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The Bartlett School of Environment, Energy and Resources

MSc ESDA Coursework Title Page

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# Indonesia’s Solar Electrical Energy Development Strategy for the Year 2030

# INTRODUCTION and LITERATURE REVIEW

INTRODUCTION:

Indonesia stands at the crossroads of advancing its energy infrastructure while maintaining environmental integrity. In recent times, the country has embarked on diversifying its energy mix, with an emphasis on solar power exploitation (Nikolina, S.A.J.N., 2016). The creation of the 2030 solar energy roadmap is critical for Indonesia's aim of sustainable and reliable energy access, reducing carbon footprints. This approach encompasses various elements, including policy development, fiscal measures, technological advancements, and infrastructure enhancement.

The purpose of this initiative is to devise a comprehensive renewable energy strategy to meet Indonesia's projected electricity requirements by 2030, focusing primarily on solar energy and incorporating elements of wind power. Through an in-depth and varied analysis, this project will address three core areas:

1. Anticipated Electricity Demand and Solar Power Potential: This aspect will estimate Indonesia's electricity demand for 2030 and assess the proportion that could be met by new solar energy installations.

2. Solar Energy Development Strategies: This segment will outline the necessary steps for effective solar energy adoption, including estimating the number of solar installations needed and identifying optimal locations based on solar intensity and land availability.

3. Financial Analysis and Subsidy Needs: This evaluation will determine the economic feasibility of increasing renewable energy's share, particularly solar power. It will discern whether such an initiative can be profitable on its own or if it requires subsidies. Recommendations will be made regarding the practicality and attractiveness of this approach, considering potential financial assistance.

Extending to solar and wind energy, this project also aims to project Indonesia's 2030 electricity demand and estimate the contribution from new solar and wind installations. Strategies for the development of both solar and wind energy will be outlined, focusing on the required number of installations and their optimal locations. Like the solar energy analysis, a financial assessment will be conducted for solar and wind energy to understand profitability or subsidy needs, with appropriate recommendations provided.

Overall, this project seeks to address Indonesia's 2030 energy challenges through a detailed examination of solar and wind energy potentials, strategic planning for development, and financial impact assessment. The goal is to offer informed guidance to decision-makers for environmentally sustainable and economically viable energy solutions. This will involve an evaluation of future electricity needs with a focus on solar energy, the determination of required solar plant numbers, site selection based on solar exposure and land availability, and financial viability analysis for increasing renewable energy's share, particularly solar power, to determine profitability or subsidy requirements.

**Literature Review**

**Current Energy Landscape in Indonesia:** Indonesia, traditionally reliant on coal, is transitioning to renewable energy, with solar power as a key focus due to the country’s abundant sunlight. This shift is driven by the need to address environmental concerns and to meet increasing electricity demands sustainably. The ample sunlight across the archipelago renders solar energy a feasible and sustainable alternative for fulfilling the nation's electricity needs.

**Policy Framework for Solar Energy Development:** The Indonesian government has played a pivotal role in crafting policies and rules to foster the advancement of solar electricity. The National Energy Policy (Kebijakan Energi Nasional) delineates the pivotal course for the nation's energy domain, stressing the significance of renewable energy sources, particularly solar power. Moreover, the government has implemented inducements such as feed-in tariffs and tax advantages to stimulate investments in solar energy initiatives. These policy strategies aim to entice both local and global investors to engage in the progression of solar energy within Indonesia.

**Investment Plans and Partnerships:** Ambitious investment strategies and global partnerships are in place to boost solar energy generation, infrastructure, and R&D. Collaborations with countries having advanced solar technologies are enhancing Indonesia's capabilities in this field. To meet its 2030 targets for solar electricity, Indonesia has set forth ambitious investment strategies. The nation strives to allure substantial investments in solar energy generation, transmission infrastructure, and research and development endeavours. Additionally, forging alliances with global entities and firms specializing in renewable energy has been pivotal in harnessing expertise and funding for extensive solar undertakings. Collaborative ventures with nations possessing advanced solar technologies have facilitated knowledge exchange and bolstered skill development within Indonesia's solar energy sphere.

**Technological Advancements and Innovation:** Indonesia is focusing on developing solar technology, including photovoltaic systems and energy storage, to improve the efficiency and reliability of solar power. Local manufacturing of solar components is also being encouraged for economic and job growth.

**Infrastructure Development for Solar Power Integration:** Upgrading the power grid and employing smart grid technologies are crucial for integrating solar power, especially in remote areas. Decentralized, off-grid solar solutions are being utilized to increase electricity access in rural regions.

**Environmental Impact and Sustainability:** The move towards solar power aligns with Indonesia's environmental commitments and global climate goals, reducing reliance on fossil fuels and lowering carbon emissions.

Indonesia's emphasis on solar electricity stems from its commitment to environmental preservation. By diminishing dependence on fossil fuels and embracing solar power, Indonesia aims to curtail carbon emissions and combat the impacts of climate change. This shift towards cleaner energy sources aligns with global climate agreements and showcases Indonesia's commitment to sustainable progress.

Indonesia's 2030 strategy for solar energy development embodies a holistic approach to leverage solar power's potential in meeting the nation's escalating electricity needs in an environmentally conscious manner. Through backing in policies, investment strategies, technological advancements, infrastructure enhancement, and environmental concerns, Indonesia is positioned to markedly increase its reliance on solar energy in the forthcoming decade.

Indonesia is anticipated to experience a notable surge in electricity demand by 2030, attributable to economic expansion, urban expansion, and industrial progress. The government has a goal to ensure universal electricity access by 2025 and aims to augment the power capacity by 35 gigawatts (GW) by 2030. A substantial portion of this anticipated increase, around 6.5 GW, is expected to stem from solar power plants. This aligns with the government's pledge to escalate the proportion of renewable energy within the nation's energy.

**Solar Energy Development Strategies:** Indonesia plans to establish a wide network of solar power plants to meet its growing electricity demand. The National Energy General Plan (RUEN) projects a significant increase in electricity demand by 2030, necessitating a major expansion in renewable energy capacity, focusing on solar and wind power. This projection marks a substantial uptick from the current electricity consumption levels, highlighting a pressing necessity for considerable capacity enhancements within the power sector to cater to the escalating energy requisites of the nation.

**Capacity Expansion from Solar and Wind Power Installations:** As outlined within the Electricity Supply Business Plan (RUPTL) 2019-2028 by the Ministry of Energy and Mineral Resources are targeted increments in renewable energy capacity, specifically in solar and wind power (Jayadi, et al., 2019). The government aims to introduce significant solar and wind power capacities (7.2 GW for solar and 2.1 GW for wind by 2028) to meet the forecasted demand of 592 terawatt-hours by 2030. Strategic placement of these installations is essential for maximizing efficiency.

Meeting the envisioned solar capacity in Indonesia necessitates the construction of a substantial fleet of solar power plants. The precise count hinges on diverse factors such as plant sizes, technological advancements, and energy policies. It is advisable to strategically position these solar power plants in areas boasting high solar irradiance and extensive available land suitable for large-scale installations. Moreover, promoting distributed solar setups in urban zones and remote areas lacking grid connections could be beneficial.

In summary, Indonesia's strategy for expanding its renewable energy capacity by 2030 involves significant investments in solar and wind power, driven by policy support, technological advancements, and environmental considerations. This approach is key to meeting the country's rising electricity needs in an eco-friendly manner.

**Methodology**

* **Filtering Potential Solar Locations:** Identification of suitable sites for solar installations using geographical data.
* **Calculating Projected Demand:** Establishing a baseline of average consumption and projecting future electricity demand.
* **Estimating Solar Capacity for 2030:** Assessing the necessary solar capacity to meet future energy needs.
* **Determining Solar Plant Requirements:** Calculating the number of solar plants needed based on projected demand and average plant capacity.

The operations executed in R programming align with the pivotal aims of the project, encompassing the estimation of future electricity demand, projection of the necessary solar energy capacity, and the identification of the requisite number of solar power plants to fulfill the forecasted demand. These calculations serve to extract crucial insights pivotal for planning and strategizing the development of renewable energy, with a specific emphasis on solar energy.

By focusing on these calculations, the project endeavors to evaluate the feasibility and viability of augmenting the renewable energy share within Indonesia's electricity capacity. This aligns seamlessly with the overarching objectives of the initiative, aiming to assess and potentially expand the incorporation of renewable energy sources, primarily solar power, within Indonesia's energy landscape. The data-driven insights derived from these computations aim to guide informed decision-making, facilitating a strategic approach towards sustainable and renewable energy development within the country's energy sector.

**Regions With Power Plants**

A map of the world with red pins

Description automatically generated

**Regions without Power Plants**

A screenshot of a computer

Description automatically generated

**Projected Electricity Demand for Indonesia by 2030**

By 2030, Indonesia's electricity demand is projected to reach 592 TWh, driven by economic growth and population increase. The government’s plan includes augmenting renewable energy capacities, with a focus on achieving 7.2 GW of solar power and 2.1 GW of wind power by2028.A screenshot of a computer program

Description automatically generated

As a response to the escalating need for electricity, Indonesia has been actively advocating the advancement of renewable energy sources, such as solar and wind power. The government has established ambitious objectives for the expansion of renewable energy capacities, aiming to diminish dependency on fossil fuels and alleviate the repercussions of climate change. Within the RUKN, there exists a target stipulating the addition of 23 gigawatts (GW) of fresh renewable energy capacity by 2025, with a substantial proportion allocated for the establishment of solar and wind power installations.

Specifically concerning solar power, Indonesia's objective is to install 6.5 gigawatts (GW) of solar photovoltaic (PV) capacity by 2025. This goal aligns with the broader governmental agenda aimed at amplifying the contribution of renewable energy within the nation's energy spectrum (Pambudi,et al 2023). Furthermore, while wind power currently holds a smaller share in comparison to solar, there are strategic plans in place to establish wind farms in suitable locations throughout the archipelago.

A graph of a number of people

Description automatically generated

Based on these specified targets and forecasts, it is anticipated that a significant segment of Indonesia's expected electricity demand by 2030 will be fulfilled through the implementation of new solar and wind power facilities. The precise capacity derived from these renewable energy sources will hinge upon several factors such as investment incentives, technological advancements, regulatory frameworks, and the execution timelines of respective projects.

**Profitability of Increasing Solar Power Share in Indonesia’s Electricity Capacity**

Present Energy Scenario in Indonesia Indonesia's energy sector leans heavily on fossil fuels, with coal serving as a substantial contributor to its electricity production. Nevertheless, concerted endeavors have been underway to broaden the energy portfolio and elevate the proportion of renewable energy sources, notably solar and wind power.

Solar and Wind Prospects in Indonesia Indonesia boasts plentiful solar and wind resources, particularly prevalent in areas like Sulawesi, Nusa Tenggara, and Maluku. The nation's geographic positioning near the equator renders it highly suitable for harnessing solar energy, while its coastal regions exhibit substantial potential for wind power generation (Daryanto, W.M. and Samidi, S., 2018). These regions are among places without power plants.

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Financial Feasibility of Solar Energy Solar energy has witnessed a global surge in cost competitiveness owing to the diminishing prices of solar panels and technological advancements. In Indonesia, the region's elevated solar irradiance levels present solar power as an appealing avenue for electricity generation (Halimanjaya, A., 2019). When coupled with adequate investments and conducive policies, solar power plants within Indonesia exhibit the potential for profitability without significant subsidy reliance.

Financial Viability of Wind Energy shows promise within Indonesia, notably in coastal regions where wind velocities favor efficient electricity generation. Although the initial capital outlay for establishing wind farms can be substantial, the ongoing operational costs are comparatively modest. Under favorable circumstances and governmental backing, wind farms in Indonesia could also demonstrate economic feasibility without heavy dependence on subsidies.

Governmental Backing and Policy Framework: Indonesian government has exhibited a strong commitment to advancing renewable energy through a variety of policy tools, including feed-in tariffs, tax incentives, and regulatory structures designed to bolster the growth of renewable energy sources (Dutu, R., 2016). These measures serve to cultivate an environment conducive to investment, potentially enhancing the economic viability of solar and wind projects.

Recommendation and Subsidy Considerations Given Indonesia's abundant solar and wind resources coupled with the decreasing costs of renewable energy technologies, amplifying the predetermined share of renewable electrical power through the establishment of solar power plants and wind farms in Indonesia's 2030 electricity capacity is likely to yield profitable returns (Sajida, S. and Ranjani, R., 2020). However, it's crucial to recognize the potential initial obstacles related to infrastructure development and grid integration.

Even if financial support is necessary, I advocate for pursuing this approach as a fundamental step toward a sustainable, long-term energy transition. Subsidies can serve as a catalyst in kickstarting the renewable energy sector and drawing in private investments. Furthermore, it's crucial to consider the environmental and social advantages associated with transitioning to clean energy sources during the decision-making process.

In summary, the augmentation of the planned percentage of renewable electricity generated through the establishment of solar power plants and wind farms in Indonesia's 2030 electricity capacity presents substantial potential for profitability, especially when backed by supportive government policies. While there might be an initial necessity for subsidies to facilitate this shift, the long-term advantages validate such investments.

Expanding the anticipated portion of renewable electricity generated by solar power plants in Indonesia's 2030 electricity capacity could yield substantial long-term benefits. Despite initial expenses associated with constructing and integrating solar power into the grid, the enduring advantages encompass diminished fuel expenses, environmental preservation, and fortified energy stability. However, it's crucial to acknowledge that, in the short run, there might be a necessity for subsidies or incentives to bolster the development of solar energy infrastructure. Despite this initial financial requirement, investing in solar power stands pivotal for Indonesia's energy resilience and sustainability. Indonesia's strategy for solar electricity development by 2030 revolves around meeting escalating electricity demands via the establishment of numerous solar power plants nationwide. While initial financial hurdles may arise, amplifying the proportion of renewable electricity through solar energy emerges as a feasible and endorsed approach for ensuring Indonesia's long-term energy stability and sustainability.

**Solar Radiation to Power Conversion Analysis:** For a 10m² solar panel in Indonesia, with an average solar radiation of 4.8 kWh/m² per day, the power output is approximately 1.4 kWh. This calculation assumes a solar panel efficiency of 17.5% and a performance ratio of 60%."

**Net Present Value (NPV) Analysis for Solar Investments:** The NPV for a hypothetical solar project in Indonesia, with an annual revenue of IDR 14,000,000, a CAPEX of IDR 150,000,000, and an OPEX at 10% of CAPEX, results in approximately IDR -164,093,945, suggesting the project may not be financially viable under these conditions.

**Levelized Cost of Electricity (LCOE) Estimation:** The LCOE for the solar project, considering the lifetime generation of electricity and the negative NPV as cost, is approximately IDR -18,441.42 per kWh, indicating that the project is highly unprofitable under the current assumptions.

**Conclusion**

Indonesia’s shift towards renewable energy, particularly solar and wind power, offers a sustainable path for meeting future electricity demands. Despite initial challenges, government support and global partnerships make this transition economically feasible and environmentally crucial.

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