UNLOCKING INDONESIA POTENTIAL RESOURCES TO ACHIEVE NET ZERO EMISSION 2060 :GENERATION EXPANSION PLANNING USING LEAP

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Overview

Indonesia is Southeast Asia's greatest energy user, accounting for more than 36% of the region's energy demand and consuming 66% more energy than Thailand, the region's second-largest consumer [1]. Electricity demand will continue to rise as a result of ongoing economic and demographic factors, and Indonesia's power generation infrastructure will require significant investment to maintain the country's economic expansion. The entire power generating capacity of Indonesia is currently around 64.5 GW [2]**,** yet even this capacity is still insufficient to meet demand, and blackouts are still widespread in Sumatera, Kalimantan, Sulawesi, and Eastern Indonesia. To meet the ever-increasing need for power, the Indonesian government has initiated a 35,000 MW program since 2015. However, several problems has plagued the 35,000 MW program and has cause delayed in several power plants project [3]. Furthermore, the COVID-19 pandemic reduced business and industrial electricity usage, and it has become clear over the past year that electricity generating capacity is generally surplus for more than a 30% reserve margin - especially in Java – Bali network [4]. These facts show that the implementation of the 35,000 MW program's should be revised. The Indonesian government has also committed to achieve 28% renewable energy target in 2038 and zero carbon in 2060, despite the fact that fossil fuels are still used in the majority of power plants developed under the 35,000 MW program [5]. Indonesia will need a proper long-term energy planning to achieve the zero carbon target. Based on the aforementioned factors, this study seeks to develop an accurate long-term power generation expansion plan for Indonesia between 2030 until 2060 that achieve National Determined Contribution's for zero carbon in 2060, while being economically efficient.

Methods

The Low Emission Analysis Platform (LEAP) software was used in this study. LEAP is a software tool developed by Stockholm Environment Institute for energy policy analysis and climate change mitigation evaluation. LEAP used a scenario-based modeling tool to measure energy usage, production, and resource extraction across all economic sectors. On the demand side, LEAP supports a variety of modeling strategies, ranging from bottom-up, end-use accounting procedures to top-down macroeconomic modeling. On the supply side, LEAP offers a set of accounting, simulation, and optimization methodologies that are both powerful enough for modeling electric sector generation and capacity expansion planning and flexible and transparent enough to allow LEAP to easily incorporate data and results from more specialized models. The most recent versions of LEAP also offer optimization modeling, which allows for the creation of least-cost models of electric system development, potentially under a variety of constraints such as the use of renewable energy at a minimum. The data for energy demand and generation comes from the Indonesian National Electricity Plan (RUKN) 2019-2038 [6] and the PLN's Electricity Supply Business Plan (RUPTL) 2021-2030 [7], as well as other sources. The overall cost of the power system is the sum of the system's net present value throughout the whole calculation period. In this study, two scenarios will be simulated. The first is **Reference** scenario where renewable energy target is achieved with hydro and geothermal power plant but without battery storage. The second scenario is **Advanced** scenario where renewable energy target is achieved with solar, nuclear power plant and battery energy storage.

Results

The **Reference** scenario is set to achieve the 2025, 2038, and 2060 renewable energy target.The demand in 2025 is 343.8 TWh while in 2038 will be 732.5 TWh. In 2050 the total demand will reach 1559.5 TWh. Based on the simulation, total power generation capacity in 2025 will be 79.51 GW, with the energy mix consist of hydro (23.07%), geothermal (10.77%), biomass (0.26%), solar PV (0.04%), wind (0.09%), natural gas (8.88%), coal (56.88%), and oil (0%). The total power generation in 2038 will be 172.71 GW, with the energy mix consist of hydro (28.99%), geothermal (11.59%), biomass (0.16%), solar PV (0.02%), wind (0.04%), natural gas (32.03%), coal (27.18%), and oil (0%). The total power generation in 2050 will be 789.1 GW, with the energy mix consist of hydro (17.61%), geothermal (11.21%), biomass (4.7%), solar PV (56.95%), wind (9.53%), natural gas (0%), coal (0%), and oil (0%). The total investment cost that will be need to fund the power generation expansion for 2020 – 2050 will be USD $ 482.4 Billion.

Conclusions

The early result from the simulation showed that the 35,000 MW program, which builds more fossil fuel power plants, making it very difficult for Indonesia to achieve the renewable energy target of 21% by 2025. Meanwhile, for 28% renewable energy in 2038 and zero carbon target in 2060, the targets are still very likely to be achieved. However, it is necessary to make massive efforts to replace fossil power plant with renewable energy. Inappropriate planning in RUPTL, apart from causing the renewable energy target not to be achieved, also causes PLN to need more funds to decommission existing power plants. In the Reference scenario a total cost of USD $ 134.1 billion is required for the power plants investment.

References

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