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Evaluation of the Effect of Green Energy Policy on Renewable Power Plant Investment in Indonesia

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ABSTRACT

Indonesia's transition to renewable energy is a pivotal aspect of its strategy to achieve sustainability and reduce greenhouse gas emissions. This study evaluates the impact of green energy policies on renewable power plant investments in Indonesia through a comparative analysis of solar, wind, geothermal, and hydropower projects. Using data from 2015 to 2024, the study examines the effectiveness of feed-in tariffs, tax incentives, and renewable energy mandates in driving investments. The results show that while policies like feed-in tariffs and tax incentives have significantly boosted investment in geothermal and hydropower projects, solar and wind energy sectors face challenges such as low tariff rates and infrastructure deficits. Comparative insights from successful international cases underscore the need for policy stability, grid expansion, and technology-specific strategies. This research provides actionable recommendations to optimize Indonesia's green energy framework, fostering a more inclusive and sustainable renewable energy sector.

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1. INTRODUCTION

Indonesia's transition to sustainable energy systems is vital for addressing climate change, enhancing energy security, and fostering economic growth. Significant progress has been made in implementing green energy policies to utilize the country's abundant renewable resources, including solar, wind, geothermal, and hydropower, aligning with global goals like SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action) [1]. The roadmap for achieving net-zero emissions by 2060 emphasizes integrating innovative renewable energy sources [2]. Government interventions, such as fiscal incentives and regulatory frameworks, are crucial for steering private investments toward energy efficiency, conservation, and equitable access [3], [4]. However, challenges such as high initial costs, technological limitations, infrastructure deficits, and energy accessibility in remote areas remain significant barriers [1], [2]. Advancing energy storage technologies is also essential to address renewable energy variability [2].

Despite these obstacles, renewable energy projects provide opportunities for job creation, social development, and poverty reduction, enhancing societal welfare [2]. Innovations have improved renewable energy efficiency and affordability, while international cooperation and public-private partnerships are vital for overcoming barriers and maximizing potential [4].

Indonesia's energy sector remains heavily reliant on fossil fuels, significantly contributing to greenhouse gas emissions. In response, the government has implemented green energy policies, including feed-in tariffs, tax incentives, and renewable energy targets, to promote renewable energy development and achieve net-zero emissions by 2060. These efforts align with the Nationally Determined Contributions (NDC) and strategic plans to diversify and intensify renewable resource utilization. As part of its Paris Agreement commitment, Indonesia aims to achieve 23% renewable energy in its energy mix by 2025 and 31% by 2050 [5]. The Production Sharing Contract (PSC) framework managed by SKK Migas supports low-carbon initiatives by reimbursing oil and gas companies for renewable energy investments [5], while the Ministry of Energy and Mineral Resources is drafting a renewable energy bill to facilitate the transition [6]. Despite a renewable energy capacity of 3,686 GW, utilization remains at only 0.3%, hindered by high initial costs, particularly in remote areas, substantial investments required for geothermal exploration, inadequate legislation, technical expertise, and grid infrastructure [6], [7]. However, opportunities such as the development of Nusantara Capital City (IKN) as a low-carbon city, with plans for extensive solar, wind, and hydropower capacity by 2045, showcase the potential for renewable energy integration. Increasing investments and adopting advanced energy technologies are crucial for accelerating Indonesia’s renewable energy transition [7].

Despite various policy initiatives, the adoption of renewable energy in Indonesia remains below expectations due to regulatory challenges, financial risks, and infrastructure limitations, which have slowed the pace of development. Evaluating the effectiveness of these policies in attracting investment is essential to identify their strengths, limitations, and areas for improvement. This study aims to assess the impact of green energy policies on renewable power plant investment in Indonesia using a comparative analysis approach. By examining different types of renewable power plants and analyzing investment trends influenced by policy measures, the research seeks to provide insights into the effectiveness of Indonesia's green energy framework. Specifically, it addresses three key questions: Which green energy policies are most effective in driving renewable power plant investment? How do investment trends vary across different types of renewable energy projects? And what are the key barriers and opportunities associated with renewable energy investment under the current policy framework?

2. LITERATURE REVIEW

2.1 Theoretical Framework on Green Energy Policy

Green energy policies play a vital role in promoting the adoption and development of renewable energy technologies by addressing market failures and fostering innovation. These policies include financial incentives, regulatory mandates, and market facilitation mechanisms, all of which reduce investment risks and enhance the economic viability of renewable energy projects. Financial incentives, such as feed-in tariffs and tax credits, make renewable energy projects more economically viable, while R&D subsidies and technology-support instruments significantly boost green innovation, particularly in competitive markets [8], [9]. Regulatory mandates, including renewable energy portfolio standards and emissions trading systems like the EU Emissions Trading System, effectively drive renewable energy innovations, though their success varies by region and technology, necessitating tailored approaches [10]. Market facilitation mechanisms, such as power

purchase agreements, reduce investment risks and encourage private sector participation, with international collaborations under frameworks like IRENA and the Paris Agreement further supporting global renewable energy deployment [11]. The success of these policies depends on supportive political institutions and a well-developed financial sector, with factors like corruption control and civil society participation creating an enabling environment for effective implementation.

2.2 Green Energy Policy in Indonesia

Indonesia's efforts to boost renewable energy investment through policies such as the National Energy Policy (KEN) and Presidential Regulation No. 112/2022 are ambitious but face significant challenges. While these policies aim to simplify procedures and offer fiscal incentives, issues like regulatory uncertainty, complex licensing processes, and high upfront costs remain significant barriers [6], [12]. The lack of a specific legal framework to harmonize new and renewable energy (NRE) policies underscores the need for integrated policy diffusion mechanisms to accelerate NRE adoption [12]. Although fiscal incentives and feed-in tariffs exist, they often fail to cover the high initial costs of renewable projects, limiting scalability [6]. The Production Sharing Contract (PSC) framework, which provides a cost recovery mechanism for low-carbon initiatives, offers a promising avenue for investment by oil and gas companies. Technological and infrastructure barriers, such as inadequate grid systems, high costs, and limited technical expertise, further hinder the adoption of technologies like Battery Energy Storage Systems (BESS), although incentives for solar installations and off-grid projects could mitigate these challenges [7]. To address these issues, a comprehensive strategy involving new energy technologies, increased investment, supportive policies, public-private partnerships, and public education is crucial for Indonesia's energy transition [13].

2.3 Renewable Energy Investment Trends

The global surge in renewable energy investment has been significant but unevenly distributed, with developing countries like Indonesia receiving less investment compared to developed nations. While Indonesia has made progress in geothermal and hydropower development, solar and wind projects face financial and infrastructure challenges, highlighting the need for targeted policy interventions to unlock their potential [14]. Renewable energy is critical for achieving the United Nations' Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action), contributing to poverty alleviation, economic growth, and sustainable urban development. However, global disparities in renewable energy investment persist, with much of the capacity concentrated in a few countries, leaving developing nations without the infrastructure needed to harness resources effectively [14]. Technological advancements in solar photovoltaics and wind turbines have enhanced efficiency and affordability, but require supportive policy frameworks, including feed-in tariffs and tax incentives, to drive adoption [8]. The Production Sharing Contract (PSC) framework in Indonesia offers potential for reducing emissions and promoting renewable energy but requires more robust policy support [15]. International collaborations and innovative policy measures are essential to address these challenges and advance the global renewable energy agenda [8].

2.4 Research Gaps

While the existing literature extensively discusses the challenges and opportunities of renewable energy development in Indonesia, empirical research evaluating the effectiveness of specific green energy policies on investment trends is limited. In addition, comparative analysis of policy impacts across different renewable energy technologies is still very rare. This study seeks to fill that gap by providing a comprehensive evaluation of Indonesia's green energy policies through a comparative

lens, providing actionable insights for policymakers and stakeholders.

3. METHODS

3.1 Research Design

This research uses a comparative analysis approach to evaluate the impact of green energy policies on renewable power plant investment in Indonesia, qualitative data obtained from policy documents, expert opinions, and case studies.

3.2 Data Collection

Data for this study was collected from various sources, including secondary data, policy documents, and case studies. Secondary data included reports from the Ministry of Energy and Mineral Resources (MEMR), the Indonesian Renewable Energy Society (METI), international organizations such as IRENA and the World Bank, and financial reports from private renewable energy projects. Policy documents analyzed include Presidential Regulation No. 112/2022, fiscal incentives, feed-in tariffs, and power purchase agreements. Case studies of solar, wind, geothermal, and hydropower projects in different parts of Indonesia were also reviewed to assess policy impacts in different contexts.

3.4 Data Analysis

Qualitative analysis involved content analysis of policy documents to identify objectives and challenges, and comparative case studies to evaluate policy impacts across different renewable energy technologies and regions.

4. RESULTS AND DISCUSSION

4.1 Overview of Renewable Energy Investment in Indonesia

Data analysis shows that renewable energy investment in Indonesia has shown a steady increase over the past decade, especially in geothermal and hydropower projects. The growth of renewable energy capacity between 2015 and 2024, particularly in geothermal energy, underscores the significant role of policy interventions in advancing renewable energy projects. However, disparities in investment across regions and technologies, such as solar and wind energy, highlight challenges in achieving balanced development. Investment is concentrated in regions like Java and Bali, supported by better infrastructure, while areas like Papua and Maluku remain underfunded despite their high renewable energy potential [7], [16]. Indonesia's geothermal potential, estimated at 23.46 GW across 357 sites, has only realized 2.38 GW of capacity as of 2023, representing 32.52% of the planned capacity for 2025. Regulatory and cost barriers continue to hinder geothermal investment, necessitating interventions like increased electricity purchase prices to attract investors [16]. Solar and wind energy, despite their promise, account for just 15% of total installed capacity, limited by inadequate grid infrastructure and high capital costs. Tools such as net metering and solar tariffs have the potential to boost solar project profitability, but their uneven implementation across regions remains a barrier [7]. While feed-in tariffs and tax incentives have been critical in promoting renewable energy, their impact varies by technology and region [17]. On a global scale, renewable energy investment has reached record levels, driven by government initiatives and private sector interest, with tools like green bonds and socially responsible investment funds facilitating the financing of sustainable projects [18]

4.2 Impact of Green Energy Policy on Investment

Renewable energy policies are vital for driving investments and achieving environmental sustainability goals, with feed-in tariffs and tax incentives proving particularly effective in promoting renewable energy projects, especially solar energy. Feed-in tariffs significantly boost investment by offering favorable rates that enhance financial returns for investors, while tax incentives lower upfront costs, making projects more financially viable and attractive [8], [19]. In regions with supportive policies, renewable energy adoption can increase by 100% to 200%, underscoring the importance of robust policy frameworks [20]. However, challenges such as bureaucratic hurdles and inconsistent

policy enforcement often undermine these efforts, delaying project approvals and reducing investor confidence. These obstacles, highlighted in interviews with industry stakeholders, emphasize the need for adaptive strategies to improve policy implementation and maximize their effectiveness [17].

4.3 Comparative Analysis of Policy Effectiveness across Technologies

The comparative analysis highlights significant gaps in the impact of renewable energy policies across different technologies. Geothermal energy, backed by government exploration funds and guaranteed purchase agreements, stands out as the most attractive investment option, capturing 40% of total renewable energy investment and demonstrating strong policy support and investor confidence [21], [22]. Large-scale hydropower projects benefit from long-term power purchase agreements (PPAs), ensuring stable revenue streams and attracting investment, but smaller hydropower projects face financing challenges, revealing a lack of policy support for small-scale initiatives [22], [23]. In contrast, solar and wind energy projects, despite their significant potential, remain underdeveloped due to low feed-in tariffs that reduce financial incentives for investors and inadequate grid infrastructure in remote areas [8], [18]. Effective policy frameworks, including feed-in tariffs and tax incentives, are essential for driving renewable energy adoption, while technological innovations such as advancements in solar photovoltaics and wind turbines improve efficiency and affordability but require robust policy support for widespread implementation [8].

DISCUSSION

Strengths of Indonesia's Green Energy Policy

The findings show that Indonesia's green energy policy has had a measurable impact on renewable energy investment, particularly in the geothermal and hydropower sectors. Feed-in tariffs and tax incentives have effectively lowered financial barriers for investors, while regulatory frameworks such as Presidential Regulation No. 112/2022 have streamlined project approvals to some extent.

Indonesia's geothermal policy stands out as a best practice, capitalizing on the country's abundant geothermal resources and minimizing exploration risks for investors. The success of this approach underscores the importance of technology-specific policies tailored to the unique characteristics of each renewable energy source.

Barriers to Policy Effectiveness

Despite the successes that have been achieved, there are several barriers that hinder the realization of renewable energy potential in Indonesia. Frequent policy inconsistencies, such as regulatory changes and unclear implementation, create uncertainty for investors and hinder long-term commitments. In addition, poor grid connectivity in remote areas limits the scalability of solar and wind projects, despite their high resource potential. High startup costs and limited access to affordable financing further challenge small-scale renewable energy developers, limiting the growth of the sector as a whole.

Comparative Insights from Other Countries

Comparative analysis with other countries provides valuable lessons for Indonesia. Germany's success in promoting solar energy through attractive feed-in tariffs and strong grid infrastructure underscores the importance of revising tariff levels in Indonesia and investing in grid expansion. Similarly, India's use of competitive bidding for renewable energy projects has significantly reduced costs and increased private sector participation, offering a strategy that Indonesia can adopt to advance its solar and wind energy sectors.

Policy Recommendations

Based on the findings, several recommendations are proposed to strengthen the renewable energy sector in Indonesia. Feed-in tariffs should be adjusted to accurately reflect the cost of solar and wind energy projects, to ensure financial viability for developers. Investment in the expansion and modernization of the electricity grid is essential, especially in undeveloped areas

with high renewable energy potential. A clear and consistent regulatory framework should be established to enhance policy stability, build investor confidence, and support long-term planning. In addition, encouraging public-private partnerships can help mobilize additional financing and share risks, thereby accelerating the development of renewable energy projects.

5. CONCLUSION

This study highlights the important role of green energy policies in shaping Indonesia's renewable energy landscape. While feed-in tariffs and tax incentives have successfully encouraged investment in geothermal and hydropower projects, solar and wind energy are still underdeveloped due to financial, infrastructure and regulatory barriers. Comparative insights from countries such as Germany and India show that increasing feed-in tariff rates, improving grid infrastructure, and encouraging public-private partnerships can significantly increase investment in these sectors. Addressing these challenges requires a multifaceted approach, including consistent policies, targeted incentives for new technologies, and strategic regional investments. By adopting such measures, Indonesia can accelerate the transition to a renewable energy-based economy, achieving environmental sustainability and energy security. This study provides valuable insights for policymakers, investors and stakeholders, and offers a roadmap to optimize renewable energy policies and achieve Indonesia's ambitious sustainability goals.

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