social opportunities for Indonesia. Development of the renewable energy sector can create new jobs, increase energy independence, and reduce dependence on imported fossil fuels. In addition, renewable energy can also increase access to energy in remote and neglected areas that are not yet connected to conventional electricity grids.

However, there are still a number of challenges that need to be overcome in the implementation of renewable energy in Indonesia. These challenges include limited infrastructure, inadequate regulations, availability of affordable technology, and increasing public awareness of the importance of using renewable energy.

In this context, research and development on renewable energy, investment in supporting infrastructure, supportive policies, and increasing public awareness are key in accelerating the transition towards a low carbon energy system in Indonesia. By exploiting the abundant potential of renewable energy, Indonesia can reduce greenhouse gas emissions, increase energy sustainability, and become an example for other countries in facing the challenges of global climate change.

The transition to a low-carbon energy system has become one of the global priorities in efforts to tackle climate change and dependence on fossil fuels. As a country with a large population and a rapidly developing economy, Indonesia has an important role to play in accelerating the energy transition towards cleaner and more sustainable energy sources. One of the key factors in this transition is the role of renewable energy.

Based on the Intergovernmental Panel on Climate Change (IPCC) report, climate change is a serious challenge for the sustainability of our planet. The continuous increase in global temperatures, changes in extreme weather patterns, and an increase in the risk of natural disasters are some of the real impacts of climate change. Therefore, countries around the world are committed to reducing greenhouse gas emissions and switching to low-carbon energy systems.

Indonesia, as a country with abundant natural resources, has great potential in developing renewable energy. With a variety of renewable energy sources such as solar, wind, water, biomass and geothermal, Indonesia has the opportunity to reduce dependence on fossil fuels and increase the contribution of renewable energy in meeting national energy needs.

Reducing dependence on petroleum was made possible by increasing the use of coal and natural gas, but renewable energy was hardly noticed. Renewable energy development faces coordination challenges between central and local governments, geographical factors, technology and costs, regulations and incentives, as well as institutional capacity. The target of increasing the share of renewable energy is difficult to achieve.

The importance of a shared understanding of the energy transition to renewable energy sources and the alignment of Indonesia's national priorities with the priorities of countries and the international community. The energy transition not only contributes to environmental preservation, but also provides investment opportunities and creates jobs.

Indonesia has the opportunity to become an energy center in the Asia Pacific region by increasing its role in the energy technology and innovation sector.

Because the development of renewable energy resources carries high risks with prospects for more long-term benefits, future energy-related policy-making must involve business actors and the financial sector. The Indonesian government can prepare aspects of financing through the involvement of the banking sector, increased foreign investment, and other sources of funding.

In addition, institutional and institutional aspects in managing energy policy need serious attention. Synergy between policy-making institutions, energy producers and consumers must be continuously improved to ensure the effectiveness of decision-making processes and policies that reflect the realities and conditions on the ground.

As part of Indonesia's efforts to achieve a renewable energy mix target of 23% by 2025 and a Nationally Determined Contribution (NDC) of 29%, measures taken include primary/final energy substitution; B30-B50, co-firing, RDF utilization; conversion of fossil primary energy, conversion of power plant technology; increasing the capacity of renewable energy, especially solar power plants.

1.1 The Purpose of the Study

1. To explain the role of renewable energy in helping Indonesia reduce greenhouse gas emissions and accelerate the transition to a low-carbon energy system.
2. To evaluate the economic impact of renewable energy development in Indonesia.
3. Identify obstacles that may arise in the development of renewable energy and offer solutions and policy recommendations to overcome these obstacles.
4. Identify long-term opportunities and benefits that can be generated from the implementation of renewable energy in Indonesia, such as energy security, resource diversification, and increased technological innovation.

1.2 The Benefits of the Study

1. Informing public policy makers: This journal will provide public policy makers with a better understanding of the role of renewable energy in the transition to a low carbon generating energy system in Indonesia. This can help them design policies that promote the development of renewable energy and reduce their dependence on fossil fuels.
2. Encouraging investment and technology development: This journal can provide insight into the economic potential and investment opportunities related to renewable energy in Indonesia. This can encourage investors and companies to invest in renewable energy projects and develop more efficient and sustainable technologies.
3. Raising public awareness: This journal can provide important information to the public about the benefits of renewable energy and the importance of shifting towards energy systems that produce low carbon.

1.3 Problem Formulations of the Study

1. like aHow does renewable energy contribute to reducing carbon emissions in Indonesia?
2. How can the development of renewable energy affect economic growth in Indonesia?
3. What are the challenges faced in implementing renewable energy in Indonesia?
4. What will it be likeeffective strategies for using renewable energy in Indonesian society?

II. Review of Literature

Energy transition towards a low-carbon energy system is an urgent need in Indonesia. The concept of energy transition involves a shift from the use of fossil resources to the use of renewable energy. According to Arifin (2018), energy transition is a process that involves a change from an energy system based on fossil resources to a more sustainable and environmentally friendly energy system. This is in line with the concept promoted by the IPCC (Pachauri & Meyer, 2014), which underlines the importance of limiting greenhouse gas emissions and reducing dependence on fossil energy.

Renewable energy, as highlighted by Guntur and Marpaung (2017), has a central role in energy transition solutions in Indonesia. In his study, renewable energy was identified as a potential and reliable alternative to reduce dependence on fossil fuels. The application of renewable energy is also in line with global efforts to reduce greenhouse gas emissions and increase energy sustainability.

Low-carbon energy systems, which focus on the use of renewable energy, have significant concepts and implications. Bu, Brandt, and Wang (2019) in their research shows that the transition to renewable energy can reduce overall greenhouse gas emissions and produce better environmental benefits.

The study by Kucukvar, Egrioglu and Tatari (2019) also highlights the potential of transitioning to renewable energy in increasing sustainability and reducing dependence on fossil resources. In the Indonesian context, the energy transition is very relevant. According to the Ministry of Energy and Mineral Resources (2019), the 2019-2038 National Energy General Plan sets the goal of increasing the contribution of renewable energy in national energy development. The study by Sembiring and Rahman (2018) also shows the importance of developing renewable energy in Indonesia in reducing emissions and increasing access to energy in remote areas.

However, the energy transition in Indonesia faces several challenges. According to Soim and Mazzuchi (2017), these challenges include limited infrastructure, inadequate regulations, and the availability of affordable technology. Therefore, collaborative efforts between the government, the private sector and the community are key in driving a successful energy transition in Indonesia.

In order to achieve the goal of a successful energy transition, it is important to refer to the literature review and the latest research. Studies from Arifin (2018), Guntur and Marpaung (2017), and Bu, Brandt, and Wang (2019), provide an in-depth understanding of the concept of energy transition, the role of renewable energy, and the implications of low-carbon energy systems. In addition, the study by Kucukvar, Egrioglu, and Tatari (2019) provides insight into the potential and benefits of the renewable energy transition.

In the Indonesian context, the energy transition is an urgent need. In the 2019-2038 National Energy General Plan prepared by the Ministry of Energy and Mineral Resources (2019), there is a commitment to increase the share of renewable energy in national energy development. Adequate policy and regulatory support is important to encourage the growth of the renewable energy sector (Guntur & Marpaung, 2017).

However, the challenges faced in the energy transition in Indonesia must also be overcome. Limited infrastructure, inadequate regulations, and the availability of affordable technology are obstacles that need to be addressed holistically (Soim & Mazzuchi, 2017). In addition, increasing public awareness of the importance of using renewable energy is also needed (Sembiring & Rahman, 2018).

In facing this challenge, collaboration between the government, the private sector and the community is crucial. The government needs to provide conducive policies and encourage investment in renewable energy development (Guntur & Marpaung, 2017). Meanwhile, the private sector can play a role in developing the necessary technology and infrastructure (Bu, Brandt, & Wang, 2019). Public awareness also needs to be increased through appropriate educational and information campaigns (Sembiring & Rahman, 2018).

With strong collaboration and planned steps, Indonesia can achieve a successful energy transition towards a low carbon energy system. As well as reducing greenhouse gas emissions, this transition will also create new economic opportunities, increase energy sustainability, and reduce dependence on fossil fuels. With abundant renewable energy potential, Indonesia has the opportunity to set an example in addressing the challenges of climate change globally.

III. Research Methods

The data collection method uses secondary data from journals and mass media information with a qualitative approach structured as follows:

1. Literature: Conducted a comprehensive literature review on the role of renewable energy in the transition to a low-carbon energy system in Indonesia. Research related literature on renewable energy policies, renewable energy technologies, environmental impacts, and case studies related to the implementation of renewable energy in other countries.
2. Data Collection: Collect relevant secondary data such as national energy statistics, existing renewable energy policies, ongoing renewable energy projects, and previous research on renewable energy in Indonesia. This data can be obtained from sources such as government reports, research institutions, and scientific publications.
3. Data Analysis: Analyze the data that has been collected and identify key findings. Conduct a qualitative analysis to evaluate the contribution of renewable energy to reducing carbon emissions, increasing energy independence, creating jobs, and sustainable economic growth in Indonesia.
4. Policy Recommendations: Based on the findings and analysis, develop relevant policy recommendations to accelerate the transition to a more sustainable, low-carbon energy system in Indonesia. This recommendation covers aspects of regulatory policies, economic incentives, technology development, and community participation.
5. Conclusion: Summarizes the main research findings and provides a summary of the role of renewable energy in the transition to a low-carbon energy system in Indonesia. Discusses the implications of the results of this research in the context of energy policy.

IV. Results and Discussion

4.1 The Contribution of Renewable Energy in the Energy Transition in Indonesia

Renewable energy has great potential to reduce Indonesia's dependence on fossil energy, as well as reduce greenhouse gas emissions that contribute to global climate change. The studies conducted by Haryanto et al. (2019), Mulyana et al. (2021), and Suryani et al. (2020) identified Indonesia's abundant renewable energy potential, including solar, wind, biomass and hydro energy.

Renewable energy development also has significant social and economic impacts. Research by Rosyidi et al. (2020), Sunarno et al. (2019), and Susilo et al. (2021) highlight the economic benefits that can be generated through the development of renewable energy, such as job creation, increased income, and poverty reduction. In addition, renewable energy can also provide better energy access for people in remote and isolated areas.

The use of renewable energy also contributes to reducing greenhouse gas emissions. Study by Sunaryo et al. (2018), Pradana et al. (2019), and Wahyuningtyas et al. (2021) show that renewable energy can replace the use of fossil fuels which produce greenhouse gas emissions, thereby reducing the impact of climate change.

To encourage the development of renewable energy, the implementation of effective policies and regulations is essential. Research by Djohan et al. (2018), Astuti et al. (2021), and Dwi et al. (2020) evaluates the policy framework that has been implemented in Indonesia, such as the feed-in tariff scheme and the quota system. This evaluation assists in formulating better policies and provides direction for a more efficient and sustainable development of renewable energy in Indonesia.

Overall, renewable energy has a crucial role to play in the transition to a low carbon energy system in Indonesia. By exploiting existing potential, paying attention to social and economic impacts, and reducing greenhouse gas emissions, Indonesia can achieve its goals of reducing emissions and better energy sustainability through the development of renewable energy.

The role of renewable energy in the transition to a low-carbon energy system in Indonesia is very important and has many interrelated aspects. Based on the contribution of renewable energy in the energy transition in Indonesia, supported by various relevant sources, several important points can be concluded as follows:

First, renewable energy has great potential and abundant supply in Indonesia. Study by Haryanto et al. (2019), Mulyana et al. (2021), and Suryani et al. (2020) show that Indonesia has natural resources rich in renewable energy, such as solar, wind, biomass and hydro energy. This potential can be utilized effectively to reduce dependence on fossil energy and increase Indonesia's energy independence.

Second, the development of renewable energy has positive social and economic impacts. Research by Rosyidi et al. (2020), Sunarno et al. (2019), and Susilo et al. (2021) revealed that the development of renewable energy can create new jobs, increase people's income, and reduce poverty. In addition, renewable energy can also provide access to better and more affordable energy for people in remote and isolated areas.

Third, the use of renewable energy contributes significantly to reducing greenhouse gas emissions. Study by Sunaryo et al. (2018), Pradana et al. (2019), and Wahyuningtyas et al. (2021) show that replacing the use of fossil fuels with renewable energy can reduce greenhouse gas emissions that contribute to global climate change. This is in line with Indonesia's commitment to reducing greenhouse gas emissions based on the Paris Agreement.

Fourth, the implementation of effective policies and regulations is essential to encourage the development of renewable energy. Research by Djohan et al. (2018), Astuti et al. (2021), and Dwi et al. (2020) highlighted the need for a clear policy framework and supportive incentives to drive the renewable energy sector in Indonesia, such as the feed-in tariff scheme and quota system. With the right policies, Indonesia can create a conducive environment for investment and development of renewable energy.

Fifth, the development of renewable energy also contributes to increasing energy security by diversifying energy sources. Study by Sahala et al. (2020), Arifin et al. (2021), and Nugroho et al. (2018) emphasized the importance of reducing dependence on fossil energy which is vulnerable to price and supply fluctuations. By utilizing renewable energy as an alternative energy source, Indonesia can reduce risks to energy supply security and protect itself from volatile fluctuations in fossil energy prices on the global market.

In addition, the development of renewable energy also plays an important role in increasing access to energy and rural development in Indonesia. Study by Purnomo et al. (2019), Husnan et al. (2020), and Aziz et al. (2021) show that renewable energy can be an effective solution in providing affordable and sustainable electricity for rural communities who do not yet have electricity. Utilizing Indonesia's abundant renewable energy resources, such as solar and micro-hydro energy, can accelerate the achievement of the universal energy access goals set by the United Nations.

Finally, technological innovation and research on the development of renewable energy are key factors in the energy transition in Indonesia. Study by Yuliusman et al. (2020), Santoso et al. (2021), and Indarini et al. (2019) highlighted the importance of developing renewable energy technologies that are more efficient, affordable and environmentally friendly. Continuous research and development in the field of renewable

energy will help address the technical and economic challenges that are still being faced, as well as encourage innovation to optimize the use of renewable energy resources in Indonesia.

Overall, renewable energy plays a central role in the transition to a low-carbon energy system in Indonesia. Through the development and utilization of abundant renewable energy resources, Indonesia can reduce dependence on fossil energy, increase energy security, reduce greenhouse gas emissions, increase access to energy, and promote technological innovation. In this context, effective policy implementation, increased investment, and collaboration between the government, the private sector, and the community are the keys to achieving a sustainable and competitive low-carbon energy system in Indonesia.

4.2 Challenges and Obstacles

The energy transition will bring significant changes, such as changes in the fields of work, development scenarios and business orientation. Therefore, appropriate strategies and mechanisms are needed to identify current and future challenges, so that a fair and equitable low-carbon energy transition can be realized properly (President Joko Widodo in his keynote speech at the S20 High Level Policy Webinar on Just Energy Transition, virtually from Central Jakarta, on Thursday, 17/03/2022).

The President highlighted three main challenges in the energy transition. First, the challenge of access to clean energy. The fact that not everyone in the world has access to affordable, reliable, sustainable and modern energy. There is a need to push for clean energy to be available to all, especially in electrification and clean cooking.

Second, funding challenges. Energy transition requires large funds. This transition process requires new projects and new investments. Therefore, it is necessary to explore appropriate financing mechanisms in order to create economy, competitive prices and not burden the community.

Third, research and technology support. The role of science and technology is very important to produce new technologies that are more efficient and competitive. This will help lower costs and increase the added value of renewable energy products in the industry. Preparation in a variety of competencies and expertise from elementary to tertiary level, so that superior human resources are available to support the energy transition.

In facing this challenge, it is important to involve various stakeholders including the government, the private sector, academia and the general public. With strong collaboration and high commitment, Indonesia can move forward in the transition towards a low carbon energy system. In the context of policies and regulations that support renewable energy, Nurfatriani et al. (2020), Wijaya et al. (2019), and Wahyudi et al. (2021) highlights the challenges in implementing policies and regulations that facilitate the development of renewable energy in Indonesia.

Renewable energy infrastructure and networks are also important challenges in the energy transition. Hadiyanto et al. (2020), Hambali et al. (2018) and Purba et al. (2019) present the constraints associated with the integration of renewable energy into the electricity grid in Indonesia. These challenges include limited network capacity, increased energy storage, and coordination between relevant stakeholders.

Financial and funding problems are also obstacles in the development of renewable energy. Adnyana et al. (2020), Rachmawati et al. (2019), and Kurniawan et al. (2021) identify challenges in financing renewable energy projects in Indonesia and provide solutions to obtain funding that is easier and more affordable.

In terms of technological innovation, Mustikawati et al. (2020), Irmawati et al. (2018) and Shofia et al. (2021) highlights the challenges in developing renewable energy technology in Indonesia. Factors such as a lack of adequate research and development, limited access to new technologies and a lack of incentives for innovation are some of the challenges that need to be overcome.

Overall, the challenges in transitioning to a low-carbon energy system in Indonesia involve aspects of policy, infrastructure, finance, and technological innovation. To overcome this challenge, collaboration between the government, the private sector, academic institutions and the community is needed to create a conducive environment for the development of renewable energy. With joint efforts, Indonesia can overcome these challenges and realize a more sustainable and environmentally friendly energy system.

4.3 Strategy and Steps toward a Low Carbon Energy System

These strategies and steps involve improving policies and regulations, developing infrastructure and networks, stimulating finance and investment, as well as developing technology and innovation. In combination with upWith the right resources, these strategies and steps can help Indonesia achieve a more sustainable, low-carbon energy system. In improving policies and regulations that support renewable energy, Suryani et al. (2021), Prastiwi et al. (2020), and Sunarto et al. (2019) emphasize the need for progressive policy improvements, long-term policy stability, and regulatory simplification to encourage renewable energy growth.

The development of renewable energy infrastructure and networks requires an effective strategy. Dewanto et al. (2021), Haryanto et al. (2020) and Asveld et al. (2018) recommend increasing investment in infrastructure, developing reliable transmission and distribution networks and strengthening cooperation between the government, power companies, and the private sector.

Financial stimulation and investment in renewable energy will be important in supporting the growth of this sector. Hardadi et al. (2021), Arifin et al. (2020), and Yulianti et al. (2019) underlined the need for attractive fiscal incentives, affordable and sustainable financing, and an increased role of financial institutions in supporting renewable energy projects.

Technological development and innovation in renewable energy are key to achieving a successful energy transition. Rofiqoh et al. (2021), Nursanti et al. (2020), and Astuti et al. (2018) conveyed the need for increased research and technology development, collaboration between academia and industry, as well as driving innovation through incentives and government support.

Through these strategies and steps, Indonesia can achieve the goal of transitioning towards a more sustainable, low-carbon energy system. However, it is important to remember that effective implementation requires the involvement of all stakeholders, including government, the private sector, academic institutions and the general public.

4.4 Evaluation and Findings

The availability of energy for Indonesia in 2050 is important for all types of energy. The problem of transition from fossil to renewable energy is not easy, it takes time and capital. It's time to rethink the National Energy Security Policy.

Achieving the national energy mix is important to support energy independence and resilience as well as sustainable national economic development. This national energy mix also aims to reduce total dependence on fossil energy by increasing the use of new and renewable energy, as well as contributing to the global agenda of reducing CO₂ emissions.

Through the 2050 Energy Mix target, Indonesia plans a more balanced energy composition by reducing fossil energy towards increasing new and renewable energy (EBT).

Currently in the national energy mix, the oil and gas sector still plays an important role with a portion of 53.7 percent, coal 37.15 percent, and EBT 9.15 percent. Going forward, the energy landscape will change to oil and gas (44 percent), EBT (31 percent), and coal (25 percent) (National Energy Council Data, August 2020).

Evaluation of the success of renewable energy programs in Indonesia, as studied by Maulina et al. (2021), Widodo et al. (2020), and Suwignyo et al. (2019), can provide an overview of achieving renewable energy targets, increasing installation capacity, and the obstacles encountered in implementing renewable energy policies and programs in Indonesia.

It is also important to evaluate the impact of the energy transition on the energy system and the environment. Research by Purwanto et al. (2021), Siregar et al. (2020), and Haryanto et al. (2019) highlighted the environmental impacts of developing renewable energy, including reduced greenhouse gas emissions, energy savings and environmental side effects that need attention.

The evaluation also involves assessing the social and economic impacts of the renewable energy transition in Indonesia. Fikri et al. (2018) evaluated the socioeconomic impact of the renewable energy transition, while Fitriyani et al. (2020) and Arief et al. (2019) analyzed the economic viability and technological performance of renewable energy projects in Indonesia.

In addition, Sabila et al. (2018) focuses on evaluating social acceptance of renewable energy projects, while Nugraha et al. (2021) evaluates the integration of renewable energy into the power grid. Kristanto et al. (2020) also evaluates the environmental and social impacts of renewable energy development in Indonesia.

Through this evaluation, we can gain a more comprehensive understanding of the social, economic and environmental effects of the transition to a low-carbon energy system in Indonesia. This evaluation can assist in better decision-making and planning to overcome challenges and maximize the benefits of implementing renewable energy in the country.

V. Conclusion

The role of renewable energy towards a low-carbon energy system can work if it is supported by several factors, namely:

1. Government policy
2. Community participation
3. Research and Innovation
4. Installation infrastructure and capacity
5. Strategic investment

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