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Potential and Challenges of Renewable Energy Management: Socio-economic Perspective in Indonesia

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Abstract

Renewable energy in Indonesia has great potential to reduce dependence on fossil fuels and combat climate change. Despite abundant resources such as solar, wind, and biomass, regulatory, infrastructure, and investment challenges still hamper its development. This study uses a qualitative approach to explore the state of renewable energy and its socio-economic impacts. The results and analysis show that renewable energy development can increase energy access, create jobs, and reduce greenhouse gas emissions. Collaboration between the government, private sector, and communities is essential for a successful transition. Recommendations include improving policies, increasing investment, and public education to ensure more equitable and sustainable benefits from renewable energy in Indonesia.

Keywords: Renewable Energy, Socio-Economic, Policy

Introduction

Renewable energy in Indonesia has become a major focus in efforts to reduce the country's dependence on fossil fuels. With abundant natural resources, Indonesia has great potential to develop renewable energy such as solar, wind, and biomass. However, there are still several obstacles that need to be overcome to maximize the use of this renewable energy, including regulatory, infrastructure, and investment issues. In this context, it is important to understand more deeply about the condition of renewable energy in Indonesia in order to formulate effective strategic steps to overcome existing challenges. Increasing the use of renewable energy can also help reduce greenhouse gas emissions that contribute to global climate change. In addition, diversifying energy sources can also improve the country's energy security and create new jobs in the renewable energy sector. Although renewable energy technologies, such as solar and wind, are increasingly cost-competitive, high initial capital costs and long payback periods remain significant barriers. Social and cultural resistance also

pose challenges, especially in communities with strong ties to traditional energy sources. Policy inconsistencies and regulatory uncertainty further complicate the adoption of renewable energy technologies (Nwankwo & Dummene, 2024). Indonesia can fully realize its renewable energy potential; a cohesive policy framework that integrates economic incentives and political support is essential (Mudhoffar & Magriasti, 2024). The energy transition in Indonesia requires a combination of government, private sector, civil society, and international stakeholders. By collaborating across sectors, investing in renewable energy generation technologies, and implementing advanced policies, Indonesia is driving the transition to a more sustainable energy system and improving the welfare of society as a whole (Sistriatmaja et al., 2024).

Literature Review

The importance of socio-economic perspective in renewable energy management

One important aspect that needs to be considered in renewable energy management is the socio-economic perspective. By considering the social and economic impacts of renewable energy implementation, we can ensure that the transition to clean energy not only provides environmental benefits, but also benefits society at large. This includes the creation of new jobs, increasing energy access for the community, and empowering the local economy. By considering these socio-economic aspects, Indonesia can ensure that the renewable energy transition is inclusive and sustainable. From the creation of new jobs in the renewable energy sector, it will help reduce the unemployment rate in the community. In addition, increasing energy access for the community will also improve their quality of life and productivity. Empowering the local economy through renewable energy can also help reduce economic disparities between regions in Indonesia. Thus, involving socio-economic aspects in the implementation of renewable energy will ensure the sustainability of a more equitable and just energy transition. Despite progress in energy initiatives, many remote areas still need access to electricity.

Finally, government intervention plays a role in directing the transition to sustainable energy solutions. Private sector investment in renewable energy sources should be supported and directed through relatively strict policies, fiscal incentives, and regulations (Sistriatmaja et al., 2024). Incorporating a socio-economic perspective into renewable energy management improves decision-making by taking into account social acceptance and ecosystem service costs, leading to more informed inclusive strategies that balance energy yields with ecological and social efficiency, ultimately minimizing external costs associated with renewable energy infrastructure (Salak et al., 2024). The main limitation of renewable energy is its volatile nature, so there are economic and reliability issues associated with renewable energy systems. To overcome this, two or more sources are combined in one system so that they complement each other (Maisanam, AKS, Biswas, A., & Sharma, KK 2021).

Research Method

The research method used in this study uses a qualitative approach, Qualitative research allows for in-depth exploration of local needs and implementation challenges, informing policy makers about community concerns (Bokemeier & Yount, 2019). Qualitative research studies often use library research methods to collect data from various sources, such as books and journals, allowing researchers to reconstruct knowledge and understand phenomena holistically in natural settings, emphasizing descriptive and inductive analysis (Fadli, 2021).

Result

Potential for renewable energy development in Indonesia

The potential of renewable energy is very large and has not been fully utilized. One step that can be taken is to encourage investment and innovation in the renewable energy sector, as well as create policies that support the growth of the renewable energy industry. With support from the government and industry players, Indonesia can accelerate the development of renewable energy and reduce dependence on fossil fuels. In addition, the development of renewable energy can also help address increasingly pressing environmental and climate change issues. A review of environmental impacts found that studies on the application of renewable energy tend to focus on negative local impacts and ignore positive global benefits, such as climate change mitigation, implicitly. In addition, there are only a few studies on the environmental impacts of renewable energy in developing countries (Virah-Sawmy, D., & Sturmberg, B. 2025). Indonesia has significant renewable energy potential: solar (207.9 GW), wind (target 255 MW by 2025), hydro (75 GW), geothermal (23.7 GW), and biomass (32.6 GW). Current utilization remains low, requiring optimization for future energy needs.

Current utilization and future prospects of renewable energy in Indonesia

The development of renewable energy in Indonesia has shown great potential in providing environmentally friendly and sustainable energy sources. Although there are still some obstacles in its implementation, by continuing to encourage innovation and investment in this sector, Indonesia can become a regional leader in the development of the renewable energy industry. Collaborative efforts between the government, industry players, and the community are the main key in achieving Indonesia's vision as a country that is independent in meeting energy needs through renewable sources. In recent years, the Indonesian government has provided various incentives and policies that support the development of renewable energy, such as feed-in tariff programs and tax incentives. This has attracted the interest of investors to participate in developing renewable energy projects in various regions in Indonesia. With the support of all parties, Indonesia has great potential to be an example for other countries in utilizing renewable energy as a solution to address climate change and increasing energy needs. Indonesia's journey towards a zero-emission future is a complex and multi-faceted effort, driven by its commitment to sustainable energy practices and reducing its carbon footprint. In 2021, the Indonesian government revised and submitted its Nationally Determined Contribution (NDC), reinforcing its commitment to the Paris Agreement goal of achieving net

zero emissions by 2060 or earlier. As part of this effort, the government has set ambitious targets for the energy mix, targeting 23% new and renewable energy by 2025 and 31% by 2050 (Syabriyana, 2024).

Regulatory challenges in renewable energy management

Regulatory challenges in Indonesia remain a major obstacle to the development of this industry. Although there have been efforts to create supportive policies, there are still obstacles such as inconsistent policy changes, complicated bureaucracy, and lack of coordination between various related agencies. In addition, technical problems such as limited infrastructure availability and lack of skilled workers are also challenges that need to be overcome. However, with a strong commitment and good cooperation between the government, private sector, and community, Indonesia has great potential to overcome these challenges and become a leader in renewable energy management at the global level. Joint efforts are needed to overcome these obstacles so that Indonesia can truly utilize the potential of renewable energy optimally. Increasing investment in infrastructure development and training skilled workers are important steps in overcoming the technical problems faced. Hydroelectric power plants contribute the highest energy production in Indonesia, followed by bioenergy, solar energy, and wind energy. Furthermore, the trend of hydroelectric power and bioenergy production has been relatively stagnant for the past 11 years, and the highest significant increase was found in the solar energy sector. However, the amount of solar energy production is still far from the target set in the 2017 RUEN (National *Energy Master Plan*). The high cost of the solar energy sector is the main reason for the unsuccessful development of solar energy in Indonesia. In addition, several administrations and regulations are considered politically motivated, thus hampering the improvement of the energy transition. The Government of the Republic of Indonesia must be able to improve and form regulations in the form of provisions for tax relief and electricity export-import subsidies to spur the growth and development of renewable energy in Indonesia (Kurniawan et al., 2022).

Technological challenges in implementing renewable energy projects

Technological challenges are something that needs to be taken seriously. One of the obstacles that is often faced is the difficulty in adapting existing technology to Indonesia's diverse geographical and climatic conditions. In addition, problems related to infrastructure maintenance and care also need to be a primary concern so that renewable energy projects can run efficiently and sustainably. Cooperation between government, industry, and society is needed to create appropriate technological solutions that can be implemented well. Cooperation between government, industry, and society is very important to overcome current technological challenges. On the other hand, support in infrastructure maintenance and care will also ensure the sustainability of renewable energy projects in the future. Appropriate technological innovation will be the key to success in facing technological challenges in Indonesia. The shortage of skilled professionals in renewable energy technologies hampers project implementation and maintenance (Riaz & Perdhana, 2024).

Financial challenges and investment opportunities in the renewable energy sector

Financial challenges are something that needs to be taken seriously, considering that government investment is not only done in the energy sector. The government needs to provide sufficient incentives to attract investment in this sector, while the industry needs to collaborate with financial institutions to obtain sufficient financial support. In addition, the public also needs to be educated about the benefits of renewable energy and how they can participate in the development of these projects. With strong collaboration between the government, industry, and the community, Indonesia can become a leader in the implementation of renewable energy technologies in the future. Country-level barriers and, to a lesser extent, program- and project-level barriers are the most prominent. At the country level, dependence on fossil fuels, lack of support and uncertainty in policies and regulations, and weak links between planning and procurement appear to be the main barriers. At the program level, insufficient procurement volumes, unattractive pricing policies, non-transparent and inefficient processes, and ineffective procurement institutions undermine investment returns. At the project level, non-transparent land acquisition and licensing processes, imbalanced risk allocation in contracts, and project financing constraints are also mentioned (Halimatussadiah et al., 2024) . Behind the abundant potential of new and renewable energy in Indonesia, there are challenges ranging from licensing, spatial planning, regulation, financing, geographical challenges, and other factors. Second, to support the acceleration of the energy transition, it is necessary to reformulate the regulatory aspects and include them in the spatial plan to facilitate investment licensing (Nurahmani & Yuda, 2024).

Discussion

Socio-economic benefits of renewable energy development in Indonesia

The socio-economic benefits of renewable energy include increasing energy accessibility for the community, diversifying energy sources, and reducing greenhouse gas emissions. With the development of renewable energy, it is also expected to reduce dependence on fossil fuels that are not environmentally friendly. The development of renewable energy infrastructure can also provide opportunities for the development of local industries and improving the regional economy. In addition, the development of renewable energy can also create new jobs and improve the welfare of local communities. Therefore, the use of renewable energy is an important step in achieving sustainable development that is competitive and equitable for all parties. Renewable energy can improve the sustainability of the Indonesian economy. However, its use must be careful, considering environmental impacts and resolving related problems. Indonesia can gain significant economic and social benefits from the energy transition if proper regulations are followed, solid public-private sector cooperation is encouraged, and public education is carried out (Purnomo et al., 2024).

The impact of renewable energy projects on local communities

The impact of renewable energy projects on local communities is very important to consider in the planning and implementation of the project. Local communities can experience

direct benefits from renewable energy development, such as increased energy accessibility, improved air quality, and improved infrastructure. However, they can also experience negative impacts, such as environmental disturbances, increased land prices, and social conflict. Therefore, it is important for renewable energy project developers to communicate and collaborate with local communities to understand their needs and concerns, and find joint solutions to minimize negative impacts and maximize positive benefits of the project. By collaborating with local communities, renewable energy project developers can identify potential problems and find solutions that are acceptable to all parties. Thus, renewable energy projects can provide long-term benefits to local communities and the surrounding environment. In addition, efforts to minimize negative impacts and maximize positive benefits of renewable energy projects can also increase support and acceptance from local communities, so that projects can run smoothly and successfully. One example of the benefits of renewable energy for the community can be seen in the fishing community in Lam Awe, Aceh Besar. The community involvement approach is used to integrate renewable energy technology into the daily lives of fishing communities. The results show that the application of renewable energy can increase energy access, reduce operational costs, and support environmental sustainability in coastal areas . The use of solar energy can reduce operational costs and overcome the difficulties of fishermen in obtaining fuel which is often scarce, avoiding operational delays due to fuel shortages (Bachtiar et al., 2024). Also in Kasepuhan Ciptagelar is a traditional village that has successfully practiced a community-based renewable energy project to adapt to the renewable energy transition. Located isolated within the Gunung Halimun Salak National Park (TNHS), Kasepuhan Ciptagelar does not have access to the electricity grid but has abundant renewable energy resources such as water and sunlight. The residents of Ciptagelar village initiated the development of traditional micro-hydro power to gain access to electricity (Pratiwi et al., 2022). Community-owned micro-hydro power plants (PLTMH) are a cost-effective technology that harnesses the potential of river energy and generates electricity that can meet the demands of remote communities in developing countries. The feasibility of a PLTMH scheme depends on physical, social, environmental, and economic factors (Arnaiz et al., 2018).

The role of government policies and incentives in promoting socio-economic development through renewable energy

Government policies and incentives are important to consider in this development. Policies that support renewable energy development, such as tax incentives and subsidies, can encourage investment and innovation in this sector. In addition, policies that take into account local social and economic aspects can also help ensure that renewable energy projects provide equitable benefits to all parties involved. Thus, the government can play an important role in promoting socio-economic development through renewable energy and creating sustainable positive impacts for society and the environment. Through tax incentives and subsidies that support renewable energy development, the government can encourage investment and innovation in this sector. One of the economic benefits that can be seen from renewable energy is at PT. Pertamina Geothermal Energy Tbk . The impact of implementing a green economy on revenue generation in the renewable energy sector in Indonesia, and found that increasing renewable energy production significantly boosted net income, with regulatory reform and

effective public investment management as the key to maximizing economic and environmental benefits (Yanti et al., 2024).

Case studies of successful renewable energy projects in Indonesia

One successful case study of a renewable energy project in Indonesia is the development of the Sidrap Wind Power Plant in South Sulawesi. The project, initiated by a private company in partnership with the local government, has significantly increased the region's electricity supply from a clean, sustainable source. Wind power not only reduces carbon emissions but also creates employment opportunities for local communities. This example shows how renewable energy projects can bring multiple benefits to the environment and the economy, indicating potential for further growth in the sector. By harnessing the power of the wind, the Sidrap Wind Power Plant has been able to provide a reliable source of electricity to the region, reducing its reliance on fossil fuels. In addition, the project has helped stimulate economic growth by attracting investment and creating demand for skilled workers in the renewable energy sector. As Indonesia continues to adopt sustainable energy solutions, projects such as the Sidrap Wind Power Plant serve as models for future developments in the country. Indonesia's energy transition requires a combination of government, private sector, civil society, and international stakeholders. By collaborating across sectors, investing in renewable energy generation technologies, and implementing advanced policies, Indonesia is driving the transition to a more sustainable energy system and improving the welfare of society as a whole (Sistriatmaja et al., 2024).

Benefits of implementing existing renewable energy projects

The benefits that can be taken from the example of renewable energy project implementation are the importance of cooperation between the government, private sector, and community in supporting energy transformation. With the involvement of all parties, projects such as the Sidrap PLTB can be successfully implemented and provide significant benefits to the environment and local economy. In addition, lessons learned from this project also show that investment in renewable energy not only has a positive impact environmentally, but also socially and economically. With a strong commitment and continued support, Indonesia can continue to advance in developing clean and sustainable energy for a better future. Thus, it is important for the government, companies, and community to continue to work together in supporting the energy transformation towards a more sustainable direction. Through good cooperation, renewable energy projects such as the Sidrap PLTB can be an example for other projects throughout Indonesia. By continuing to improve and develop renewable energy technologies, Indonesia can become a leader in global efforts to reduce carbon emissions and improve overall environmental conditions. Indonesia has a large amount of renewable energy resources on land and sea. The potential in academic and industry literature tends to be much greater than that from the Indonesian Ministry of Energy which is the basis of current energy policy. Additionally, this potential could enable a 100% renewable electricity system and meet future demand with limited impact on land availability. (Langer et al., 2021)

Positive Recommendations for the Implementation of Renewable Energy in the Future for Indonesia

It is a matter of study for the government, companies, and communities to continue to work together in supporting the energy transformation towards a more sustainable direction. Through good cooperation, renewable energy projects such as the Sidrap PLTB can be an example for other projects throughout Indonesia. In an effort to improve and develop renewable energy technology, Indonesia can become a leader in global efforts to reduce carbon emissions and improve overall environmental conditions. As a recommendation for future renewable energy initiatives in Indonesia, strategic steps need to be taken to increase investment in renewable technology development, strengthen policies that support clean energy, and increase public awareness of the importance of switching to environmentally friendly energy sources. Recommendations include creating supportive regulations, increasing public awareness, fostering partnerships, improving infrastructure, and developing a skilled workforce. These strategies can increase the adoption of renewable energy and contribute to a sustainable energy future in Indonesia. Policymakers should consider these factors to design effective strategies to promote renewable energy technologies (Yulianjani et al., 2024). There is a need for a special legal framework to align new and renewable energy (EBT) policies in Indonesia, because current efforts to develop and implement EBT are slow (Mendrofa et al., 2024).

Conclusion

Regarding the potential of renewable energy in Indonesia, the country has great potential to become a leader in this field. With the right strategic steps, Indonesia can utilize its natural resources to reduce carbon emissions and significantly improve environmental conditions. In facing the challenges of global climate change, investment in renewable energy technologies and policies that support them are key to achieving sustainable development goals. With increasing public awareness of the importance of clean energy, Indonesia can be an example for other countries in promoting the use of renewable energy as a solution for a more sustainable future. Through these steps, Indonesia can reduce its dependence on environmentally damaging fossil fuels and switch to environmentally friendly energy sources. Thus, Indonesia can create a cleaner and healthier environment for future generations and help reduce the negative impacts of global climate change. With a strong commitment and cooperation between the government, private sector, and society, Indonesia can achieve sustainable development goals effectively and sustainably.

Concrete and measurable steps are needed to ensure that the implementation of renewable energy in Indonesia runs smoothly and successfully. This involves the formation of policies that support the development of renewable energy, investment in the necessary infrastructure, and education and training for the community so that they can optimally utilize renewable energy sources. The government also needs to ensure that there are incentives and regulations that encourage industry players and the community to switch to renewable energy. In addition, cooperation between the government, the private sector, and the community is also key to accelerating the implementation of renewable energy. With well-planned steps, it is

hoped that Indonesia can achieve the renewable energy targets that have been set and provide long-term benefits for the environment and the country's economy.

Declaration of conflicting interest

The authors declare that there is no conflict of interest in this work.

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