

Sustainable Development of Renewable Energy Potential and its Impact on Community Life in Indonesia: A Systematic Review

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ABSTRACT

Indonesia is very rich in new and renewable energy potential. Indonesia's population growth continues to increase and in line with technological advances that are developing very rapidly, causing the need for energy to increase. Problems related to resources and energy are still problems that have not found the right solution to overcome them. Society's dependence on fossil energy sources seems to make it difficult for new ideas and innovations for clean and affordable energy to enter people's lives. The purpose of this article is to find out the potential for new energy sources and renewable energy in accordance with the goals of the 2030 SDGs. The method used is a systematic literature review, by searching journal articles on renewable energy and successful case studies using Google search and Artificial Intelligence (AI) application review, while the data analysis technique is in the form of data reduction, data presentation to draw conclusions. The results of the study show that many cases show that if new renewable energy is well developed in Indonesia, this potential will become a very tangible benefit for people's lives. These potentials include the potential for solar power, biomass, and micro-hydro.

Keywords: energy; sustainable; development; renewable energy.

INTRODUCTION

Indonesia, with its diversity of natural resources, holds great potential in the development of new and renewable energy (NRE). Population growth and rapid technological development have increased energy demand, reinforcing the need for sustainable energy solutions. Renewable energy has an important role in achieving sustainability, especially considering the negative impact of fossil energy use on the environment. Indonesia, with its wealth of natural resources and geographical conditions, has the opportunity to develop various sources of renewable energy such as solar, biomass, and micro hydro power. However, in reality, the development and utilization of NRE in Indonesia is far from optimal, and dependence on fossil energy is still very high.

NRE includes energy sources such as solar power, biomass, micro hydro, and others. Indonesia has great potential to develop this renewable energy, in line with the goals of the 2030 Sustainable Development Goals (SDGs) for affordable and clean energy (Azmy 2014, Asian Development Bank 2019).

Although the potential of NRE in Indonesia is quite large, there are several challenges and obstacles in its development. One of the main problems is the lack of public understanding and awareness about the benefits and sustainability of NRE. Other challenges include limited technology, access to financing, and inadequate policy support for renewable energy development, all of which hinder the acceleration of the energy transition towards a more sustainable direction.

The purpose of this study is to examine the potential of NRE development in Indonesia and its positive impact on people's lives. In addition, this article will explore the problems and challenges faced in the RE development process and propose recommendations to overcome these challenges. It is hoped that through this article, effective strategies can be found to optimize the potential of NRE in Indonesia, thus creating a more sustainable life and improving people's welfare.

RESEARCH METHODS

In this study, the method used was a systematic literature review. It is a method used to review, evaluate, and interpret all relevant literature available on a particular topic. Systematic literature review method to explore the potential of NRE in Indonesia and its impact on people's lives (Kitchenham & Charters 2007, Khan 2019). Scientific articles and case studies are selected through search on Google Search and using artificial intelligence review applications, with data analysis including data reduction, data presentation, and conclusions. The main purpose of this method is to identify, evaluate, and synthesize empirical evidence from studies that have been conducted (Creswell, 2017).

This research identifies relevant data sources through literature searches in various scientific article databases such as PubMed, ScienceDirect, and IEEE Xplore, as well as national databases such as Garuda (Cooper 2010, Creswell 2010). The selected articles are articles that discuss the development of new renewable energy in Indonesia and its influence on people's lives. Irrelevant articles, such as those that do not discuss Indonesia or renewable energy, will be excluded. Articles that meet the selection criteria will be downloaded and further analyzed. The data taken includes the type of renewable energy, the technology used, the location of the development, and its impact on the local community.

The data that has been collected will be analyzed by qualitative synthesis methods to identify patterns, themes, and relationships. This analysis will include an evaluation of the sustainability of NRE development and its impact on people's lives. The results of data analysis will be presented in the form of narratives, tables, or graphs, as needed. Conclusions and recommendations will be drawn based on the results of data analysis.

RESULTS AND DISCUSSION

Through a systematic study process, a number of relevant information has been found regarding the development of new and renewable energy (NRE) in Indonesia and its impact on people's lives.

The Development and Sustainability Potential of NRE in Indonesia

Indonesia has great potential in the development of renewable energy, including solar, biomass, and microhydro power. Harnessing this potential can reduce dependence on fossil energy and contribute to the reduction of greenhouse gas emissions.



Figure 1. The Development and Sustainability Potential of NRE in Indonesia

Indonesia has great potential in the development of renewable energy such as solar, biomass, and micro hydro power. However, its utilization is still not optimal and constrained by various factors such as lack of understanding and support from the community and other stakeholders. Some of the

potential for sustainable NRE development in accordance with the goals of SDGs 2030 in Indonesia are as follows:

1. **Solar Power:** Indonesia, located on the equator, has enormous solar energy potential with high levels of solar radiation throughout the year (REN21, 2021). This makes the use of solar panels as an energy source very potential and can be used in almost all regions of Indonesia.



Figure 2. Solar Panel in Indonesia

2. **Biomass:** With a large area of agricultural and forestry land, Indonesia has great potential to develop biomass energy. Agricultural and plantation wastes such as coconut fibers, empty oil palm bunches, and rice waste can be used as raw materials for biomass energy generation (Sugandhy 2012, Sulistyo 2018).
3. **Micro hydro:** Indonesia has many rivers with sufficient water discharge to develop micro hydro power plants. It is an ideal solution for remote areas with limited access to electricity (World Wildlife Fund 2018, World Energy Council 2019, World Bank 2020, World Bank 2021).
4. **Wind Power:** Several regions in Indonesia have the potential to develop wind energy, especially in coastal areas and small islands, where wind speeds are fairly consistent (Nugroho 2017, Pramudita 2017, REN21 2021).
5. **Geothermal Energy:** Indonesia has the largest geothermal energy potential in the world, with geothermal resources spread across various regions, especially in areas with high volcanic activity such as Sumatra and Java (Ministry of Energy and Mineral Resources Republic of Indonesia 2019, Wibowo & Nurhidayat 2021, Sustainable Development Goals Indonesia 2022).
6. **Bioenergy:** Feedstocks for bioenergy such as palm oil and jatropha are abundantly available in Indonesia, and can be processed into biofuels (biodiesel) and ethanol (Sudiyanto 2016, Soetopo, & Supriatna 2018, Renewable Energy Potential in Indonesia 2021).

Despite its great potential, NRE development in Indonesia still faces many challenges such as lack of investment and regulatory support. Further efforts are needed to overcome these obstacles so that the development of NRE can contribute optimally to the achievement of the 2030 SDGs target.

Problems of Sustainable NRE Development

However, the implementation of NRE in Indonesia faces several challenges, including lack of understanding and support from the public, technological and financing constraints, and regulatory barriers. Solutions involve education and community outreach, government incentives, and infrastructure and technology development.

Some of the problems faced in sustainable NRE development are as follows:

1. **Technology Limitations:** Although the potential of NRE is large, the technology to extract energy is still lacking, so Indonesia still depends on technology imports (Amran 2020, BPPT 2021, Budya 2021).

2. **Lack of Investment:** NRE development requires large investments, but the lack of understanding and interest from the private and public sectors makes the allocation of funds for NRE less than optimal (Cooper 2010, BMKG 2022).
3. **Regulations and Policies:** There are no consistent policies that support RE development, and the lack of incentives for RE developers and users make RE development less attractive (Djohar 2015, ESDM 2022).
4. **Lack of Awareness:** Indonesian society in general still has low awareness of the importance of using NRE, resulting in a lack of public support for NRE development policies and programs (Susandarini 2018, UNDP 2020).
5. **Lack of Competent Human Resources:** There are limitations in the number and quality of human resources who have expertise in the development and management of NRE, which ultimately becomes an obstacle in the development of NRE in Indonesia (IRENA 2021, ESDM2022).
6. **Infrastructure Problems:** Infrastructure to support the development and distribution of NRE such as uneven electricity transmission and distribution networks is also one of the main problems (Sulistyo, 2018).

Impact of NRE Development on Society

The development of NRE has a significant impact on people's lives. RE offers cleaner and more sustainable energy solutions, reduces dependence on fossil energy, and mitigates climate change. However, suboptimal implementation has resulted in this potential not being fully felt by the community.



Figure 3. NRE Development in Indonesia

The development of New and Renewable Energy (NRE) has a significant impact on society, both directly and indirectly. These impacts relate to the following economic, social, environmental, and technological aspects:

1. **Economic Impact**
 - **Job Creation:** RE development can create new job opportunities in the clean technology sector, especially in installation, operation, and maintenance (IRENA, 2020).
 - **Energy Cost Saving:** The use of renewable energy can help people save energy costs by reducing dependence on fossil fuels whose prices fluctuate (World Bank, 2020).
 - **Local Economic Improvement:** The development of renewable energy in remote areas can provide energy access to local communities and encourage economic activity (Impact of Renewable Energy on Rural Development in Indonesia 2020, IPCC 2021).
2. **Social Impact**
 - **Improved Energy Access:** NRE can provide wider energy access to the community, especially in remote areas and not covered by the national electricity grid (ESDM, 2022).
 - **Education and Health:** Access to stable and clean energy from renewable energy supports the improvement of the quality of education and health services in remote areas (World Wildlife Fund, 2018).

3. Environmental Impact

- Reduction of Greenhouse Gas Emissions: The use of NRE helps reduce greenhouse gas emissions by reducing fossil fuel consumption (IPCC, 2021).
- Environmental Protection: NRE reduces air and water pollution, protects biodiversity, and reduces the use of non-renewable natural resources (Wibowo & Nurhidayat, 2022).

4. Technology Impact

- Innovation and Research: RE development supports research and innovation in clean energy technologies and provides opportunities for communities to engage in the development of such technologies (Amzy, 2014).
- Technology Deployment: The development of RE promotes the deployment of clean technology to remote areas, supporting sustainable development in the area (ESDM, 2022).

The development of renewable energy can improve people's welfare through increasing access to clean and affordable energy, job creation, and improving air quality and public health. Communities in several regions have benefited directly from the development of NRE, such as increased access to energy and improved quality of life. However, this impact is still limited to certain areas and has not been evenly distributed throughout Indonesia.

Effective Strategies to Optimize NRE Potential in Indonesia

In optimizing the potential of New and Renewable Energy (NRE) in Indonesia, an integrated and comprehensive strategy is needed. Here are some strategies that can be applied:

1. Formulation of Supporting Policies and Regulations:

- Regulation making that supports NRE investment and development.
- Simplification of licensing procedures for RE projects.
- Setting clear and measurable targets for the use of NRE in the national energy mix.

2. Increased Investment and Funding:

- Allocate the state budget for NRE research and development.
- Attract private and foreign investment through tax incentives and other fiscal policies.
- Develop innovative funding and financing schemes for RE projects, such as green bonds and crowdfunding.

3. Infrastructure and Technology Development:

- Develop supporting infrastructure, such as electricity transmission and distribution networks.
- Provide support for research and development of local RE technology.
- Increase the production capacity of domestic renewable energy components, such as solar panels and wind turbines.

4. HR Capabilities and Knowledge:

- Conducting training and human resource development in the NRE sector.
- Integrate the NRE curriculum in formal and non-formal education.
- Holding workshops, seminars, and other activities to increase public awareness and understanding of NRE.

5. Community and Stakeholder Participation:

- Galvanizing the participation of local communities in the development and management of NRE projects.
- Involving stakeholders such as local communities, local governments, and industry in the planning and implementation of RE projects.
- Establish partnerships with non-governmental organizations and community groups in the development of NRE.

6. Utilization of Local Potential:

- Identify and map the potential of NRE in various regions in Indonesia.
- Develop NRE projects that are in accordance with the characteristics and needs of each region.
- Prioritizing the development of NRE in areas with great potential and high energy needs.

7. Education and Socialization:

- Educating the public about the benefits and importance of NRE for environmental and economic sustainability.
- Disseminate NRE technology to the wider community to encourage public adoption and participation in the use of NRE.
- Campaigning for a green and environmentally friendly lifestyle, with an emphasis on efficient and sustainable use of energy.

CONCLUSION

NRE has great potential to support sustainable living in Indonesia, through the development of solar, biomass, and micro hydro power. Community, government, and investment in technology and infrastructure support are key to successful RE implementation. The development of new renewable energy has great potential in improving people's welfare and achieving sustainable development goals in Indonesia. Nonetheless, there are still many challenges and obstacles that need to be overcome to realize this full potential. The development of NRE not only contributes to increased energy access and reduced environmental impact but also provides social and economic benefits to the community. Despite the challenges in the development of NRE, its positive impact on society and the environment makes it an important component in sustainable development in Indonesia. By implementing a comprehensive and integrated strategy, and involving all stakeholders, the potential of NRE in Indonesia can be optimized to support sustainable development and national energy security.

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