ADVANCING INDONESIA'S LOW-CARBON INDUSTRY TRANSITION: A CAPTIVE-GENERATION FOCUSED STUDY

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Overview

Indonesia is attempting to transition its energy system from coal while ensuring reliable and affordable electricity. The international community, led by Japan and the U.S., established the Just Energy Transition Partnership (JETP) to offer financial and technical support for Indonesia's clean energy transition, but the investment plan leaves crucial gaps in terms of the phase-out and replacement of existing captive coal power plants. These facilities contribute significantly to national greenhouse gas emissions, predominantly in the metals and mining industries, sectors Indonesia is expected to grow in the future. China has promised significant investments in green energy and power grids, inking over $50 billion of MOUs with the grid company Perindustrian Listrik Negara (PLN). However, these and other high-level bilateral initiatives largely ignore the challenges of the off-grid industrial sectors. The prior president of Indonesia also released a Presidential Regulation that requires captive industrial parks to reduce carbon emissions by 35% within 10 years of operation.

China is at the center of Indonesia's low-carbon industry transition. Chinese firms retain ownership in part or in full of 81% of the captive coal-fired power plant capacity in Indonesia. In addition, due to the complexity of these industrial processes, reducing carbon emissions is more costly than other decarbonization options (namely, grid-connected renewable energy). Therefore, direct incentives, improved regulations, industry standards, and specific financing are needed to decarbonize these facilities.

Methods

To that end, we model clean energy transition efforts in Indonesia related to JETP implementation and successor initiatives expanding to captive power from the perspective of generating collaborative efforts among major powers, notably the U.S. and China, while assessing decarbonization options at the plant level for Indonesia's captive power facilities. We are developing a generation and transmission expansion model for Indonesia's major islands, which can optimally plan infrastructure to meet JETP and other climate targets. The model is powered by a detailed open database of current large-scale grid and captive infrastructure in Indonesia, priority projects outlined in the JETP Comprehensive Investment and Policy Plan (CIPP), and reports published by the Indonesian government and PLN.

For the industrial parks that use these captive generators, we are also performing renewable energy resource assessments to identify the candidate sites for industrial parks to build their clean energy plants (captive renewables) to replace the current coal captive power plants. These candidate sites and their investment costs will also be added to the generation and transmission expansion model as options from which the model could choose. We evaluated candidate sites for 19 industrial parks in Sumatera, Jawa-Bali, Sulawesi, and Kalimantan, accounting for about 14787 MW of installed coal capacity. These candidate sites were selected based on the distance to the industrial park, renewable energy capacity factors, and land use constraints. In addition to these candidate sites, the model also has the option to choose to connect these industrial parks to the national grid. Hence, under this model simulation, a captive industrial park has three options based on the lowest cost among other constraints: connect to the national grid, build a captive renewable plant, or keep the current coal captive generator.

Several scenarios were studied under three main categories: captive generation scenarios, clean energy scenarios, and policy target scenarios. Under the captive generation scenario, the reference scenario does not include any captive generators in the model and simulates the current power system, which serves as a benchmark. There is a captive full scenario where the captive generators are added into the generation mix while accounting for the captive demand and a captive no generation scenario where captive demand is added while excluding the generators in the generation mix, simulating retirement of all captive generators. Clean energy scenarios add a minimum renewable energy and maximum CO_2 emission constraint to the model. Policy target scenarios are scenarios that simulate the

JETP targets and also the Presidential Regulation targets. The model is run with a combination of these scenario categories, helping us to understand how the captive generators will behave under different policy conditions.

The model was run for the investment year of 2030 to simulate all the investments promised by the JETP agreement, and we are also running the model for the investment year of 2035 to simulate the effect of the Presidential Regulation that sets the emissions cap on these generators.

Results

Our preliminary results show that it is possible to include the captive generators within the policy targets set by the Indonesian government and the international community funding the transition. For the year 2030, 7018 MW of captive power capacity, or about half of the installed captive capacity studied, are from cleaner options (grid connection and captive renewables) in the scenario where captive generators were added to the model. Coal captive generators still play a significant role in powering these industrial plants, especially the industries that require heating demand. In most of the islands, gas generators become the highest fossil fuel-based generation after coal in the scenarios where captive generators were included. As for renewables, solar and geothermal remain the primary renewable energy generation in most of these islands except for Kalimantan, where biomass plays a more prominent role in generation.

Conclusions

This is an ongoing study with a few minor steps remaining. We are introducing a new scenario with multiple candidate sites for captive renewables for industrial parks. The model can choose to build more than one renewable plant to power the industrial park. We are also working on separating heating and electricity demands to understand better how the results will change, as not all of the heating demand met by these coal-captive generators can be replaced with electricity. We will also update some of the modeling inputs for this model based on the latest policy documents that are expected to be released by the first quarter of 2025.

We hope this study will shed some light on how the inclusion of captive generators will impact the policies and targets laid out by the JETP implementation secretariat and the Ministry of Energy and Mineral Resources Indonesia. We also want to understand better how captive generators interact in the Indonesian electricity market and how that would impact other market participants like PLN. We aim to provide actionable strategies to relevant actors like industrial park owners on transitioning to clean energy options through grid connection or the development of captive renewables. And for the necessary upgrades that should be made to these industrial parks, we also plan to identify potential funding sources.