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Fossil Energy Technology And The Future Of Energy In Indonesia

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Abstract – This article discusses the urgency and role of fossil energy technology in providing clean, affordable, and sustainable electricity in Indonesia. The focus on the Clean Coal Program as a strategic step by the Government reflects concrete efforts in developing a technology portfolio. Despite challenges related to environmental impact, the essence of this article summarizes the progress of fossil energy technology, emission standards, and adaptation to diverse environmental conditions. The Electricity Supply Business Plan (RUPTL) for 2021-2023, as a crucial foundation, demonstrates the ambition to enhance the role of Renewable Energy (RE), although the current realization falls below the target. The transformation of coal-fired power plants into RE generators and the commitment to the Paris Agreement represent proactive steps in the energy transition, emphasizing sustainability and positive environmental impacts. The dynamics of Indonesia's energy transition face complex challenges and debates regarding acceleration or gradual approaches. While new and renewable energy takes center stage, an evaluation of optimistic scenarios highlights the complexity of the energy system transformation towards a green future. This article depicts the dynamics and complexity of the shift towards clean energy and explores opportunities and challenges in Indonesia's future.

Keywords – Technology, Energy, Fossil

I. INTRODUCTION

With the rapid growth in energy demand and the determination to achieve clean energy resources, this discussion highlights the importance of exploring the potential of fossil energy technology to ensure the availability of clean, affordable, and abundant electricity in the future. Furthermore, the focus on the Clean Coal Program as a strategic step in technology portfolio development demonstrates concrete efforts by the Indonesian Government. Progress in fossil energy technology and efficiency improvements takes center stage, providing a foundation for creating revolutionary concepts in coal-based power generation. The introduction of NSPS standards and emission limits for power plants creates the necessary regulatory context, emphasizing government involvement in directing the energy sector towards sustainability principles. Assumptions about fuel feed rates and condenser operational conditions, even under ISO conditions, provide an overview of the need for adaptation of fossil energy technology to diverse environmental conditions in Indonesia. The emphasis on the importance of cooling systems in fossil energy technology reflects awareness of environmental impact and the sustainability of water use. Efficiency improvements with dry and parallel cooling systems, especially under ISO conditions, indicate potential solutions that can be applied to support sustainability goals in the energy sector.

The Electricity Supply Business Plan (RUPTL) 2021-2023 serves as a crucial foundation for the Indonesian Government's efforts to enhance the role of Renewable Energy (RE) in electricity supply. In the context of the National Electricity General Plan (RUKN), Indonesia aims to achieve a 23% RE mix by 2025. However, realization by the end of 2020 only reached 14%, raising serious concerns for the Government regarding the sustainability of future energy supply. The transformation of Diesel Power Plants (PLTD) into RE generators is the latest strategy implemented by the State Electricity Company (PLN). This

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effort aims not only to reduce dependence on fossil energy but also takes a proactive step in exploring environmentally friendly energy sources and maximizing local energy potential. Indonesia's national energy policy underscores a serious commitment to transition from fossil energy to cleaner, low-emission, and environmentally friendly energy sources. In line with this commitment, Indonesia aims to achieve greenhouse gas emission reduction targets in accordance with the Paris Agreement, with a 29% self-target and 41% with international assistance. This program focuses not only on sustainability but also targets positive environmental impacts. With the increasing proportion of Renewable Energy reaching 51.6%, while the proportion of fossil energy decreases to 48%, Indonesia strives to create a new paradigm in environmentally friendly and sustainable electricity provision. This paper will delve deeper into the concrete steps and impacts of this transformation on the energy sector in Indonesia.

In the context of global energy dynamics, Indonesia faces complex challenges as the domestic energy sector strengthens. While efforts to enhance energy resilience continue, debates about the energy transition become increasingly polarized, considering potential energy crises. Some perspectives advocate for accelerating the energy transition to improve resilience, while others support a gradual approach, emphasizing a balance between pressure on the fossil energy supply side and acceleration on the demand side. The importance of commitment to the energy transition towards clean and low-carbon energy sources is increasingly evident. New and Renewable Energy (NRE), such as wind, solar, water, and geothermal energy, takes center stage, despite challenges related to intermittent characteristics and dependence on natural factors. The paper will also explore the dynamics of energy transition in Indonesia, considering options such as nuclear energy, increasing biofuel use, and Carbon Capture and Storage (CCS) technology to support low-carbon hydrogen production. Although fossil energy, especially coal and oil, still dominates Indonesia's energy landscape, the proportion of NRE in 2022 has not yet reached the ambitious national target. By evaluating optimistic scenarios involving an increase in primary energy needs to achieve per capita income equivalent to developed countries and reach the Net Zero Emission (NZE) target, we can grasp the complexity of the energy system transformation towards green energy. Despite significant challenges, government commitment and green technology developments are expected to bring about significant changes in the future.

This paper also examines global efforts to reduce emissions, particularly through the use of renewable energy in power generation. While some fossil energy companies divest assets, increasing investments in the low-carbon energy sector provide a positive outlook for the growth and evolution of this sector. Considering affordability and supply security, this paper will investigate the crucial role of fossil fuels in the global energy context by 2050, while highlighting positive changes in low-carbon business investment

II. The Potential of Fossil Energy Technology in Indonesia.

The rapid growth of energy demand in Indonesia drives the necessity for exploration and utilization of fossil energy technology. This discussion highlights the essence of tapping into the potential of fossil energy technology as a primary strategy to ensure the availability of clean, affordable, and abundant electricity in the future. The focus on the Clean Coal Program serves as a concrete example of the Indonesian government's steps in building a sustainable technology portfolio, with increased efficiency and technological advancements at the forefront.

The potential of fossil energy technology in Indonesia indicates that the country still heavily relies on fossil energy sources, especially oil, gas, and coal. Nevertheless, the Indonesian government is also promoting the transition to the use of New and Renewable Energy (NRE) to reduce dependence on fossil energy. Indonesia has a potential NRE resource of over 400 GW, but only about 2.5% or 10 GW is currently utilized. The Minister of Energy and Mineral Resources (ESDM) states that an energy transition is crucial to maintain energy availability in the future. Additionally, Indonesia is regulating various strategies to optimize the use of new and renewable energy, such as solar, wind, and bioenergy. However, during the energy transition period, fossil energy will still be utilized as a temporary energy source in Indonesia. Therefore, while Indonesia continues to rely on fossil energy, efforts to develop and utilize new and renewable energy are also underway.

III. The Transformation of New and Renewable Energy (NRE) through the Electricity Supply Business Plan (RUTPL) 2021-2023

The Electricity Supply Business Plan (RUPTL) 2021-2023 serves as a critical foundation in the Indonesian government's efforts to enhance the role of New and Renewable Energy (EBT) in electricity provision. Despite ambitious targets for a 23% share of EBT in the energy mix by 2025, the realization only reached 14% by the end of 2020, raising concerns about the

sustainability of future energy supply. The transformation of Diesel Power Plants (PLTD) into EBT generators is a strategic step to reduce dependence on fossil energy and optimize local energy sources.

Through the General Electricity Plan (RUTPL) 2021-2023, Indonesia is committed to increasing the use of New and Renewable Energy (EBT) in the national energy mix. In 2022, the EBT generator capacity in Indonesia is 12 GW, and by 2060, the targeted EBT generator capacity is 700 GW, derived from energy sources such as solar, hydro, wind, bioenergy, ocean, geothermal, including hydrogen and nuclear. Accelerating the utilization of solar energy is necessary to achieve the 23% renewable energy mix by 2025 and to reach net-zero emissions by 2060 or sooner. Additionally, Indonesia is formulating various strategies to optimize the use of new and renewable energy, including the development of geothermal power plants, the utilization of Carbon Capture and Storage (CCS) technology, and the implementation of other New and Renewable Energy and Energy Conservation projects across Indonesia.

IV. The Dynamics of Energy Transition in Indonesia: Challenges and Opportunities

The dynamics of energy transition in Indonesia reflect complex challenges amid the strengthening of the domestic energy sector. While efforts to enhance energy resilience are ongoing, debates surrounding the energy transition have become more polarized, raising questions about potential energy crises in the future. Some perspectives advocate for accelerating the energy transition to improve resilience, while others support a gradual approach, emphasizing the need for a balance between pressure on the fossil energy supply side and acceleration on the demand side.

In this context, the importance of commitment to the energy transition towards clean and low-carbon sources is increasingly evident. Although New and Renewable Energy (NRE) such as wind, solar, water, and geothermal energy takes center stage, challenges related to intermittent characteristics and dependence on natural factors become critical factors. The dynamics of energy transition in Indonesia also include exploring options such as nuclear energy, increasing biofuel use, and implementing Carbon Capture and Storage (CCS) technology to support low-carbon hydrogen production. Despite fossil energy, especially coal and oil, still dominating Indonesia's energy landscape, the proportion of NRE in 2022 has not yet reached the ambitious national target. Evaluating optimistic scenarios, with an increase in primary energy needs to achieve per capita income equivalent to developed countries and reaching the Net Zero Emission (NZE) target, indicates the complexity of the energy system transformation towards green energy. Despite facing significant challenges, government commitment and the development of green technology are expected to bring significant changes in the future, opening new opportunities for energy sustainability in Indonesia.

The Title of the Article	Review
Cost and Performance Baseline for Fossil Energy Plants Volume 1: Bituminous Coal and Natural Gas to Electricity (2022)	Research, Development, and Demonstration of Fossil Energy aim to ensure the availability of highly clean ("0") domestic electricity and energy, abundant, and low-cost, including hydrogen, to promote prosperity, economic strengthening, and energy security. A broad technology portfolio is being developed in the Clean Coal Program to achieve these goals, with continuously improving technology at various research stages. Various paths are being pursued to create a promising technology portfolio for eventual development, demonstration, and implementation. Technological advancements in recent years have created incredible new opportunities for coal. Increasing energy efficiency and significantly reducing environmental impact are key focuses. The goal of the Clean Coal RD&D Program is to leverage these advancements and integrate them into a revolutionary concept for future coal-based power generation and energy production. New NSPS standards apply to units with electricity-generating capacities exceeding 73 MW using fossil fuels, including combined cycle power plants such as

	IGCC power plants. All limitations are based on gross power output, providing options for units to meet emission limits or percentage reductions. These assumptions involve constant fuel feed rates and condenser operational conditions for all cases, though in reality, fossil energy plants are designed for extreme temperatures in both summer and winter. The importance of cooling systems in fossil energy technology is highlighted in this research. Parallel and dry cooling have a significant impact on water consumption, with water savings ranging from 240 to 2.077 million gallons per year. Cost and performance penalties for dry and parallel cooling systems at ISO conditions are smaller compared to higher ambient summer design temperatures, representing the typical power plant design point
Electricity Supply Business Plan (RUPTL) of PT PLN (Persero) 2021-2030.	Through the Electricity Supply Business Plan (RUPTL) 2021-2023, the Indonesian Government is making efforts to increase the contribution of Renewable Energy (EBT) generators. The target for the EBT mix in the National Electricity General Plan (RUKN) is set at 23% by 2025. However, as of the end of 2020, the realization has only reached around 14%, posing a serious concern for the Government regarding the sustainability of future electricity supply. The transformation of Diesel Power Plants (PLTD) into Renewable Energy generators is part of the State Electricity Company's (PLN) initiative to explore environmentally friendly energy sources, tap into local energy potential, and consider estimates of future electricity development and consumption in the respective regions. Indonesia's national energy policy emphasizes the transition from fossil energy use to cleaner, low-emission, and environmentally friendly energy. This step reflects Indonesia's commitment to achieving greenhouse gas emission reduction targets in accordance with the Paris Agreement, aiming for a 29% reduction independently and 41% with international assistance. The program is directed to have a positive environmental impact as it increases the proportion of renewable energy to 51.6%, while reducing the proportion of fossil energy to 48
Pertamina Energy Outlook 2023: Navigating Indonesia’s Energy Transition: Climate-Related Risks	In addition to strengthening domestic energy, the energy crisis has also sparked polarity in the energy transition. Views emerge that the energy transition should be accelerated to enhance energy resilience. Conversely, there's a perspective advocating for a gradual energy transition, where pressure on the fossil energy supply side should be balanced with an acceleration on the demand side. This is crucial because pressure on the supply side, coupled with growing demand, can lead to price volatility or even the next energy crisis. Aligned with the commitment to transitioning towards low-carbon clean energy, the utilization of New and Renewable

	Energy (NRE) continues to rise. Dominant NRE sources include wind, solar, water, and geothermal energy, despite being intermittent and dependent on natural factors like seasons and weather. To support the energy transition, nuclear energy becomes one solution. On the other hand, the global trend of biofuel usage is increasing, driven by lower emissions compared to fossil fuels. Carbon Capture and Storage (CCS) technology supports the development of low-carbon hydrogen technology. CCS can capture and store carbon emissions from fossil energy-based hydrogen production. Although fossil energy still dominates in Indonesia, especially coal and oil, the proportion of NRE in 2022 is still below the National Energy General Plan (KEN) target of 23% by 2025. In an optimistic scenario (ER), primary energy needs significantly increase to achieve per capita income equivalent to developed countries and Net Zero Emission (NZE) targets. Significant challenges arise in transforming the energy system to green energy, especially regarding affordability and energy resilience. While fossil energy remains dominant, government commitment and the development of green technology can bring changes in future scenarios. Various global efforts are being made to reduce emissions and achieve NZE targets, including the use of renewable energy in power generation. Despite some fossil energy companies divesting assets, investments in the low-carbon energy sector continue to grow. The importance of engagement and transparency in addressing climate issues is also emphasized as a more effective step than divestment. Fossil fuels will still be significant in 2050, but investments in low-carbon businesses are increasing. Affordability and supply security remain challenging factors not entirely replaceable by renewable energy. With increasing economic competition in the low-carbon energy sector, there has been positive investment growth in recent years.

REFERENCES

[1] Direktorat Jendral Energi Baru Terbarukan dan Konservasi Energi (EBTKE), 2020, Mentri Arifin: Transisi Energi Mutlak Diperlukan, Humas EBTKE, Quoted on December 22, 2023.

[2] Direktorat Jendral Energi Baru Terbarukan dan Konservasi Energi (EBTKE), 2022, Masa Transisi Energi Menuju Net Zero Emission, Humas EBTKE, Quoted on December 22, 2023.

[3] Direktorat Jendral Energi Baru Terbarukan dan Konservasi Energi (EBTKE), 2022, Energi Baru Terbarukan Berperan Besar Dalam Upaya Penurunan Emisi Di Sektor Energi, Humas EBTKE, Quoted on December 22, 2023.

[4] Schmitt, Tommy, 2022, Cost and Performance Baseline for Fossil Energy Plants Volume 1: Bituminous Coal and Natural Gas to Electricity, Pittsburgh: National Energy Technology Laboratory.

[5] Mentri Energi dan Sumber Daya Mineral, 2021, Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) PT PLN (Persero) 2021-2030, Jakarta.

[6] Nugraha, Adhitya, dkk., 2023, Pertamina Emergy Outlook 2023, Panduan Transisi Energi Indonesia: Risiko dan Peluang Terkait Iklim

[7] Kementrian Sekretariat Negara Republik Indonesia, 2023, Buka IIGCE 2023, Wapres Paparkan Empat Strategi Tingkatkan Sumber Energi Bersih, https://www.setneg.go.id/baca/index/buka_iigce_2023_wapres_paparkan_empat_strategi_tingkatkan_sumber_energi_bersih, Quoted on December 22, 2023.

[8] Hasjanah, Kurniawati, 2023, Mendorong Energi Surya Menuju Capaian Bauran Energi 23% di 2025, IESR, https://iesr.or.id/mendorong-energi-surya-menuju-capaian-bauran-energi-23-di-2025, Quoted on December 22, 2023.

[9] Sun Energy, 2023, Transformasi Energi: Menuju Masa Depan Berkelanjutan Indonesia Melalui Energi Terbarukan, https://sunenergy.id/blog/perusahaan-renewable-energy-indonesia, Quoted on December 22, 2023.