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ADB Working Paper Series

**TRANSITION FROM COALS TO
RENEWABLE ENERGY: EVIDENCE
FROM INDONESIA**

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and Nova Amalia Sakina

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Abstract

The energy sector's position as the second-largest contributor to Indonesia's total emissions underscores a critical environmental challenge. This concern is further compounded by the substantial carbon footprint attributed to coal-based power plants. As a result, the energy sector has been included in an updated Indonesian Nationally Determined Contribution (NDC) to reduce 314 million metric tons CO₂eq by 2030. The energy transition program in the subsector of electricity power plants, shifting from non-renewable fossil fuels to sustainable renewable sources, is one of the programs that will play a significant role in reducing emissions. However, the transition to renewable energy will necessitate numerous synergistic efforts in policy, technical, and financial arenas. This paper qualitatively identifies challenges and constraints of Indonesia's energy transition mechanism from four aspects: national energy planning; regulatory and legal framework; technology and infrastructure; and renewable energy financing. The study exposes diverse challenges, highlighting the complexity that characterizes the transition process and the need for a holistic approach, where policy decisions are seamlessly integrated with technological advancements and bolstered by robust financial support. This holistic approach will give information about the strategic decision-making by dissecting the intricacies of the energy transition, incentivizing renewable energy adoption through financial mechanisms, recalibrating regional structures, and instituting organizational reforms, paving pragmatic paths forward.

Keywords: energy, NDC, coal-fired power plant, renewable energy, energy transition

JEL Classification: P48

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1. INTRODUCTION

The Republic of Indonesia is one of the world's most important and largest coal producers (Kennedy 2018). It plays a strategic and vital role in the global coal commodity market (International Energy Agency [IEA] 2017). The Republic of Indonesia's coal production¹ is ranked third in the world after the People's Republic of China (PRC) and India (Arinaldo and Adiatma 2019). The coal reserves and resources of the Republic of Indonesia in 2020 amounted to 186.6 billion tons comprising 37,604.6 million tons and 149,009.5 million tons, respectively. The majority of the Republic of Indonesia's coal is located on the islands of Sumatra and Kalimantan. A number of them are found on the islands of Java, Sulawesi, Maluku, and Papua. The Republic of Indonesia's coal reserves are predicted to be sufficient for the next 71 years with annual production of 600 million tons (Ministry of Energy and Mineral Resources [MoEMR] 2021). Therefore, if we carried out coal production control of 400 million tons per year, as mandated by the National Energy Planning (NEP), the Republic of Indonesia's coal reserves should be sufficient for the next 97 years (Hudaya and Madiutomo 2019; Ministry of Finance 2022a).

However, coal-based energy has negative environmental consequences, including the release of CO₂ emissions into the atmosphere. In energy efficiency aspects, coal-based electricity has the lowest energy efficiency compared to petroleum-based gasoline, coal-based synthetic natural gas, coal-based hydrogen, and coal-based diesel. In the context of a coal-dependent electricity approach, it is feasible to reduce the regeneration energy to 4.0 GJ/tCO₂ within the carbon capture procedure designed for a 500-MW coal-fired power station (Wu and Shang 2022). The energy sector has overtaken agriculture as the second-largest emitter of total emissions in the Republic of Indonesia, with coal-based power plants contributing significantly. As a result, the energy sector has been included in an updated Indonesian NDC to reduce emissions by 314 million metric tons CO₂e- by 2030. The energy transition program in the subsector of electricity power plants, from fossil fuels to renewable sources, is one of the programs that will play a significant role in reducing emissions.

For the Republic of Indonesia, making the shift to renewable energy is of utmost importance. This transition is vital to sustain economic growth, fulfill its commitments outlined in the Paris Agreement, and attain the Sustainable Development Goals (SDGs) objectives. In the 2014 National Energy Policy, the Republic of Indonesia established ambitious targets: achieving 23% of its energy from renewable sources by 2025 and reaching 31% by 2050 (MoEMR 2022a). The country boasts a considerable and largely untapped reservoir of renewable energy resources, notably abundant geothermal and solar energy assets. Additionally, this transition can catalyze new local industries and generate employment opportunities (Fuentes et al. 2019). However, the transition to renewable energy will necessitate numerous synergistic efforts in policy, technical, and financial arenas (Adiputro and Martini 2022).

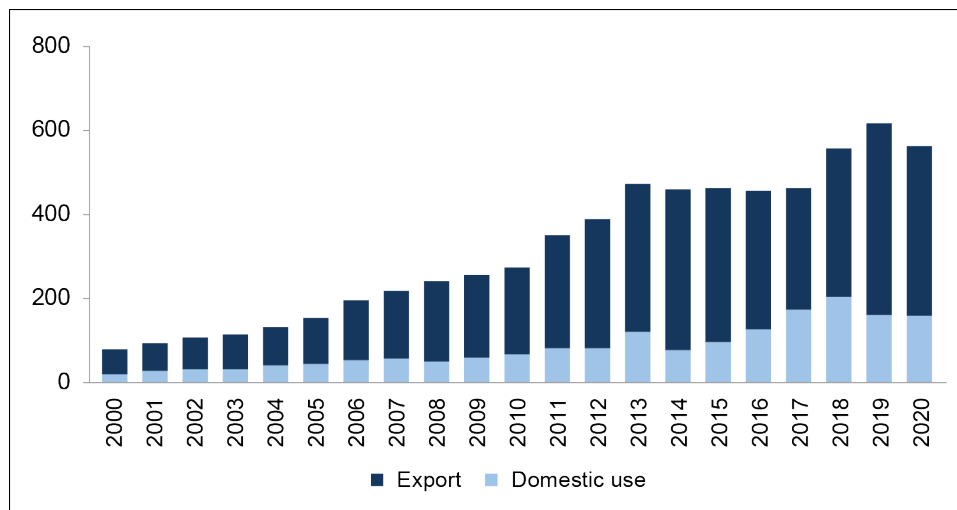
This paper explains the Republic of Indonesia's plans for retiring coal power plants and accelerating the energy transition mechanism to renewable energy. This paper also discusses the challenges and constraints that the Republic of Indonesia's energy transition policies face in meeting the NDC target in the energy sector. However, based on the lessons learned from its implementation thus far, the paper makes recommendations to support The Republic of Indonesia's energy transition mechanism.

¹ Accounting for approximately 7.3% of global production or around 600 million metric tons in 2020.

2. COAL-FIRED POWER PLANT IN INDONESIA

The Republic of Indonesia's status as a prominent player in the global coal industry cannot be overstated. Within this sector, private enterprises firmly hold the reins, functioning under the framework of a government contract system (Sumarsono, Wahyuni, and Sudhartio 2022). As of 2021, the yearly output from coal mining operations was impressively estimated at around 560 million tons, constituting a notable 6%–7% slice of worldwide production. This remarkable trajectory becomes even more apparent when Indonesia's coal production has witnessed an eightfold surge over the past two decades, from a modest 77 million tons in 2000 to an unprecedented peak of 616 million tons in 2020 (MoEMR 2022b). The intricate interplay between export and domestic utilization can be further comprehended through the visual representation found in Figure 1.

Figure 1: Indonesia Annual Coal Production 2000–2020



Source: Ministry of Energy and Mineral Resources (MoEMR). 2022a. Handbook of Energy and Economic Statistics of Indonesia Final Edition. Ministry of Energy and Mineral Resources Republic of Indonesia

The bulk of the current coal production is directed towards exports, making up approximately 40% of the global international coal trade and contributing to an annual value of roughly \$40 billion. Indonesia's coal finds its primary overseas destinations in India and the PRC (IEA 2022). Aligned with the NDCs of India and the PRC, Indonesia's coal exports are anticipated to remain relatively stable over the next 10–15 years. For a discernible impact on Indonesia's exports, it is estimated that the PRC and India would need to collectively decrease coal consumption by no less than 100 million tons annually.

The remaining coal output is almost exclusively directed to fueling domestic coal-fired power plants (CFPPs), with a significant concentration linked to the Sumatra and Java-Bali grids, collectively satisfying 88% of the nation's electricity demand. By the close of 2018, the mining sector employed around 250,000 individuals, further magnified by the extensive supply chain intertwined with mining, transportation, and end-use, particularly CFPPs, creating a substantial economic interdependence (Ministry of Finance 2022a). Indonesia currently has 74 gigawatts (GW) of installed power generation capacity. The power supply of the State Electricity Company (PLN) is made up of 44 GW of its own generation and 21 GW purchased from independent power producers (IPPs).

Other parties generate and consume an additional 8.7 GW, i.e., captive generation. These captive assets operate primarily outside of the national power system and medium-term planning. They are primarily designed to meet the needs of a single customer or industrial park, taking into account their location and available alternatives to meet specifications (MoEMR 2022a). As a result, forecasts for power demand for these off-grid locations remain highly uncertain, and it is difficult to predict how much of the pipeline will materialize in the coming years.

However, the PLN, in contrast, is responsible for seamlessly integrating governmental policies and endeavors into its functioning and autonomous strategies. This dynamic has led to the present composition of the generation mix, a culmination of Indonesia's historical governmental approach to power provisioning. This approach primarily revolved around the pivotal objective of cost-effective service expansion to cater to the swiftly escalating demand for electricity and attain comprehensive electrification nationally (Ordenez et al. 2021). The emphasis on utilizing coal to surmount this challenge is evident in the progression of installed capacity since 2010 when Indonesia was compelled to satiate the mounting power requirements of its rapidly burgeoning economy. This evolution in capacity highlights the interplay between economic and power supply demands.

Between 2016 and 2021, the collective power generation capacity integrated into the grid saw a notable surge, climbing from 52.8 GW to 74 GW, as documented by the Ministry of Energy and Mineral Resources (MoEMR 2022a). This significant expansion, however, is predominantly attributed to a sequence of accelerated initiatives, primarily centered around CFPPs, set in motion in 2015 with an ambitious target of injecting 42.5 GW of additional capacity into the system by 2024. Consequently, coal's influence has become strikingly evident, constituting a formidable 50% of the overall installed capacity. In contrast, oil and gas contribute 35%, while the contribution of renewable energy sources remains a meager 15% (Afin and Kiono 2021). The adoption of CFPPs, while undoubtedly fostering capacity growth, has concurrently accentuated emission intensity, thereby escalating the intricacies of emissions management. However, these environmental concerns do not operate in isolation. They coexist with the intricate web of financial and operational challenges stemming from an overabundance of grid capacity. Notably, historical trends have demonstrated an inclination for demand forecasts to surpass actual demand growth consistently. This trend has paved the way for substantial reserve margins, reaching 59.5% in the Java-Bali region and 34.8% in the Sumatra system, a pivotal consumer of 88% of Indonesia's total electricity output (Ordenez, Fritz, and Eckstein 2022). The confluence of these factors underscores the multifaceted nature of Indonesia's power landscape.

The total capacity of CFPPs predicted to peak in 2026–2030, with a total installed capacity of 48 GW because of the coal power plant fast-track program, will fully load in 2026. Most of the coal power plant fast-track program contract will end in 20 years, that is in the year 2046. At that time, the coal power plant will be predicted to be reduced significantly and naturally and will be replaced by the renewable energy power plant, and is predicted to be reduced until 2060. So, there are many challenges to achieving these predictions. For example, the projected CFPP pipeline could not be canceled due to legal aspects. Another challenge is some resources (nickel and cobalt) play an essential role in energy transition, which needs a huge amount of power to run the smelter. Geothermal and hydropower also take time to develop which need intermediate power supply (MoEMR 2022b). This condition is due to the attempt to reduce the PLN's CFPPs and the completion of the Power Purchase Agreement (PPA) contract with the IPPs. Although the PPA's contract can be extended with the IPP, it is very complicated and frequently requires discussion and negotiation before being

settled. Therefore, the contract must be limited to reduce the PLN's CFPPs, so that the latter can be expected to gradually decrease over time and to be completely out of operation by 2058 (Sumarsono, Wahyuni, and Sudhartio 2022).

3. POLICY CONTEXT: INDONESIA'S COAL PHASE-OUT POLICY

Indonesia, the largest economy in Southeast Asia, is among the top countries in terms of envisioned coal-fired power plant expansion. Despite the fact that the cost of major renewables energy, particularly solar and wind power, has decreased significantly in recent decades, their role in power sector planning in Indonesia remains very small (Ordonez et al. 2021). Some of the main reasons behind the continued use of coal-fired power generation include keeping electricity prices low, the flexibility of coal power plants, and public revenue from coal royalties, which is still very important for generating national revenue (Kennedy 2018). When compared to other power sources such as oil and gas or other renewable energy sources, coal power plants have a lower cost and produce lower electricity prices.

The dominance of CFPPs in Indonesia began with policy decisions to develop megaprojects with an energy capacity of 35,000 MW (Clark, Zucker, and Urpelainen 2020). This policy was put in place to address the shortage of electricity and increase the electrification ratio. Coal power plants account for approximately 47% of all power plants built (Adiputro and Martini 2022). Data from the Central Agency of Statistics show that the coal-fired power plants in Indonesia had an energy capacity of 32,920 MW in 2020 and 33,092 MW in 2021 (Central Agency of Statistics 2023). Therefore, the demand for coal also increases from 558 million tons in 2020 to 625 million tons in 2021 (MoEMR 2021). The government still relies on CFPPs to increase the electrification ratio by considering that the purchase price of electricity produced by these plants is still cheaper. In addition, Indonesia has large coal reserves, which are recorded at 29.48 billion tons, which is far greater than oil reserves.

However, increased coal consumption for power plants will result in increased carbon dioxide (CO₂) emissions. Faced with this unfavorable situation, the Indonesian government began to take action by prioritizing energy supply security through the diversification of energy resources. Indonesia's energy mix is based on five main resources: crude oil; natural gas; coal; hydropower; and other renewable energy. This commitment is then set forth in Indonesia's NDC submitted to the United Nations Framework Convention on Climate Change (Republic of Indonesia 2022). Figure 2 explains the Indonesia's climate change agenda in terms of mitigation and adaptation.

The electricity sector is pivotal in Indonesia's potential to curtail emissions by effecting a transition toward a decarbonized power supply. Aiming to fulfill the NDC target, particularly within the energy realm, the Indonesian government has taken a proactive stance. This stance is evident through its articulation of intent and subsequent endeavors to formulate a comprehensive road map for phasing out coal utilization or instituting a policy for the early retirement of CFPPs. As of 2020, Indonesia boasted a cumulative operational capacity of 33.4 GW attributed to CFPPs, complemented by an additional 13.8 GW capacity plant under construction (Ministry of Finance 2022a). These CFPPs are primarily concentrated in the Java-Bali and Sumatra regions.

Figure 2: Indonesia Government Commitment on Climate Change in Enhanced Nationally Determined Contribution

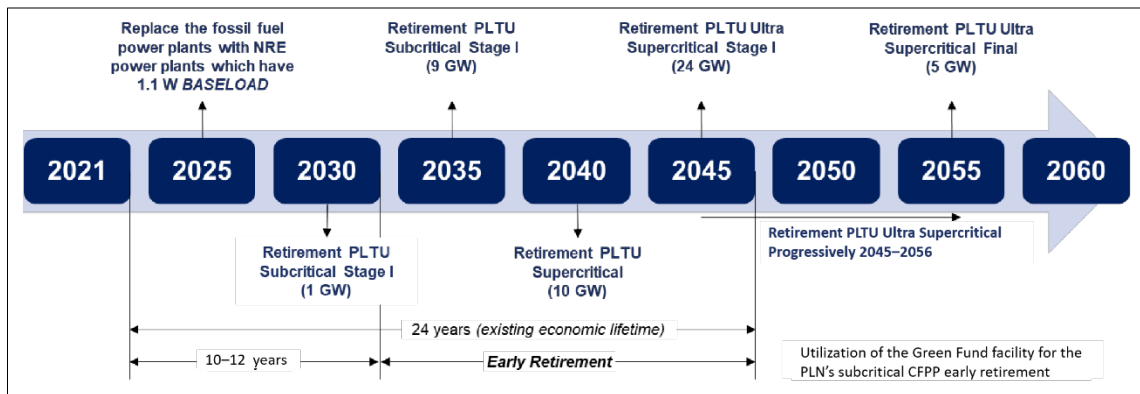


Source: Republic of Indonesia. 2022. Enhanced Nationally Determined Contribution Republic of Indonesia

Given the surplus of capacity reserves compared to historical standards and established benchmarks, a prudent approach involves the curtailment or postponement of fresh generation capacity initiatives. This strategy is deemed appropriate until the trajectory of load growth reclaims its trajectory and converges with pre-pandemic levels, anticipated sometime around 2029–2030. This deliberate pause in capacity expansion would facilitate the early retirement of aging and less efficient power plants. This early retirement, in turn, could potentially expedite the scale-up of renewable energy deployment, ushering in cleaner alternatives at an accelerated pace. Another efficacious avenue entails the conversion of selected middle-aged CFPPs into adaptable operational modes for a finite duration. This temporary transition would contribute to reducing overall utilization, concomitantly leading to diminished emissions. Simultaneously, these power plants could cater to grid requirements for seamlessly integrating variable renewable energy sources. The eventual objective remains the retirement of these converted CFPPs, aligning with the directives outlined by the Central Electricity Authority.

The MoEMR and PLN collaborated to develop such a staged preliminary retirement plan, as shown in Figure 3. A formal retirement road map is expected to be issued as a regulation in time for the G20 meeting in November, as required by the newly issued presidential regulation on renewable energy. As per the preliminary blueprint, the PLN has outlined its intention to commence the phased retirement of the initial 1 GW of power plants before 2030. This action will be succeeded by subsequent retirements extending until 2055, culminating in decommissioning the final unmitigated CFPPs. This meticulously devised strategy aligns with Indonesia's objective of achieving its 2060 net-zero emissions (NZE) aspirations, underscoring the nation's resolute commitment to sustainable energy objectives.

Figure 3: The PLN for Early Retirement of CFPP to Support Net-Zero Emission 2060



Source: National Electricity Company (PLN). 2021. Business Plan for Providing Electricity, Jakarta.

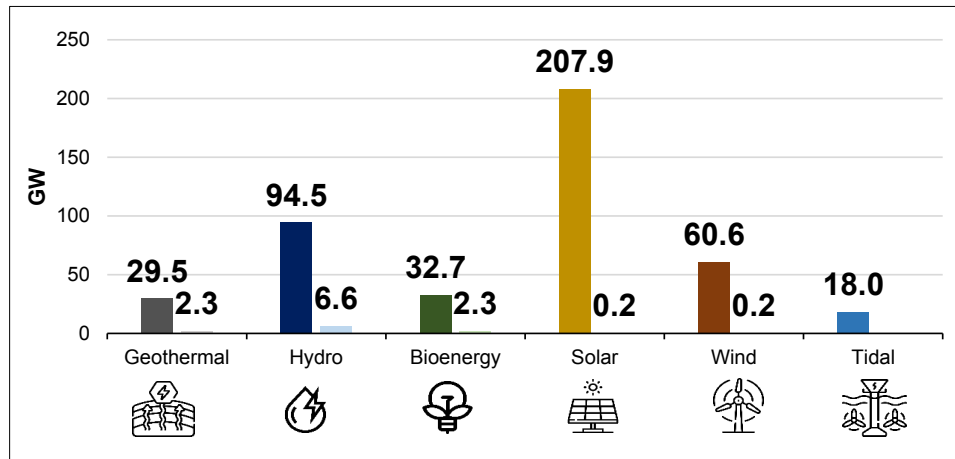
Although fossil fuels still attracted the largest share of investment of around 65% in the energy sector, the PLN also plans to increase renewable energy capacity from 15% to 24.8% of total generation capacity by 2030 and will increase the capacity to 31% in 2050 and will be majority power supplier in 2060. The PLN, together with the IPPs and other developers, are committed to building renewable energy in Indonesia. These investors contributed around US\$1.4 billion to renewable power investments, which represents 7.8% of the total investment in the energy sector (Hendriwardani et al. 2022). To catalyze more private sector financing, the PLN's Electricity Power Supply Business Plan (RUPTL) also allocates a larger share to private sector IPPs in developing new renewable energy generation capacity. Due to increased renewable energy penetration, coal's share of total generation is expected to fall from 67% in 2021 to 59.4% by 2030 (PLN 2021). The fall seems very slow from 2021 to 2030 due to the development of coal power plants through fast-track programs, which ends in 2026. The number of coal power plants will fall significantly after the fast-track program contract finishes in 2046.

The plan to phase out coal completely will be in 2060 in relevance with the government net-zero emission targets. However, the next RUPTL is likely to be amended further to reflect a more ambitious target of the upcoming CFPP early retirement plan, which will be announced at the G20 summit (Ministry of Finance 2022b). According to Indonesia's national energy plan, which was approved by Presidential Regulation No. 22/2017, the country has the potential for 29.5 GW of geothermal power, 75 GW of large hydropower, 19.4 GW of mini and micro hydropower, 32.7 GW of bioenergy, 207 GW of solar power, 60.6 GW of wind power, and 18 GW of tidal power. As of 2021, the combined renewable energy potential was 443.2 GW, but the installed capacity was only 11.6 GW (see Figure 4).

The Government of Indonesia is committed to a just and affordable transition informed by broad stakeholder consultation that focuses on (i) the availability of vital essential services such as electricity, (ii) the stability of energy prices, food, and public transportation, (iii) social protection for the poor and vulnerable, and (iv) the application of sustainable development principles (Government of Indonesia 2022). Because coal is a source of employment, public and private revenues, and power in Indonesia, a just transition of the coal sector is critical. If the transition is not well managed, negative consequences are likely to be felt across the country. This could include direct and indirect effects on formal, informal, and contract workers, along with their families and communities, as well as induced effects on communities and the economy as a

result of reduced spending and government revenue, and potential electricity price increases. Women (Indonesian women with intersectional identities) and other marginalized groups—minority ethnic groups, rural communities, and youth—are especially vulnerable. The impacts felt from power generation to coal mining, as well as related industries up and down the value chain, such as coal transport, manufacturers, including small and medium-sized enterprises (SMEs) and other formal and informal vendors, must all be considered in a just transition.

Figure 4: Indonesia Renewable Energy Estimated Potential vs. Installed Capacity



Source: Institute for Essential Services Reform (IESR). 2021b. Beyond 443 GW Renewables Energy Potentials: Indonesia's Infinite Renewables Energy Potentials

Achieving an energy transition requires upstream analytics and planning, the development of a framework for managing a just transition during implementation, and protocols for monitoring. Additional efforts will be made to include nonenergy ministries such as labour and education, as well as to establish interministerial coordination regarding the energy transition. To oversee these coordination and collaboration efforts, the Ministry of Finance has formed an energy transition Steering Committee. Furthermore, as part of the Limited Liability Company Sarana Multi Infrastruktur's (LLC SMI) appointment as the energy transition mechanism (ETM) Country Platform Manager, they will develop a just transition framework for energy transition – informing the development of a framework at the national level. The ETM is launched by the Asian Development Bank (ADB), which aims to help confront the issue of climate change by reducing the greenhouse gas emissions in Asia and the Pacific. The ETM uses commercial capital and concessional funds to accelerate the retirement or repurposing of fossil fuel power plants and replace them with clean energy alternatives (ADB 2023).

4. CHALLENGES AND CONSTRAINTS OF INDONESIA'S ENERGY TRANSITION MECHANISM

4.1 National Energy Planning

The recently announced plans by PLN to gradually eliminate coal in the long term and enhance the supply of green energy is an advancement. However, how this transformation will be enabled from a regulatory, financing perspective, and

technological perspective needs to be clear. It should additionally tackle the problem of excess capacity by reevaluating the initiation of new CFPPs, potentially idling them, minimizing unnecessary payments to the private sector based on the take-or-pay principle, and constraining ineffective coal subsidies.

A policy on power wheeling allows IPPs and private power utilities to use existing PLN transmission and distribution networks in an attempt to increase the durability and speed of supplying additional generating capacity (ADB 2020). IPPs have had limited involvement up to this point, yet there exists greater potential for them to engage in the ownership and management of assets within the electricity sector. This can lead to fresh avenues of financial support for investment and a reduction in the economic strain on the PLN. Certain IPPs encounter ambiguity in the project development process, while the procedure for linking IPPs to the grid remains unclear.

PLN revenues fall short of requirements to cover all costs, and the utility runs financial losses, being bailed out by the government budget annually. This gives PLN little incentive to improve its operational efficiency. The government's payment falls short of addressing the space deficits for investment in renewable energy. However, the government can plan for incentives and regulation to attract investment in renewable energy. Furthermore, there is a possibility that the government might not reimburse the subsidy to PLN on time, resulting in a financial burden for PLN, especially during the pandemic. Transitioning from a cost-plus model to a performance-driven system would enhance efficiency and ensure the financial sustainability of the power sector. Equally crucial are the implementation of a transparent and predictable strategy and the provision of fair compensation for the PLN's investments. Other suggestions might be electricity market reform or PLN's privatization. However, those suggestions are very hard to be implemented since the electricity sector is highly regulated by the government.

The PLN needs to boost the use of renewable energy power plants by attracting more investment and implementing electricity reform. However, as a state-owned company, PLN depends heavily on government regulation. PLN's plan for developing renewable energy should be in line with government policy. In order to increase the share of renewable energy power plants, PLN needs to invest in energy storage to store the energy generated. Investment mobilization by PLN needs more support and action to improve the capacity of PLN to attract more investment.

4.2 Regulatory and Legal Framework

Competitive RE auctions hold promise in terms of assisting Indonesia in attaining its renewable energy objectives. However, their use has been limited thus far. A comprehensive, long-term energy transition strategy for Indonesia should clearly outline the extent to which auctions will contribute to goal achievement. Enhancing the regulatory framework to specify the future role of auctions is crucial as Indonesia redefines and untangles PLN's responsibilities in the energy procurement process. Competitive tenders for fixed price supply or contracts for differences are potential options to ensure a desired amount of renewable energy investment.

Several actions would improve RE auctions, most notably the establishment of a standardized process for their scope and application, rather than ad hoc procedures that are confusing for participants. Investors emphasize the importance of providing ample preparation time for submitting bids, the necessity for transparency in auction prerequisites, and the requirement for additional details regarding the auction plan, including its location. The auctions should be competitive, since the market gives

advantage to ensure low bids and predictable revenue shift risk to public sector, which mean lower financing costs.

In the process of standardizing PPA practices in Indonesia, incorporating the interconnection tariff cost into the final decision of the winning bid could be considered, eliminating the need for negotiation and thus saving time. Furthermore, by strategically planning for the local equipment supply capacity, local content requirements could be incorporated into the auction scheme. An independent body could also assist in monitoring the auction mechanism. The development of market access is crucially important to mobilize private renewable energy investment.

With the growing presence of emerging businesses actively seeking renewable energy solutions to achieve their emission reduction objectives, corporate procurement of renewables is poised to become a prominent business model in Indonesia. The IPPs are currently only allowed to directly sell power to consumers in selected areas where PLN does not hold responsibility. Therefore, IPPs need to be able to contract with power distributors in a competitive situation. The power wheeling regulation has been established, yet the tariff remains unset, the regulation itself is still pending, and the implementation to open PLN's grid to power wheeling has not yet been enacted. This is a significant impediment to the implementation of a corporate sourcing mechanism. Moreover, it is essential to establish clear guidelines for corporate sourcing to ensure that the renewable energy generated and marketed is indeed newly produced. It is unclear whether IPPs can obtain renewable energy certificates under the current PLN structure. This is a prerequisite for the new system to draw investment in the advancement of renewable energy.

4.3 Technology and Infrastructure

Due to the deceleration in economic expansion, PLN has consistently reduced its new investment initiatives in accordance with the RUPTL. Nonetheless, there are still substantial capacity investments in the pipeline for both the distribution and transmission sectors. Transmission is typically the bottleneck for large-scale RE integration. Distribution networks can be a limiting factor for localized power grids. Renewables will face grid integration challenges due to widespread oversupply. Especially within the Java-Bali system, there is a necessity to redirect investment away from increasing generation capacity towards infrastructure development. This approach would not only support Indonesia's infrastructure investment objectives but also mitigate the potential problem of excessive oversupply that could impede critical growth.

This holds particular significance because there is an anticipation of increased investment needs. These investments will be essential for interconnecting Indonesia's diverse islands, ensuring grid reliability for the integration of renewable energy sources and bridging the 0.8% gap in achieving complete electricity access, with a specific focus on the less developed regions of the country. Decentralized power supply can be one of the solutions that reduce the need for inter-island transmission or remote areas. The investment in energy storage is also important, especially for remote areas or small islands which the electricity generated by renewable energy. Adequate storage systems can increase renewable energy penetration and reduce technical losses and eventually loadshedding. There will always be challenges when dealing with renewable energy penetration. It contributes to the instability in the power grid due to interconnected technical and operational factors – for example, intermittency and variability, a mismatch between supply and demand, frequency and voltage

fluctuations, limited grid flexibility, lack of energy storage, grid balancing, and ancillary services – so careful management is required to ensure grid reliability.

Enhancing the distribution grid will be necessary to support the increased integration of decentralized renewable energy sources. Analysis indicates that the technical and operational potential for integrating renewables into grids is significantly greater than what is planned, but there are barriers to achieving this. Many cities that are connected to isolated grids have limited capacity. Outdated grid operation practices, limited interconnector capacity with neighboring countries, inflexible CFPPs, and a small gas share all contribute to a rigid grid. There is also no explicit grid code aimed at regulating solar and wind penetration.

To ensure predictability in the market for investors, the RUPTL must be published on time. In order to guarantee that the comprehensive strategy is applicable across the entire nation, regional plans must be aligned with the RUPTL. Furthermore, it is imperative to incorporate specific and precise site information for various renewable energy sources, just as it was accomplished for geothermal and hydropower capacity through an improved auction mechanism. This approach will facilitate investment strategizing and the strategic placement of wind and solar facilities to minimize grid integration expenses. PLN's efforts to permit private firms to engage in grid infrastructure development will play a pivotal role in this endeavor.

4.4 Renewable Energy Financing

The Renewable Energy Target (RET) of 23% in 2025 necessitates an investment of approximately IDR1.6 trillion, or approximately \$120 billion (76% of Indonesian government spending in 2016) (Sumarsono, Wahyuni, and Sudhartio 2022). To accomplish this, PLN's business plan (RUPTL) 2015–2024 estimated the need for a US\$63 billion private sector investment in power generation (47% of total investment). In 2022, the aim of the government was to draw in investments totaling US\$33.5 billion within the energy sectors. This allocation comprised US\$17 billion for the oil and gas sectors, US\$7.6 billion for the power sector, US\$5 billion for coal and mineral endeavors, and US\$3.9 billion directed towards renewable energy initiatives. Notably, the most substantial surge in investment targets was witnessed in the renewable energy sector compared to the previous year, yet it remained comparatively lower than allocations for other subsectors (IESR 2021a, 2021b). This emphasizes that not only does the government play a role in this, but so too does the entire ecosystem, including the private sector or entrepreneurs.

Nonetheless, financial institutions encounter several hurdles because of their limited experience with RE ventures, a perception of elevated risks attributed to a scarcity of operational projects, the absence of appropriate financial tools and capital, and a dearth of environmentally friendly financing for corporate renewable procurement. These challenges are also mirrored in bank financing. While some financial organizations possess expertise in financing, national banking regulations impose limitations on their participation in funding endeavors. This restriction is because no risk assessment method is considered convincing to assess green projects' risk level. Moreover, the regulation by the government has no long-term regulatory certainty to make a significant investment in RE projects, such as the uncertainty of feed-in rates, licensing procedures, and grid connection processes. The complexity of the bureaucracy and the length of the approval process can prolong the project's development period, further reducing investor interest (Loeis 2023).

At the same time, numerous regional financial institutions lack familiarity with such projects, making them unable to offer extended-term funding due to their own resource constraints. Additionally, these local financial institutions encounter challenges in securing long-term funding from institutional sources like pension funds. Moreover, uncertainties surrounding the prerequisites, schedules, and results of licensing and permitting processes contribute to increased risks for project developers. The regulatory framework's uncertainty and local content requirements make private investors wary, while project developers struggle to present their projects as bankable. The survey of the top 20 asset management companies in Asia with total assets under management of US\$ six trillion stated that the constraints to green economy funding or investors to achieving net-zero emissions include a lack of instruments or equipment to measure green impact (45%), a lack of client demand for green investments (30%), and those opportunities that exist are not worth the risks due to long-term funding (25%). These constraints can lead to the investor's interest in green projects waning (Yogatama 2022).

Establishing guarantee programs, novel financing frameworks, and the execution of risk-mitigation mechanisms will be necessary. Blended financing mechanisms can aid in the mobilization of private capital from both domestic and international sources. Putting financial risk on the government balance sheet also reduces financing costs. Long-term fixed prices can offset take contracts, so the government can act as intermediary between generators and electricity users. These can help to reduce project risks and give the banking sector experience in financing clean energy projects.

Enhanced backing for clean energy initiatives managed by LLC SMI, which oversees two clean energy funds—the Geothermal Resources Risk Mitigation Fund and SDG Indonesia One—could contribute significantly to mitigating risks and securing funding. Currently, the Ministry of Finance is engaged in partnerships with various stakeholders to reduce policy-related risks and explore avenues for financing and promoting private-sector involvement. It is imperative that these deliberations align with the ongoing initiatives of the Ministry of Energy and Mineral Resources. It will also be critical to support the increased use of green bonds.

One of the primary obstacles hindering the development of off-grid systems in Indonesia and the attainment of the country's electricity access goals is the absence of reliable off-takers who can guarantee financial stability. While certain project developers might consider receiving tariff payments directly from communities, this approach poses economic difficulties due to the extensive presence of scattered, unelectrified villages characterized by a low electricity demand and the inability of residents to afford the necessary tariffs that cover both initial capital outlay and ongoing operational costs.

The government also has promoted policy actions to boost RE investments. In Indonesia, in the latter part of the previous year, ADB linked a Memorandum of Understanding with Cirebon Electric Power, an IPP, along with other partners, to explore the early retirement of the initial coal-fired power plants as part of the ETM initiative. The proposed endeavor, set to decommission a 660-MW coal-fired power plant in West Java, is designed as a replicable model applicable to other IPPs within Indonesia. Furthermore, ADB lends its support to the formulation and operation of the ETM Country Platform in Indonesia, an entity responsible for overseeing the overarching structure of energy transition endeavors within the country, as well as future programs intended to hasten the cessation or repurposing of CFPPs. ADB has also assisted in shaping Indonesia's investment plan within the framework of the Climate Investment Funds Accelerating Coal Transition (CIF-ACT) program,

which obtained preliminary approval to access concessional capital amounting to US\$500 million in October 2022.

Additionally, ADB engages with Indonesia and Viet Nam through their Just Energy Transition Partnerships (JETPs). In the case of Indonesia, ADB extends institutional support to the JETP secretariat, playing a pivotal role in reporting and analysis during JETP implementation. ADB anticipates ETM to serve as a central mechanism for ensuring the successful execution of JETPs. In Viet Nam, ADB is currently engaged in discussions with a consortium of international partners concerning its role within the JETP framework, encompassing potential contributions via ETM and prospective support for the secretariat. Across all participating countries, ADB collaborates closely with governments and third-party entities to facilitate an equitable shift from fossil fuels to clean energy. The progress achieved in recent months merely marks the initial phase. Over the upcoming years, ADB will continue collaborating with member countries to conduct feasibility studies, establish country platforms, and facilitate transactions, all geared towards accelerating the transition to clean energy and providing a blueprint for the global community (ADB 2023).

4.5 Coal-Rich Regions in Indonesia

Indonesia is known for its abundance of coal sources. In Indonesia, coal is the primary energy production with 687,432.38 thousand tonnes, while there is a 299.19 million barrel of oil equivalent (BOE) of energy consumption. In December 2022, the data mentioned that the total inventory of coal in Indonesia is 34,711.01 million tons. East Kalimantan has 15,724.45 million tons followed by South Sumatra with 10,749.68 million tons as of December 2022. Moreover, South Sumatra has 4,885.39 million tons as its exploration target (MoEMR 2022a). Indonesia stands as one of the nations with the most extensive proposed increments in coal-based power capacity on a global scale, thereby presenting a significant obstacle to achieving worldwide objectives for mitigating climate change (Ordonez et al. 2021). Transitioning away from coal-dependent regions holds significant promise for environmental conservation and sustainable development. This discussion delves into the progress, challenges, and opportunities associated with the transition in Indonesia's coal-rich regions. However, in the Republic of Indonesia, coal is one of the natural resources that are still the central pillar of the country's economic. This condition brings with it consequences of land ownership problems, deforestation, damage to landscapes, deforestation, and public health issues (Afkarina, Wardana, and Damayanti 2019). The transition involves a comprehensive reconfiguration of consumption paradigms and energy production (Bridge et al. 2013).

5. CONCLUSION AND POLICY RECOMMENDATION

5.1 Conclusion

Phasing out coal requires policies that take political and economic factors into account. Indonesia has only recently begun discussing the goal of reaching carbon neutrality by the mid-century, while at the same time achieving key policy goals, such as expanding its electricity infrastructure and maintaining affordable electricity prices for end consumers. PLN's plans to transition away from coal and increase renewable energy sources are positive. However, the issues of overcapacity, inefficient coal subsidies, and the lack of incentives for RE projects should be addressed. Moreover, Indonesia faces substantial financial challenges in achieving its RE targets, with a significant

investment requirement. These challenges include financial institutions' lack of familiarity with renewable projects, regulatory uncertainties, and difficulties in securing long-term financing. Blended financing mechanisms, guarantee schemes, and government involvement can help reduce project risks and attract private capital.

The policy of power wheeling for IPPs offers potential benefits, but challenges in project development and grid connection persist. PLN faces financial losses, relying on government bailouts, which hinder operational efficiency. The absence of an independent regulator has been observed as a notable gap, considering the expanding presence of independent electricity providers and companies operating within Indonesia. Therefore, an independent regulator is needed to ensure fair competition and optimize consumer protection.

Competitive renewable energy actions hold significant potential for Indonesia's renewable energy goals, yet their utilization remains limited. Addressing Indonesia's renewable energy challenges requires a shift in investment focus from generation capacity to infrastructure development, particularly in transmission and distribution networks. This transition is vital for grid integration and reliability, especially in less developed and remote regions. Therefore, PLN plays a key role in this sector. Energy storage systems are crucial in increasing renewable energy penetration and avoiding technical losses. However, the grid faces various challenges, including intermittency, inflexibility, and outdated practices. Clear regulations, timely publication of plans, and alignment with regional strategies are essential to create a predictable market for investors. Therefore, it is essential to reform the PLN Plan.

Indonesia's abundant coal resources have played a central role in its energy production and economic development. However, the significant reliance on coal poses environmental and public health challenges. The transition away from coal in coal-rich regions presents both opportunities and challenges for sustainable development and mitigating climate change. This shift requires a comprehensive reconfiguration of energy consumption and production paradigms to move towards more sustainable and environmentally friendly alternatives.

5.2 Policy Recommendation

Taking into account the challenges and constraints of Indonesia's energy transition, this paper proposes the following recommendations to phase out coal and encourage the development of renewable energy:

5.2.1 Improve Financial Incentives for Renewable Energy Projects

Renewable energy expansion necessitates regulatory certainty for investors. It requires, in particular, a modified power market structure that favors renewable energies by lowering regulatory barriers and avoiding frequently changing regulations. This would lower financing costs by lowering risk premiums, as well as the overall costs of renewable energy deployment. Energy companies in Indonesia would then be able to diversify their business models toward renewable energies, compensating for eventually declining coal profits. The investment in renewable energy and market access also need further improvement to boost the development of renewable energy power plants that will largely replace the coal power plants.

5.2.2 Reform the Institution's Plan

PLN is a key player in energy sector decarbonization, as it is Indonesia's sole buyer, transmitter, and distributor of electricity. Because Indonesia is an archipelago, PLN generation, transmission, and distribution infrastructure remain fragmented. The distribution infrastructure consists of eight major grid networks and 600 isolated grid systems. PLN should invest more in renewable energy storage that will boost the electricity resources. The highly anticipated JETP Investment and Policy Plan, set to be unveiled in August 2023, will serve as the definitive road map for enacting the essential policy reforms geared towards the attainment of Indonesia's ambitious climate objectives. These instrumental policies will encompass a broad spectrum of strategic facets, including but not limited to, tariff structuring, mandates for domestic content integration, facilitation of power purchase agreements, stimulation of supply-side motivations, streamlining of permitting prerequisites, optimization of procurement methodologies, fostering the growth of local renewable energy manufacturing, and an array of other pivotal reforms. It is worth emphasizing that PLN is poised to assume a pivotal and active role in the effective execution of these transformative measures.

As a wholly state-owned utility, its planning and operations are overseen by three major ministries: (i) Ministry of Energy and Mineral Resources (MoEMR), the primary government body responsible for setting energy sector policies and regulations; (ii) Ministry of State-Owned Enterprises (MSOE), the government body responsible for overseeing governance and operations of state-owned enterprises; and (iii) Ministry of Finance, which is involved in everything from subsidies to financial and project planning. The Ministry of Energy and Mineral Resources should also become PLN's regulator, and PLN itself should be reformed to reduce its proclivity for political capture. For such reforms to be successful, they must be part of larger efforts to strengthen the institutional capacity of the regulatory bodies that oversee Indonesia's energy policy and the power sector in general.

5.2.3 Creating an Independent Regulator

The Ministry of Energy and Mineral Resources of the Republic of Indonesia is pivotal as the singular regulatory authority overseeing PLN, in Indonesia (MoEMR 2019). This role stems from the constitutional principle that asserts the state's control over all natural resources, including earth, water, and their contents, to ensure the welfare and prosperity of the nation's citizens. This central regulatory approach has been established to streamline and harmonize policies, operations, and investments within the energy domain.

However, as the landscape of the electricity sector evolves, there is a growing recognition of the potential benefits of introducing an independent regulatory body specifically overseeing the sector's intricacies. The absence of an independent regulator has been observed as a notable gap, considering the expanding presence of independent electricity providers and companies operating within Indonesia.

Evidence from various international contexts showcases the advantages of having an independent regulator in the electricity sector. Such an entity could ensure a level playing field for all market participants, guarantee fair competition, and optimize consumer protection. Additionally, an independent regulator could enhance transparency and accountability, effectively monitor and enforce compliance with standards and regulations, and provide an avenue for addressing disputes or grievances within the sector. Many countries have their own energy regulator. For example, Ofgem, the energy regulator for Great Britain, which protects energy consumers by ensuring society is treated fairly and benefits from a cleaner, greener

environment (Blakelock and Turnpenny 2022). Participatory methodologies offered Ofgem a distinct window of opportunity to shape policies with legitimacy from 2007 to 2016. Engaging stakeholders through consultative processes and deliberative focus groups paved the avenue for impartial, easily approachable, and transparent procedures enriched by the infusion of pertinent insights extending beyond the regulatory confines. Nevertheless, drawing comprehensive conclusions regarding the unreserved realization of participatory tool objectives within this context proves to be a nuanced endeavor. Scrutinizing the key players, the platforms of interaction, institutional capacities, and the resultant impact of policy formation mechanisms has brought to light conspicuous disparities between these participatory instruments' intent and actual execution. These divergences bear consequential implications, particularly concerning the two focal criteria of regulatory legitimacy that have been subjected to examination.

Another example from Ireland is Commission for Regulation of Utilities (CRU), the independent regulator for energy and water for a changing climate change. This commission addresses the role of grid tariffs in promoting grid-friendly practices and incentivizing battery storage, introduces the concept of virtual metering points for equitable benefits, discusses initial findings from the BEYOND project, and underscores the importance of transmissions system operator-distribution system operator (TSO-DSO) coordination and regulatory alignment with European Union smart grid goals (Maldet et al. 2022).

In light of these considerations, it is recommended that Indonesia consider establishing an independent regulatory body for the electricity sector. This consideration would help modernize the regulatory framework and align it with the evolving dynamics of the energy landscape. This proposition does not undermine the Ministry of Energy and Mineral Resources' role but rather complements it by providing an extra layer of oversight.

For a comprehensive understanding of this topic and to bolster these recommendations, one can refer to scholarly works, policy reports, and case studies that delve into the benefits and implementation challenges of independent regulatory bodies in the electricity sector. Notable references might include works by recognized energy policy think tanks, academic articles from reputable journals, reports from international organizations like the World Bank, International Energy Agency, and regulatory bodies from other countries that have successfully established independent regulators in their energy sectors.

5.2.3 Promote Transition in Coal-Rich Regions

A fiscal reform that directs public funds to affected coal-producing provinces is critical. This is especially true for coal-rich regions like South and East Kalimantan, and to a lesser extent South Sumatra, where public revenues are currently derived from coal production. Fiscal coal revenues could also be offset by income from a carbon pricing scheme, increasing subnational governments' political support for a coal phase-out. The government needs to formulate an incentives policy to increase the renewable energy investment, especially in the coal-producing provinces.

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