

Energy transition towards renewable energy in Indonesia

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Abstract

This study aims to see how efforts to optimize renewable energy resources are seen in the energy transition in Indonesia. High fossil energy consumption is the primary driver of a country's need for an energy transition. Renewable energy is important because it is a natural energy source that can be renewed freely and without limits. This research is qualitative and descriptive, with data sources from government reports, related articles, and various regulations on renewable energy. The results showed that the optimization of this energy is opposite from the massive potential of renewable energy in Indonesia. Indonesia's primary energy sources are still dominated by fossil energy and impact various problems, especially the environment. The findings showed that energy must be converted into renewable energy. Policies that need to be aligned and fully aligned with energy transition efforts in Indonesia are obstacles to efforts to transition to renewable energy. The renewable energy policies developed thus far have been limited to concepts. However, action is still required in the energy transition, as evidenced by the policy content, particularly regarding funding and investment, which is less than 5 percent. Therefore, government involvement is required to accelerate the transition to renewable energy, particularly regarding policies and collaboration among actors.

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1. Introduction

This research aims to determine how optimization efforts in utilizing renewable energy resources are viewed from the perspective of Indonesia's energy transition. Renewable energy is a natural energy source that can be replenished indefinitely [1]. Renewable energy can be produced using technological advances, making it an alternative energy source [2]. Countries with high levels of fossil energy consumption and other non-renewable resources, including Indonesia, require renewable energy. Indonesia has one of the world's fastest-growing energy consumption rates, driven by long-term economic growth, urbanization, and population growth [3], [4]. Indonesia consumes 40% of the total energy consumed by the Association of Southeast Asian Nations (ASEAN) members [5]. Indonesia's energy consumption increased by about 65 percent between 2000 and 2014 and will continue until 2020.

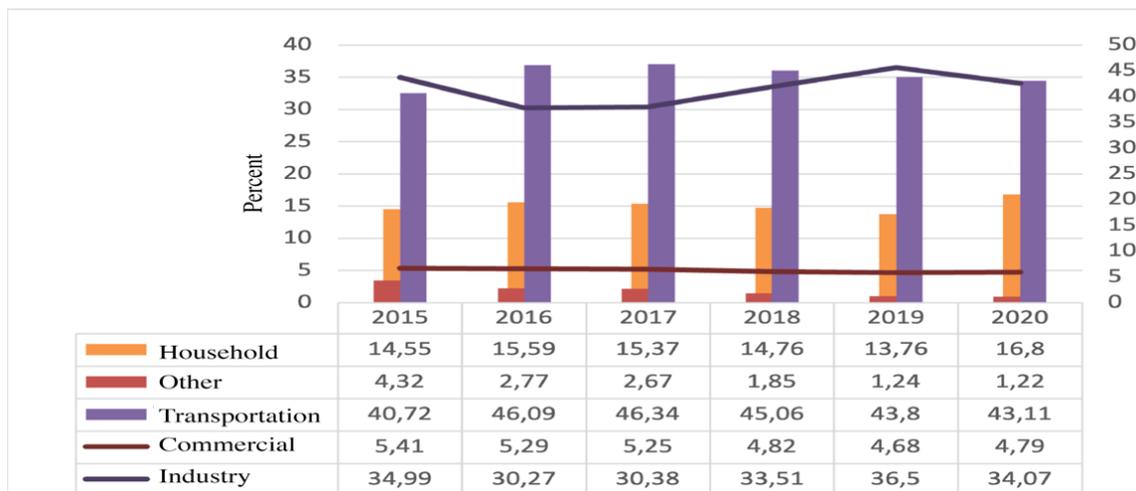


Figure 1. The proportion of Final Energy Consumption 2015-2020 (percent)

Source: Ministry of Energy and Mineral Resources, 2021 [6]

Energy use estimates for transportation and industry show the fastest growth [7]. Transportation energy consumption is 364.44 million Barrels of Oil Equivalent (BOE), which is 43.11 percent of total final energy consumption, which is 845.15 million BOE (excluding biomass) [8]. Furthermore, energy consumption in Indonesia is also followed by household, commercial, industry, and others. The rise in energy consumption corresponds to economic growth in various sectors, which is expected to increase by 80% by 2030, particularly in the transportation and industrial sectors, which can wreak havoc on the environment [9].

Energy consumption is still dominated by fossil energy (petroleum, natural gas, and coal), though renewable energy is an option [10]. Dependence on fossil fuels poses at least three serious threats: 1) depletion of existing petroleum reserves (assuming no new oil wells are discovered); 2) price increase/instability due to a higher demand rate than oil production; and 3) greenhouse gas pollution from fossil fuel combustion) [11]. Fuel oil and coal continue to dominate the national primary energy mix. Aside from that, the renewable energy transition in Indonesia is critical for the region as a whole [12] because it is frequently the case that sustainable power does not correspond with efforts to optimize it.

Through resource availability and fulfillment, Trilemma energy, developed by the World Energy Council, is used to evaluate energy performance by balancing security energy, energy equity, and environmental sustainability [13]. Further, renewable energy technology is widely acknowledged as a tool for reducing greenhouse gas emissions and as an integrated solution for establishing energy security, energy equity, and a sustainable environment [14]. This renewable energy is considered better for the environment, cleaner, more affordable, and friendlier [15]. In general, the advantages of renewable energy sources can boost energy security and lessen reliance on fossil fuels [11], [16]. Moreover, increasing renewable energy can lessen reliance on oil imports and price fluctuations, encourage diversification of energy sources, and stabilize the trade balance [17].

In Indonesia, the country's renewable energy potential is thought to be capable of elevating it to the world's leading capital for renewable energy development [18]. This energy source could increase opposition to renewable and clean energy sources [10]. According to the Ministry of Energy and Mineral Resources (ESDM), renewable energy sources include solar, water, micro-hydro, wind, geothermal, ocean waves, and bioenergy [19], [20]. Indonesia has a total renewable energy potential of 443 gigawatts (GW), with solar power accounting for the most energy, 207 megawatts (MW), followed by water, wind, bioenergy, geothermal, and mini hydro. This energy source can potentially increase access to clean, renewable energy. Most renewable energy sources, such as geothermal, water, bioenergy, and solar, are used for power generation [6].

A common obstacle to renewable energy development is dependence on fossil fuels [16]. Indonesia's slow energy transition is also affected by a policy climate that has yet to lead to reasonable solutions for investors

and the government. For example, the government's policies give investors relatively small subsidies and incentives to develop renewable energy instead of fossil energy subsidies [3]. Constraints in developing other renewable energy are the scarcity of domestic components for technology, poor interagency coordination, and ineffective resulting in unwillingness to consistency in the development process [16] even though the development of renewable energy is a strategy for the Indonesian government's program aimed at people's prosperity [21]. Due to the enormous potential for stimulating the growth of quality employment [22], the government must formulate policies to seek breakthroughs to increase the renewable energy sector, including by providing convenience to investors, thus enabling effective and efficient management of the renewable energy supply chain [23].

Therefore, developing the renewable energy sector needs some shape to collaborate with related parties because the government is no longer the sole actor in the energy transition effort [21]. Furthermore, the government and business actors must have a joint commitment and support from the national financial sector to build capital-intensive, technology-intensive, and high-risk renewable energy infrastructure [23] that can be achieved through fiscal incentives, investment guarantees, regulatory guarantees, subsidies, and special programs. The use of renewable energy in Indonesia is governed by several central government policies, including Law No. 30 on Energy. Furthermore, various renewable energy policies have been issued at the regional level. Even in the General National Energy Plan (RUEN), Indonesia aims to increase the use of New Renewable Energy (EBT) by 23% and 31% in 2025 and 2050, respectively [9]. However, renewable energy accounts for only about 6% of total energy consumption in Indonesia [24]. The imbalance shows a gap between what has been planned and regulated. Current conditions hinder the acceleration of renewable energy development due to slow policy implementation, complicated licensing processes, and social, economic, and political pressures [21]. However, the resulting policy factors are one the important factors in supporting the development of renewable energy potentials effectively [1].

Indonesia's renewable energy development needs to catch up to the transition of Group of Twenty (G20) countries towards a low-carbon economy to fulfill Paris Agreement commitments [25]. Involvement in the Paris Agreement is a legally binding international agreement on climate change to increase resilience to climate change and reduce greenhouse gas emissions by fully utilizing technology [25]. Indonesia faces a difficult task in promoting effective renewable energy while reducing dependence on fossil fuels [26]. With a high level of energy consumption, the utilization of the large and diverse potential of renewable energy could be better. As a result, a particular renewable energy policy is intended to serve as a foundation of government commitment and a reference for the development of renewable energy, as well as assurances for risk impacts [14]. Hence, examining how efforts are being made to transition Indonesia's energy supply is critical. Given the significant potential and lack of resource optimization in the renewable energy sector. Furthermore, other similar studies have only examined the potential for renewable energy resources, which can be an option for their utilization. As a result, this research will assist the government and policymakers in Indonesia in accelerating renewable energy.

2. Research method

This study used a qualitative descriptive method to analyze the optimization of renewable energy in Indonesia as part of the country's energy transition. The methodology is not only a collection of methods or research techniques but rather the entire foundation of values (especially those concerning the philosophy of science), assumptions, ethics, and norms that become the rules used to interpret and infer research data, including criteria for assessing the quality of results research [27]. Based on a review of reputable international journals from the last five years, 2018-2022, there is a linkage or relevance to renewable energy sources, energy policies, and alternative energy to see the energy transition [28]–[30]. As a result, the optimization of renewable energy in Indonesia through energy transition from the source and policy side was examined [31]. This study's data collection method includes literature reviews, secondary data from government reports on renewable energy,

and articles related to energy transition efforts in Indonesia from the media over the past five years (2018-2022). In addition, infrastructure and policies supporting the energy transition acceleration are visible evidence of the energy transition efforts [32]. However, in this study, the authors analyze energy transition policies in planning and developing renewable energy infrastructure.

Table 1. Policies of renewable energy infrastructure

Number	Policies
1	Presidential Regulation Number 47 of 2017
2	Regulation of Minister of Energy and Mineral Resources Number 3 Years 2017
3	Regulation of Minister of Energy and Mineral Resources Number- 12 Years 2018
4	Regulation of Minister of Energy and Mineral Resources Number 5 Years 2018
5	Law No. 30 of 2007

Source: Indonesia Ministry of Law and Human Rights [33]

The authors then analyzed the data using the NVivo 12 plus software, particularly the crosstab tool. Indicators that show the substance of the policy are discovered through policy analysis. To ensure objectivity and improve the quality of the analysis, the authors double-checked the data by comparing it to data from other sources as a confirmation technique [34].

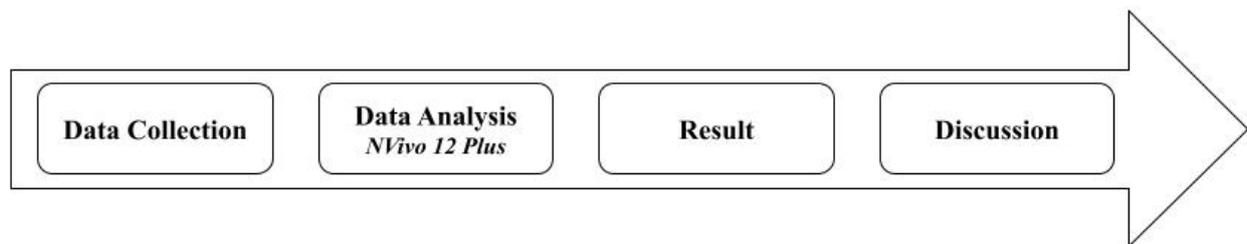


Figure 2. Data collection process

Figure 2 shows the stages of this research: 1) data collection via Twitter (1 June 2022 until 14 June 2022 with government account @djebtk, @kementerianESDM, and @dewanenergi), data sources from government reports, articles, and renewable energy policy products (look at table 1); 2) data is gathered from each source; 3) data is collected using the NVivo 12 plus software; 4) the following stage is data visualization as a study material for study and discussion by using NVivo 12 plus software [35].

The final stages is data analysis. Data analysis was carried out concurrently with the data collection process using data analysis techniques commonly used in qualitative research. The qualitative data were analyzed using inductive and logical methods. This qualitative data analysis procedure has two major components: data reduction and interpretation. The data analysis process in qualitative research includes examining, selecting, categorizing, evaluating, comparing, synthesizing, and finalizing coded data, which is done cyclically to build conclusions, retest premises, and conclude.

3. Results and discussion

3.1 Renewable energy for sustainable development

Energy plays a critical and strategic role in the social, economic, cultural, and political sectors, promoting advanced civilization by meeting the needs of all people. Energy works as basic community activities like household needs and transportation [30]. Energy's role in meeting the needs of households, businesses, and industry, as well as traded goods, promotes its widespread use [24]. As a result, the growing energy demand necessitates unlimited and abundant energy availability. The increase in community energy demand must be balanced with energy availability to meet the needs [36].

In Indonesia, fossil energy (oil, natural gas, and coal) dominates energy consumption, while renewable energy is still a marginal alternative [17]. Dependence on fossil energy threatens stability, including price instability and high demand for fossil energy production, which reduces fossil energy reserves if no new fossil energy sources are discovered. The environmental damage caused by pollution is another threat when fossil energy is still used as a primary energy source [5], contrary to the goal of sustainable development as an effort to meet the needs of the present without jeopardizing future generations' ability to meet their needs.

Ensuring access to affordable, reliable, sustainable, and modern energy for all sustainable development goals demonstrates how energy security and sustainable development are inextricably linked. This connection highlights that energy security influences the overall system's sustainability [14]. To achieve prosperity by ensuring energy security, inclusive governance in the energy sector is required, as are changes or transitions from fossil energy use to renewable energy [37].

The availability of resources, of course, aids efforts to realize the energy transition [38]. The sun, water, micro-hydro, wind, geothermal, ocean waves, and bioenergy have great potential in Indonesia [26].

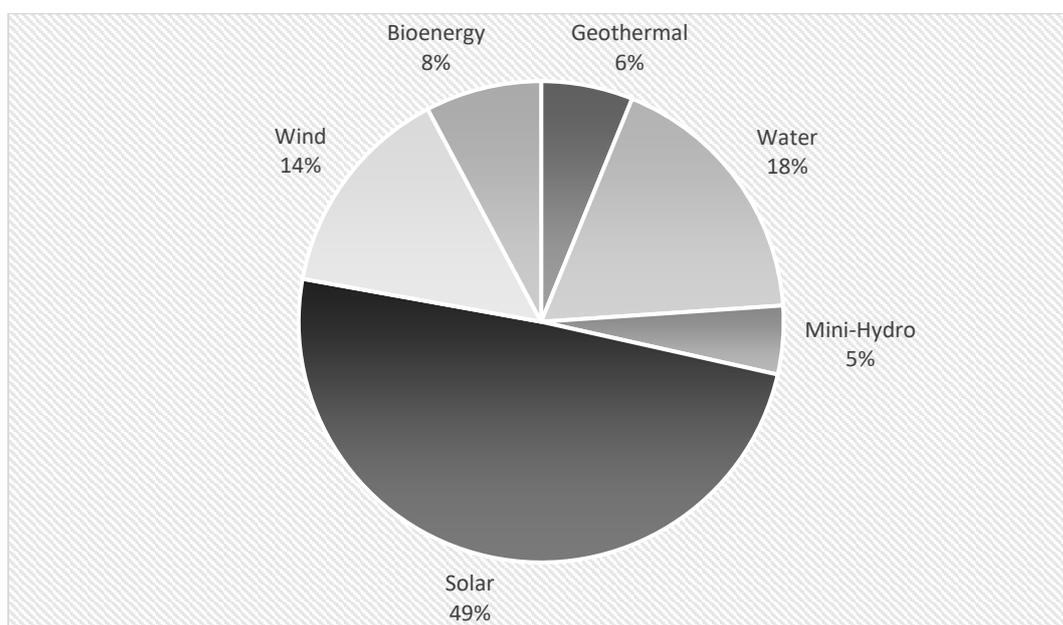


Figure 3. Renewable energy potential (MW) [26]

Indonesia has a renewable energy potential of 443 GW, with solar power accounting for 49 percent (207 MW), water accounting for 18 percent, wind accounting for 14 percent, bioenergy accounting for 8%, geothermal accounting for 6%, and mini-hydro accounting for 5% [19]. With such enormous resource potential, it should be possible to create access to clean, and renewable energy to achieve sustainable development. Most renewable energy sources, such as geothermal, water, bioenergy, and solar, are used for power generation [6]. However, only 7 GW of Indonesia's total renewable energy sources are used and commercialized [32]. Hydro and geothermal energy are used to generate total energy, particularly in new power plants. Due to the high level of need and the inability to manage other resources, Indonesia lags in sustainable development efforts [39]. This issue should be prioritized in sustainable development efforts so that renewable energy can be managed optimally. The underutilization of renewable energy sources in Indonesia demonstrates that efforts to transition to renewable energy have not been carried out optimally. These optimization efforts need to match the considerable potential of natural resources owned.

According to the United Nations, energy is the main point of every challenge and opportunity facing today [25]. Therefore, energy is vital for human development [6]. However, energy has two opposite effects; with good benefits, energy also has a domino effect and potential for harm [12]. Energy production can negatively impact human health and the environment due to pollution, production-related accidents, and greenhouse gas emissions

[40]. There is, indeed, no actual energy, that it has no adverse side effects and is safe. In contrast to clean energy from renewable sources, fossil energy sources cause short-term damage [41].

As a country with significant resource potential in the renewable energy sector, Indonesia still needs to catch up in the transition towards renewable energy following predetermined targets [6]. As of 2025 and 2050, Indonesia targets 23% and 31% renewable energy. However, there is an imbalance in its implementation which is considered slow because, in 2021, renewable energy only reached 6%. In addition, Indonesia has also been predicted to experience a significant increase in energy consumption, which is in line with economic growth in various sectors, projected to increase by 80% in 2030, harming the environment. Directly with Indonesia's primary energy sources of fossil energy will have a direct impact on CO₂ production [26].

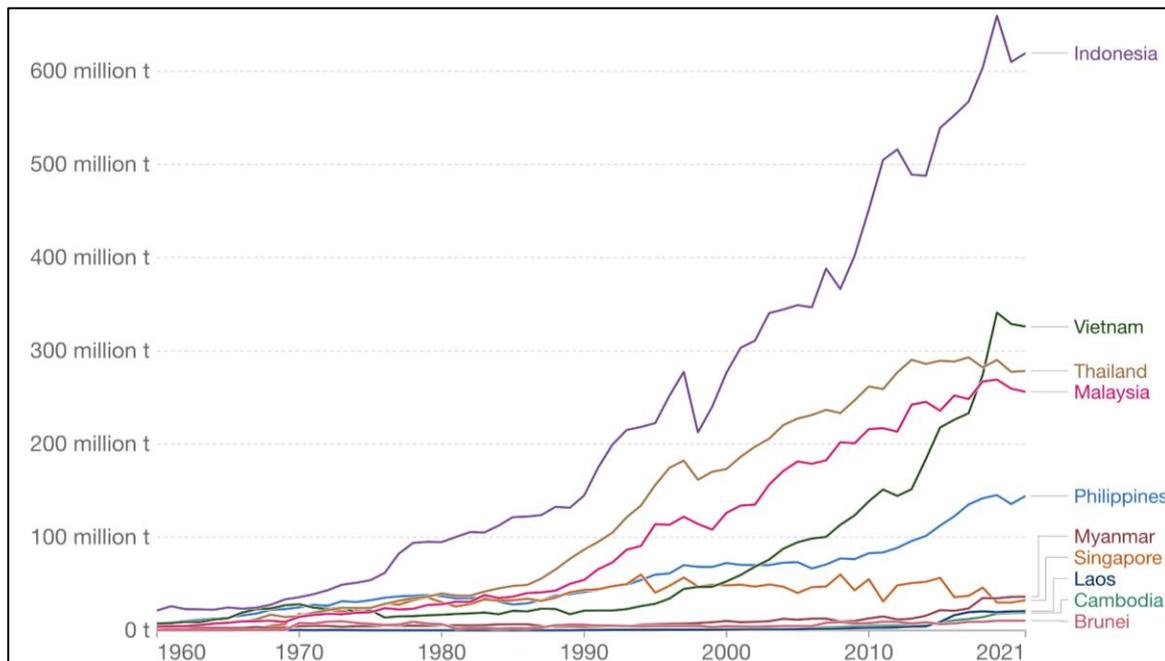


Figure 4. Annual CO₂ Emissions [42]

Based on Figure 4, Indonesia is a country in Southeast Asia with CO₂ production (619.28 million t in 2021), which continues to experience a fluctuating increase every year. The accumulation of data in Figure 4 is based on the production of emissions from burning fossil fuels [42]. The emissions increasing each year are also affected by growth of population size [18]. There needs to be more balance between Indonesia's primary energy and the utilization and development of renewable energy resources in Indonesia, which directly affects the high production of emissions in Indonesia.

Following sustainable development and the energy trilemma, including energy security, energy equity, and environmental sustainability efforts on energy transition and implementation on Indonesia's energy consumption have not optimally implemented the concept of sustainability, especially in the three indicators of the energy trilemma [13]. Consequently, renewable energy clearly explains how to provide opportunities to minimize the energy sector's environmental impact and promote sustainable development strategies. Therefore, renewable energy is an effective way to overcome the dilemma of increasing energy needs and environmental problems by using energy as efficiently as possible to reduce greenhouse gas emissions.

3.2 Renewable energy policy

The decreased production of fossil energy due to high consumption levels, particularly oil, and the global commitment to reducing greenhouse gas emissions have prompted the government to continuously increase the role of new and renewable energy to ensure energy security and independence. According to Government

Regulation 79 of 2014 on the National Energy Policy, the target for the renewable energy mix in 2025 is at least 23% and 31% by 2050 [32]. Renewable energy policies are critical when considering fuel energy for economic growth and development. The core of policymaking is ensuring energy supply security, diversity, and sustainability at competitive prices [9].

Supporting policies are needed as a framework for Indonesia's energy transition to renewable energy, which is still in its early stages. Several efforts have been tried to support this transition, such as developing low-cost funding facilities for investment, creating a good transition roadmap, and improving governance [10]. Stakeholders' commitment to renewable energy infrastructure planning and development policies is one of the keys to the success of energy transition efforts [9]. Also, it aims to create a highly complex and competitive energy transition [39].

It demonstrates barriers to renewable energy transition from 30 renewable energy regulations and five policies in the planning and developing renewable energy infrastructure, as depicted in Figure 5.

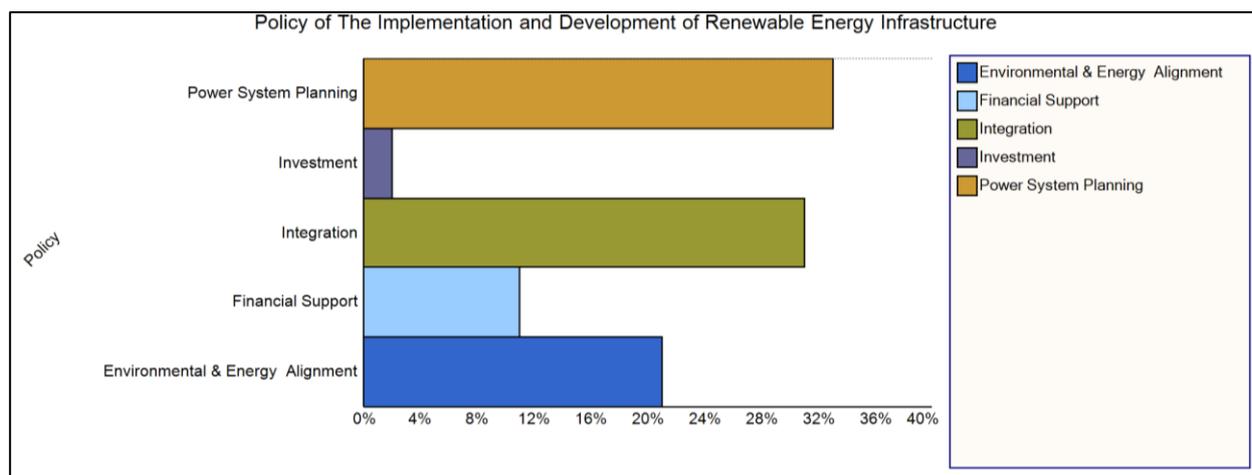


Figure 5. The implementation and development of renewable energy infrastructure policy (percent)

Source: Processed by the authors through NVivo 12 Plus

The substance of government policies is mostly related to power system planning, followed by integration, environmental & energy alignment, financial support, and investment, according to the five indicators for looking at renewable energy policies to support the energy transition. The government's policy products identify the factors causing Indonesia's slow transition to renewable energy. Discussions about the planning system alone often dominate its policy products. The government then discusses integration in implementing the energy transition to renewable energy in approximately 30% of its policy products. In this case, integration includes the integration of regulations with implementing actors at both the central and regional levels, as well as managing renewable energy resources. For example, the integration of the General National Energy Plan (RUEN) and the Regional Energy General Plan (RUED) is one of implementation on this integration.

Efforts on energy transition have resulted in 22 percent of them harmonizing the environment with energy. The proportion of environmental and energy harmony for government policy products is deemed adequate because the energy transition effort aims to create environmental stability by utilizing environmentally friendly energy, specifically renewable energy. Referring to Presidential Regulation No. 5 of 2006 concerning the National Energy Policy for the development of renewable energy in Indonesia, the renewable energy mix target for 2025 is 23%, and the target for 2050 is 31% [32]. The renewable energy mix target for 2025 is 23%, and the target for 2050 is 31%. The installed capacity of biomass will be 180 MW in 2020, the installed capacity of wind (PLT Bayu) will be 0.97 GW in 2025, the solar capacity will be 0.87 GW in 2024, and the nuclear capacity will be 4.2 GW in 2024. The total investment required for EBT development through 2025 is anticipated to amount to USD 13,197 million. Accordingly, the government's commitment to the target amount is required, particularly in specific policies for funding the transition to renewable energy [9].

However, Indonesian policy products in conceptual energy transition efforts still need to be improved. For example, less than 12% of policy products produced are related to financial support; in general, financial support policy products are still primarily sourced from the State Revenue and Expenditure Budget (APBN) and Regional Revenue and Expenditure Budget (APBD) [43]. Furthermore, the Energy Policy Tracker in 2021 discovered that the government allocated USD 6.5 billion for fossil energy while only channeling USD 0.24 billion for clean energy [9]. The complete energy transition requires substantial costs or capital. In addition, the government cannot independently fund energy transition projects that have not made substantial progress. Thus, other actors were required to collaborate to realize the energy transition, particularly in terms of financial support, including investors' investments [9], [19], [44].

However, in Figure 5, the obstacle is that the resulting policies are still minimal in the discussion, leading to investment in energy transition projects. Of the total policies produced, only 2 percent of the substance in the policy talks about investment. On the other hand, investment plays an important role in the development of a country because large investments will create the production of goods and services and create jobs, which, of course, affect the economy and development of the country. Also, investment can boost the economy and become a component of a country's income [41]. Through the need for large fees or costs, financial support from private and other investments is needed.

Given the enormous investment needs, the government needs to establish the supporting policies and regulations needed to improve the investment climate in Indonesia. However, one of the reasons for the slow energy transition in Indonesia is the investment climate that is still low and not yet good in this country [22]. The investment climate in Indonesia is considered unfavorable for developing renewable energy. In addition, the licensing process among developers is considered to take a long time, which will impact swelling transaction costs. This poor investment trend is indicated by the low investment that contributes to renewable energy, which is USD 1.17 billion, in contrast to fossil investment which reached USD 2.01 billion in the same period, namely Q3 2021 [11].

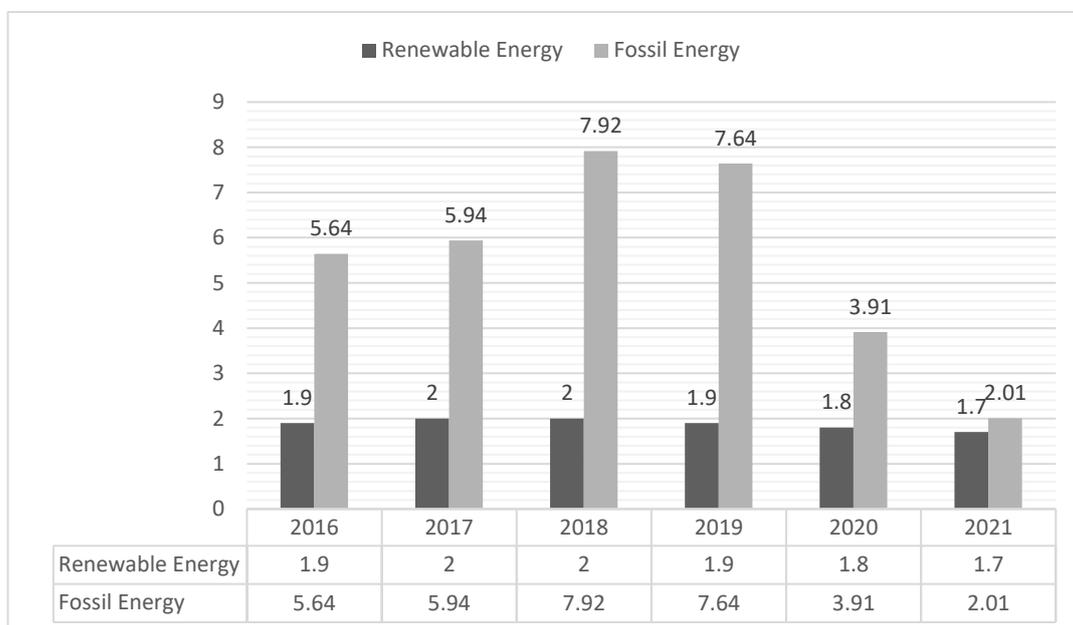


Figure 6. Policy energy investment in Indonesia (USD)

Source: Outlook Energi Indonesia, 2021 [6]

Based on Figure 6, there are significant differences related to energy investment between renewable energy and fossil energy. From 2016 to 2021, the investment trend in the renewable energy sector has never exceeded 2 billion USD. Where the graph of investment in renewable energy on average only increased from 0.1 to 0.2

billion USD. However, this number is different from the trend of investment in fossil energy which is classified as larger than investment in renewable energy.

Seeing the trend of investment in the renewable energy sector, which tends to be slow, as well as high barriers, the government is serious about improving the investment climate. Then the government must build strong and competitive investments, allowing the investment process to be transparent, clear, and predictable [22]. The procedures and requirements for developing renewable energy are too complex and complicated. Therefore, to make the energy transition a success, the government needs to improve the investment climate by improving the policy and regulatory framework. In addition, the involvement and participation of multiple actors, especially policymakers, is crucial in transitioning energy to renewable energy.

On the other hand, the economic crisis has caused delays in renewable energy development projects in various regions, and due to policies during COVID-19, such as regional and physical restrictions to prevent the spread of COVID-19. Several countries were forced to adjust the target and schedule of renewable energy development projects by extending the project time [6]. For example, in Austria, the government extended the construction time of wind power plants by six months. France extended the target by two to six months. COVID-19 can change the direction of government policies toward renewable energy. The emergency of health and economic recovery and the uncertainty of the world situation due to COVID-19 can hamper the energy transition [37].

Although, government commitment to renewable energy is also progressing. In this supporting this idea, the government also, enacted five more polices to achieve the implementation of renewable energy up to 125 percent of the target 2021 [9]. Moreover, regulations that have been enacted based on the Directorate General of New Renewable Energy (EBT) performance report in 2021, including (a) Minister of Energy and Mineral Resources Regulation No. 2 of 2021 concerning the Implementation of Quality Standards for Crystalline Silicon Photovoltaic Modules. (b) Minister of Energy and Mineral Resources Regulation No. 14 of 2021 concerning implementing Minimum Energy Performance Standards and the Inclusion of Energy Saving Labels for Energy Saving Equipment. (c) Minister of Energy and Mineral Resources Regulation No. 24 of 2021 Amendment to the Minister of Energy and Mineral Resources No. 41 of 2018 concerning the Provision and Utilization of Biodiesel Types of Biofuels in the Financing Framework by the Oil Palm Plantation Fund Management Agency. (d) Regulation No. 26 of 2021 of the Minister of Energy and Mineral Resources relates to Rooftop Solar Power Plants Connected to the Electric Power Network. Although the direction of Indonesia's energy transition strategy becomes clearer with each passing year, the pace of energy transition must be accelerated to achieve the desired results [45]. Accelerating the rate of the energy transition, of course, necessitates synergy in a variety of areas, including financial support, because using renewable energy is expensive [2].

Finally, each indicator, beginning with power system planning, integration, environmental and energy alignment, financial support, and investment, is linked to the achievement of Indonesia's energy transition efforts. The proportion of each indicator, whether large or small, affects the rate of the energy transition. In this case, the resulting policy products related to the transition to renewable energy in Indonesia do not yet have the appropriate proportion for implementation. It has not been prioritized because the policy products produced thus far have only been based on concepts rather than actions to realize the energy transition, as seen from the low financial support and the government-created climate or environment, which has not been directed or profitable for investment. Wardhana [11] found that efforts to meet Indonesia's energy needs still need to complete the three key indicators of the energy trilemma: energy security, energy equity, and environmental sustainability backs this up. On the other hand, the country might need to meet its goals for clean energy [11]. The findings are by evidence of the Indonesian government's in the implementing renewable facing some obstacles. The government policy is just a concept but is lack of implementing. In addition, the polices do not give an incentive for the investor to provide renewable energy sources. Policies already establish but the implementation is just bit service. The renewable energy can not be implemented due to of COVID-19 and a government lack of financial, climate, or environmental support, which has yet to be directed or profitable for investment.

4. Conclusion

Indonesia has enormous clean energy potential as a country rich in natural resources. However, the magnitude of this potential is different from optimal utilization. Indonesia's primary energy sources are still dominated by fossil energy. This condition will cause problems, especially in the environment. As a result, energy must be converted into renewable energy. Policies that must be aligned and entirely in favor of Indonesia's energy transition efforts are roadblocks to the renewable energy transition. Based on the results of data analysis, policies regarding renewable energy in Indonesia are dominated by power planning systems by 34%. These study findings proved that the resulting policies are still conceptual, and actions to realize the energy transition have yet to be prioritized. In addition, financial support remains low, and the climate or environment created by the government needs to be geared or favorable for investment. Therefore, the authors recommend that government commitment and stakeholder collaboration be required to accelerate the renewable energy transition. The resulting policy products, especially the resulting policy products, must fully support the energy transition efforts needed. This study has limitations regarding data collection time and process, which consists of examining laws or policies about the energy transition, official government reports, and various scholarly sources. Therefore, additional research on renewable energy sources or a broader perspective is necessary.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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