

Addressing Indonesia's Fossil Fuel Dependence: A Path Towards a Sustainable Future

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Abstract

Fossil energy technologies, such as coal, oil, and natural gas, have been crucial in meeting Indonesia's energy demands but contribute significantly to greenhouse gas emissions and environmental degradation. This study examines Indonesia's current energy landscape, the potential for transitioning from fossil fuels to renewable energy, and the role of clean energy technologies in supporting this shift. A qualitative research approach was employed, systematically reviewing recent literature to analyze the challenges and opportunities in Indonesia's energy sector. The findings highlight that while fossil fuels remain a dominant energy source, clean technologies like Carbon Capture and Storage (CCS) and improvements in energy efficiency offer promising solutions to reduce emissions. However, significant barriers remain, including high production costs for renewable energy, lack of infrastructure, and technological limitations. The study also finds that increasing investments in renewable energy and diversifying energy sources are critical to achieving Indonesia's energy security and sustainability goals. In conclusion, Indonesia must prioritize a gradual but firm transition to renewable energy, supported by clear policy frameworks, financial incentives, and international cooperation. A diversified energy mix will not only enhance energy security but also help reduce environmental impacts, aligning Indonesia with global climate goals.

Keyword : Clean Fossil Energy Technology, Renewable Energy, Energy Transition Policy.

INTRODUCTION

Indonesia is a country with abundant natural resources, including fossil fuels such as coal, oil, and natural gas. These resources have played a major role in Indonesia's economic development, providing electricity, transportation, and industrial energy. However, the use of fossil fuels also contributes to greenhouse gas emissions, which are a major cause of climate change. In recent years, Indonesia has begun to transition away from fossil fuels and towards renewable energy. In 2021, President Joko Widodo announced that Indonesia would achieve net-zero emissions by 2060 or sooner. This announcement has led to a number of changes in Indonesia's energy policy, including the revision of the RUPTL (Rencana Usaha Penyediaan Tenaga Listrik, or Electricity Supply Business Plan) and the Pertamina Energy Outlook as shown in Figure 1.



Figure 1. PT PLN (Persero) Business Area Map.

Fossil energy technologies have played an important role in Indonesia's economic and industrial development. However, continued reliance on fossil energy has serious consequences, such as increased greenhouse gas (GHG) emissions that contribute to global climate change and environmental degradation. Currently, Indonesia faces major challenges in transitioning from fossil energy to more sustainable energy sources for the future. The use of fossil fuels significantly increases GHG emissions, leading to climate change and extreme weather. Therefore, a massive transition to renewable energy is needed to reduce negative environmental impacts (Raihan, 2023). Indonesia, once a major exporter of oil, is now a net importer of oil since 2004. Predictions show that Indonesia will become a net importer of natural gas and coal by 2028 and 2038, respectively. This decline in fossil energy reserves necessitates the development of new and renewable energy technologies (Ngarayana et al., 2021). The potential for renewable energy in Indonesia is enormous, including solar, hydro, wind, bioenergy and geothermal energy. However, the implementation of renewable energy technology is still slow despite its enormous potential (Langer et al., 2021). The Indonesian government has set a target to increase the contribution of renewable energy in the national energy mix to 23% by 2025 and 31% by 2050. This reflects Indonesia's commitment to reducing GHG emissions and achieving sustainable development goals (Paundra & Nurdin, 2022).

In addition to the challenges mentioned above, Indonesia faces significant challenges in its efforts to transition from fossil fuels to renewable energy sources. The development of renewable energy in Indonesia is hindered by high production costs, lack of infrastructure, and technological limitations. To overcome these barriers and accelerate the energy transition, cooperation between the government and the private sector is crucial (Sinaga & Manullang, 2022). This aligns with research by Vilas et al., (2021), which emphasizes the importance of public-private partnerships in driving Indonesia's renewable energy development. Indonesia has enormous potential for bioenergy, which could be a solution to achieving energy independence in the future. However, to realize this potential and convert it into tangible benefits, supportive policies and regulations are needed, including incentives, competitive prices, and appropriate subsidies (Saputra et al., 2022). This is supported by a study conducted by Kumar et al., (2021), which highlights the need for a comprehensive policy framework to promote bioenergy development in Indonesia.

Furthermore, Indonesia has a great opportunity to develop hydrogen energy as one of its renewable energy sources. Green hydrogen technology can be developed in Indonesia through the electrolysis process of water, methanol, and biomass. The main challenge faced in this regard is the high production cost, necessitating the participation of other parties for the development of this technology (Sinaga & Manullang, 2022). This finding is consistent with research by Hardi et al., (2021) which identifies cost as a major barrier to the adoption of green hydrogen technology in Indonesia. Indonesia's dependence on fossil fuels not only contributes to environmental degradation but also creates energy insecurity risks due to the limited availability of fossil energy resources. Since 2004, Indonesia has been a net oil importer. The use of fossil energy also produces CO₂, a greenhouse gas that contributes to global warming and climate change. One strategy to address this issue is to implement a new energy system that incorporates renewable energy development and energy efficiency (Hadi et al., n.d.) This is in line with research by Setyono & Kiono, (2021). which emphasizes the importance of energy efficiency measures in reducing Indonesia's reliance on fossil fuels and mitigating greenhouse gas emissions.

In conclusion, Indonesia finds itself at a critical juncture in its energy transition journey. While reliance on fossil energy technologies brings negative environmental and economic impacts, the country's vast potential for renewable energy offers hope for a more sustainable future. Collaboration between the government, private sector, and society is essential to overcome the challenges and optimally utilize the potential of renewable energy in Indonesia.

By embracing renewable energy sources and implementing supportive policies, Indonesia can pave the way for a cleaner, more secure, and sustainable energy future. This is supported by research from Broska, (2021) which highlights the critical role of multi-stakeholder collaboration in accelerating Indonesia's energy transition. This paper will review the relationship between fossil energy technology and the future of energy in Indonesia. It will discuss the role of fossil fuels in Indonesia's energy system, the challenges of transitioning to renewable energy, and the implications of Indonesia's net-zero emissions target.

RESEARCH METHODS

This research uses a qualitative approach, which analyzes the literature systematically. The steps in this research include literature searches, the literature referred to in this research is in the form of books, journals, theses/dissertations, as well as papers related to the title, filtering based on inclusion and exclusion criteria, and data extraction. The data used in this research are scientific publications over the last 10 years and focus on the role of fossil energy technologies in shaping indonesia's sustainable energy future. The data is then analyzed to answer the research problem formulation. This method is a method that is suitable for use in research that aims to provide an overview of a particular problem or problem in this research (Morgan, 2019).

RESULT AND DISCUSSION

Potential Fossil Energy Technologies in Indonesia

Fossil fuels, including oil, natural gas, and coal, dominate Indonesia's primary energy mix, accounting for over 90% of the total energy consumption. This heavy reliance on fossil fuels significantly contributes to greenhouse gas emissions and environmental pollution, highlighting the need for a transition to more sustainable energy sources (Pambudi et al., 2023). However, there is significant potential for future development in Indonesia's fossil energy sector. The natural gas sector, for instance, presents considerable potential for development as a cleaner alternative to coal and oil and can serve as a transitional energy source until renewable energy technologies become more widespread (Dutu, 2016). Additionally, there is substantial potential for biomass co-firing in existing coal power plants, which can help achieve Indonesia's target of 23% new and renewable energy in the national energy mix by 2025 (Sugiyono et al., 2022).

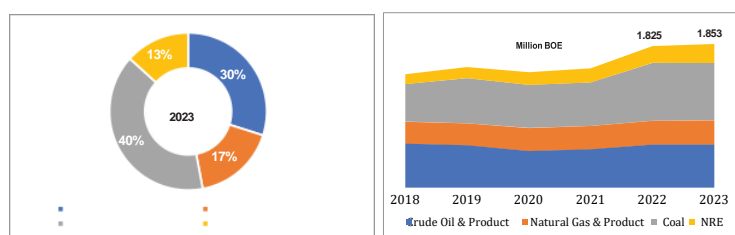


Figure 2. Primary Energy Supply

In line with the growth of the Indonesian economy, Indonesia's energy supply in 2023 will also increase by 1.55% from the previous year with a value of 1,853 million BOE or the highest in the last six years. The supply of fossil energy such as crude oil and products and coal experienced a slight decline from the previous year, while natural gas and renewable energy (NRE) products experienced an increase of 3% and 13.8% respectively from the previous year.

The primary energy mix is still dominated by coal at 39.69%, followed by petroleum at 29.91%, natural gas at 17.11%, and NRE at 13.29%. The NRE mix is targeted to reach 23% by 2025 as shown in Figure 2. Economically, fossil fuels remain a cost-effective option due to their established infrastructure and lower operational costs compared to renewable energy sources (Aswadi et al., 2023). The export of fossil fuels, particularly coal and oil, continues to be a significant source of revenue for Indonesia, supporting economic stability and growth (Resosudarmo et al., 2023). Technically, the technology for extracting and utilizing fossil fuels is well-established and reliable, with existing infrastructure supporting further development (Firmansyah et al., 2023). Moreover, utilizing domestic coal and natural gas resources reduces dependence on imported oil, enhancing national energy security.

While there is a significant push towards renewable energy, fossil fuels still play a critical role in Indonesia's energy mix due to their cost-efficiency, established technology, and contribution to economic growth. However, balancing the development of fossil fuels with the transition to renewable energy sources is essential to achieve sustainable energy goals and reduce environmental impacts.

Challenges of Fossil Energy Use

The use of fossil energy brings significant challenges, particularly in terms of environmental impacts, climate change, fossil fuel import dependency and energy price fluctuations. Fossil energy such as coal, oil and natural gas are the main sources of greenhouse gas emissions, especially carbon dioxide (CO₂). Burning fossil fuels produces CO₂, which contributes greatly to global warming and climate change. In addition, burning fossil energy also produces other pollutants such as sulfur dioxide (SO₂), nitrogen oxides (NO_x) and particulate matter (PM). These pollutants cause human health problems, including respiratory and cardiovascular diseases. Fossil fuel exploration and extraction can also cause ecosystem damage, such as deforestation, water pollution and biodiversity loss. For example, oil spills can damage marine and coastal habitats (Jian-peng et al., 2019).

Indonesia is still heavily dependent on imports of fossil fuels, especially petroleum. This dependence makes the country vulnerable to global price fluctuations that can affect national economic stability. Fossil fuel prices in the international market are highly volatile and are influenced by a variety of factors, including politics, economics and weather. These price fluctuations can lead to instability in domestic energy prices, which in turn can impact industrial production costs and the prices of goods and services. The use of fossil energy has significant impacts on the environment and climate change, and leads to import dependency and price fluctuations that affect economic stability. To address these challenges, there is a need to diversify energy sources and increase the use of renewable energy.

The Role of Fossil Energy Technologies in the Energy Transition

Clean fossil energy technologies, such as Carbon Capture and Storage (CCS) and improved power generation efficiency, can contribute significantly to reducing greenhouse gas emissions during Indonesia's energy transition. By capturing CO₂ and improving efficiency, these technologies allow the fossil energy industry to play a role in global climate change mitigation efforts. However, investment in renewable energy technologies remains crucial for achieving a sustainable energy transition. Allocating funds for research and development in solar, wind, and hydro power can accelerate the adoption of cleaner energy sources while promoting economic growth. Appropriate policies and regulations are necessary to support Indonesia's energy transition. The government must set clear emissions reduction and renewable energy targets, provide financial incentives, and implement strict emissions and efficiency standards. Increasing public awareness and participation through education and training campaigns is also essential.

Future Scenarios for Fossil Energy in Indonesia

Potential scenarios for a phased reduction of fossil energy use in Indonesia include improving energy efficiency in key sectors, implementing supportive policies, and adopting clean technologies like CCS. This gradual transition requires strong commitment from the government and private sector to invest in clean energy infrastructure. Increased use of renewable energy can help Indonesia achieve a sustainable energy future, reduce greenhouse gas emissions, drive technological innovation, and create new jobs. Diversifying Indonesia's energy sources is critical for improving energy security and resilience. By reducing dependence on a single energy source, Indonesia can better withstand price fluctuations and supply disruptions. Diversification should include a mix of renewable energy sources and clean technologies for fossil fuels, as well as developing local energy resources to reduce import dependence. In conclusion, Indonesia's energy transition requires a multi-faceted approach that includes adopting clean fossil energy technologies, increasing investment in renewable energy, implementing supportive policies and regulations, and diversifying energy sources. By pursuing these strategies, Indonesia can build a more sustainable, resilient, and secure energy future.

CONCLUSION

Fossil energy technologies play an important role in meeting Indonesia's current energy needs. However, fossil energy use needs to be reduced to achieve a sustainable energy future. Clean fossil energy technologies, such as Carbon Capture and Storage (CCS) and improved power plant efficiency, can help reduce greenhouse gas emissions and negative impacts on the environment. CCS works by capturing and storing CO₂ produced from burning fossil fuels, while energy efficiency technologies reduce the amount of fuel required to produce the same energy. An effective energy transition is needed to reduce emissions and improve Indonesia's energy security. This involves increasing the use of renewable energy, such as solar, wind and hydro power, which not only reduces dependence on fossil fuels but also reduces greenhouse gas emissions that contribute to climate change. Investments in renewable energy technologies are essential to drive innovation, create new jobs, and increase the country's energy independence. In addition, appropriate policies and regulations are needed to support Indonesia's energy transition. The government needs to set clear targets for emissions reduction and renewable energy use, and provide financial incentives such as subsidies and tax incentives to encourage investment in clean energy technologies. Strict regulations on emissions and energy efficiency standards can also ensure that energy companies operate in a more environmentally friendly way.

By adopting clean fossil energy technologies, increasing investment in renewable energy technologies, and implementing appropriate policies and regulations, Indonesia can achieve a more sustainable energy future and reduce negative environmental impacts. Diversification of energy sources is also crucial to improving Indonesia's energy security, reducing dependence on imports, and creating an energy system that is more stable and resilient to various economic and environmental challenges.

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