Industrial Decarbonization Study for Captive Power Market in Indonesia

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Introduction

Abstract

This project is a collaboration between KPMG and NUS's MSc in Green and Sustainable Finance, supported by the Southeast Asia Energy Transition Partnership (ETP). It aims to support Indonesia's energy transition by addressing the decarbonization of coal-based captive power in key off-grid industrial sectors such as steel, aluminum, and nickel. The project focuses on Deliverable 5: a sectoral and regional assessment of decarbonization challenges and opportunities to enable the development of Net Zero Industrial Parks (NZIPs).

Objectives & Scope

- Select one ASEAN country with a clear decarbonization goal.
- Prioritize two sectors to compare decarbonization challenges and opportunities
- Dentify energy-intensive processes, inputs, outputs, and tech
- Explore clean energy options for off-grid industries.
- Assess financial and emission impacts of decarbonization pathways

Industrial Overview

Steel Industry: We summarized the two main production processes in the steel industry—BF-BOF and EAF—highlighting the energy consumption at each stage and proposing potential optimizations for production steps.

Nickel Industry: Nickel production has 2 different methods. In the RKEF process, the highest energy consumption and emissions occur during calcine reduction and smelting, driven by intensive fossil fuel use, while in the HPAL process, refining is the most energy- and carbon-intensive stage, accounting for over half of electricity use and CO_2 emissions.

Aluminium Industry: Electrolysis is the most energy-intensive step in aluminum production. Technologies like wetted drained cathodes and inert anodes can reduce energy use by over 20% each. While inert anodes remain under development, industrial upgrades like DX+ Ultra have already improved energy efficiency and cut emissions, as shown in INALUM's successful pilot project.

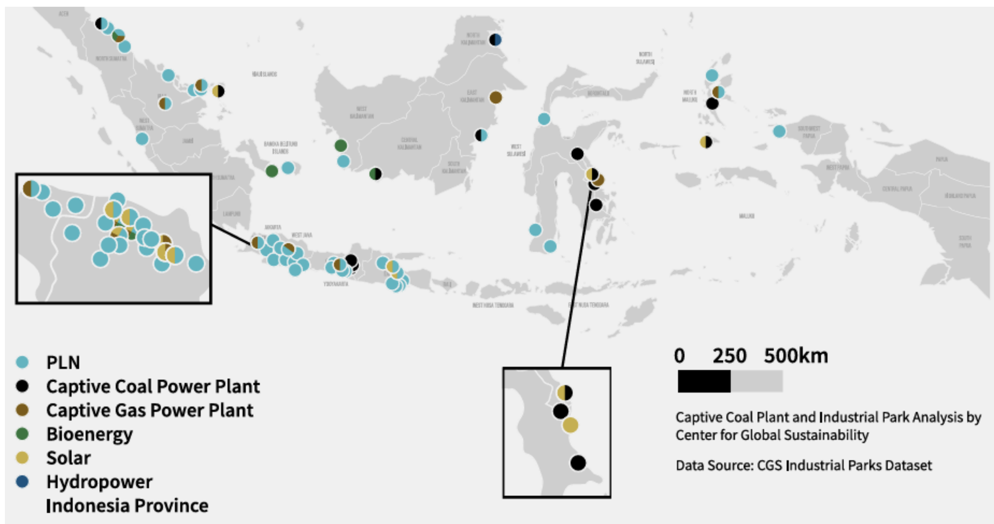
Paper and Pulp Industry: Indonesia's pulp-and-paper industry is led by APP and APRIL, whose plantation-linked kraft mills supply over 75 % of capacity; while chemical pulping needs \~400 kWh and 4–6 GJ/tones steam, the paper-machine—especially its 4–5 GJ/tones drying section—dominates total energy use, making it the prime target for efficiency gains.

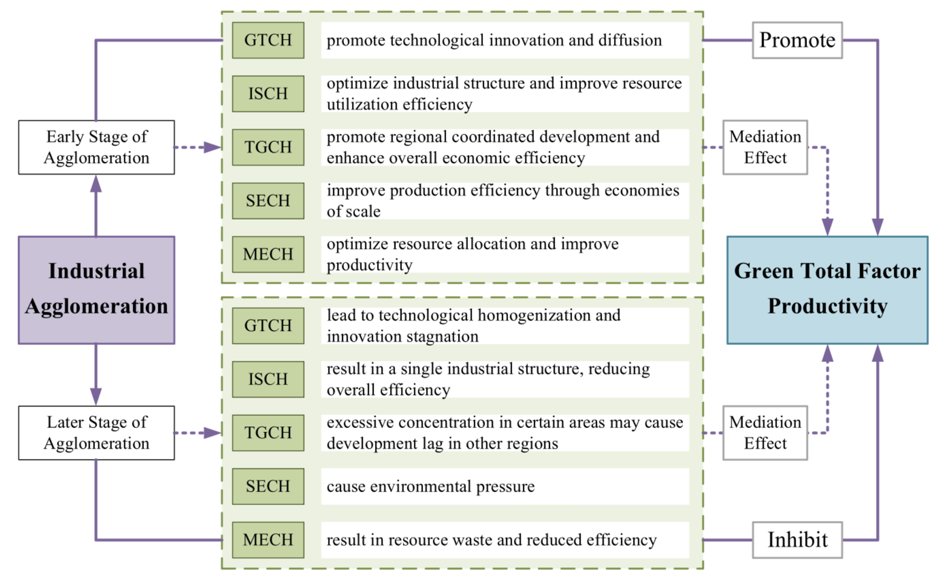
Industrial Cluster

Industry Clustering in Indonesia

Indonesia's 130+ industrial parks remain heavily reliant on fossil fuels, especially captive coal power. Most parks use national grid (PLN), hybrid, or captive coal/gas setups, with minimal adoption of renewables. ava leads in installed capacity (9.9 GW), followed by Sulawesi and Maluku, but many parks still lack access to clean energy.

Synergy of Industrial Cluster

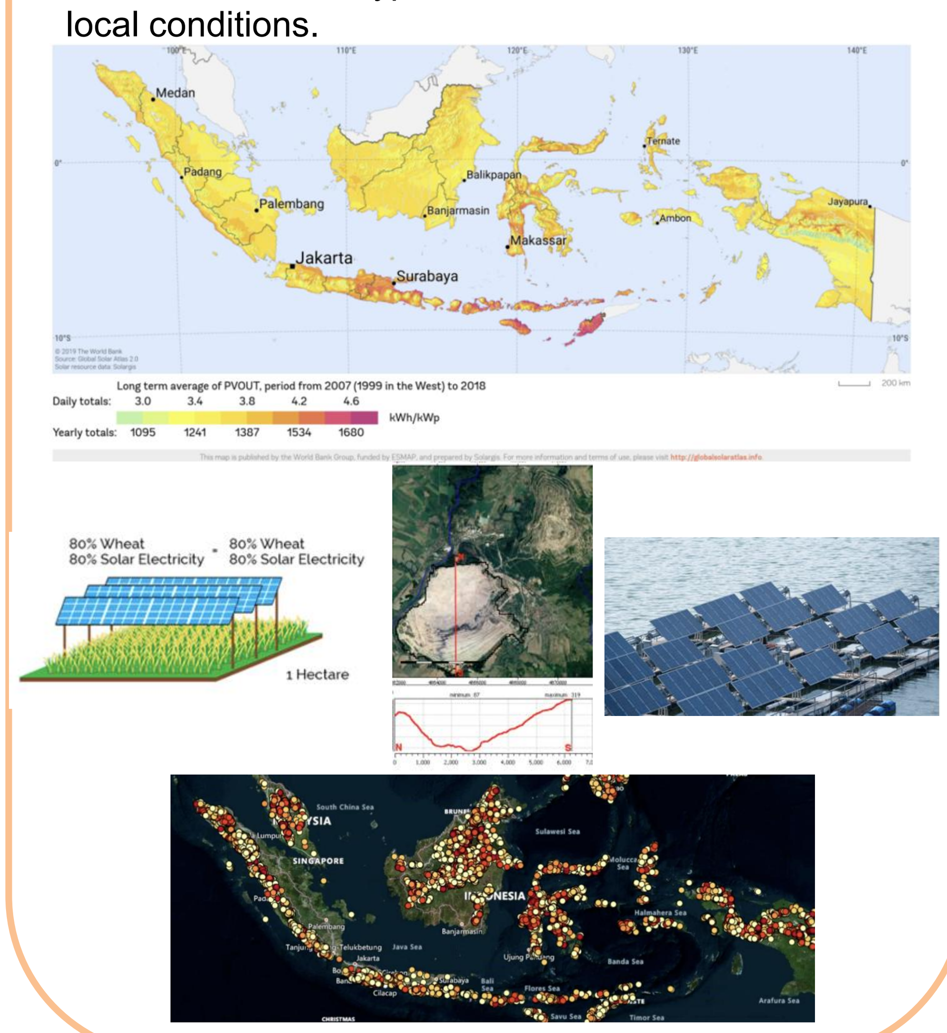




Green Technology

Solar Power

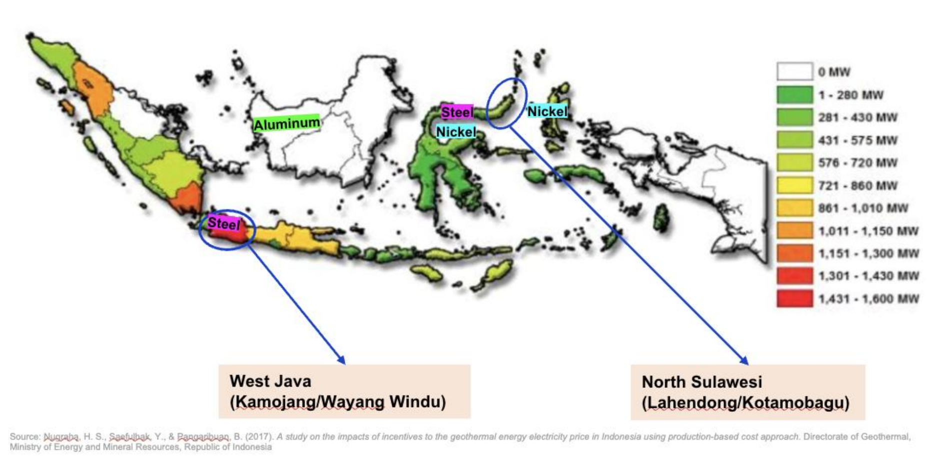
Indonesia possesses exceptional solar resources. Approaching the issue from multiple dimensions, we found that the cost of solar PV in Indonesia is significantly lower than that of other clean energy sources. At the same time, Indonesia has also identified solar PV types that are more suitable for its local conditions.



Geothermal

Indonesia possesses one of the world's largest reserves of geothermal energy, with extensive resources across Java, Sumatra, North Sulawesi, and parts of Flores。

DISTRIBUTION OF GEOTHERMAL POSSIBLE RESERVES



H. S., Saefulbak, Y., & Pangaribuan, B. (2017). *A study on the impacts of incentives to the geothermal energy electricity price in Indonesia using production-based cost approach.* Directorate ... and Mineral Resources, Republic of Indonesia

Location	Lahendong	Kotamobagu	Kamojang	Wayang Windu
Thermal Suitability	~200°C	150–200°C	~200°C	150–200°C

Direct Use of Geothermal Heat for Industrial Processes

- Suitable for medium-heat industries (180–250°C)
- Too low for nickel, steel, and aluminum (>1000 °C)
- Best for pulp & paper, F&B, textiles

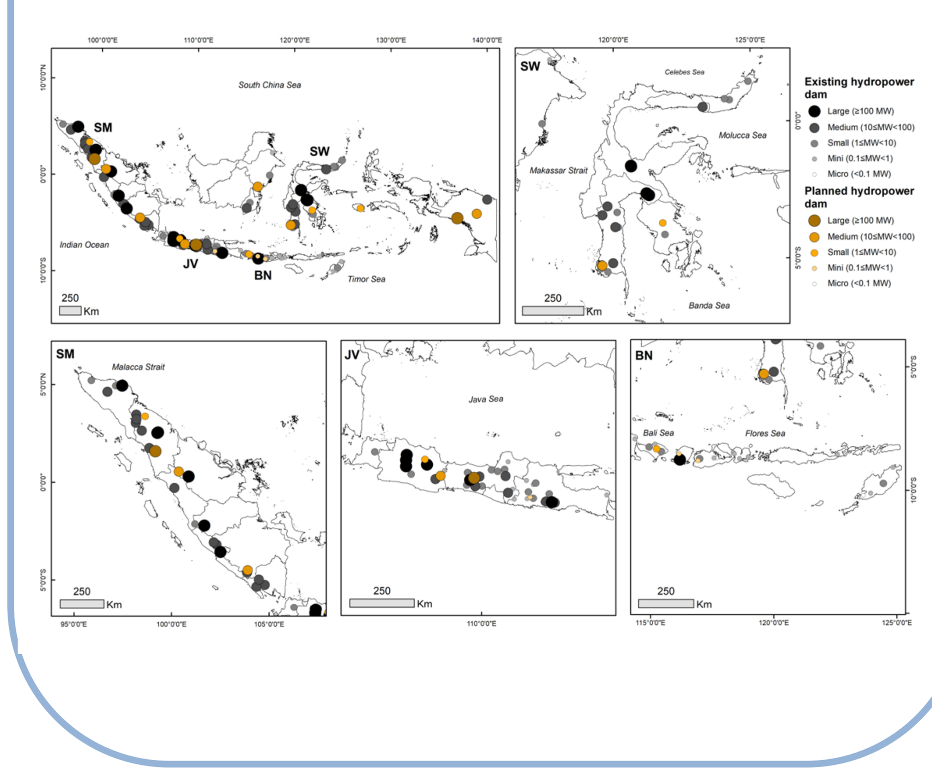
Geothermal Power Generation for Industrial Electricity Use

- Plants located in Java & Sumatra, far from heavy industry
- Low capacity (30–150 MW) vs large industrial demand
- High grid costs & losses limit remote transmission
- Best for light industry or grid decarbonization, not metals

Hydro

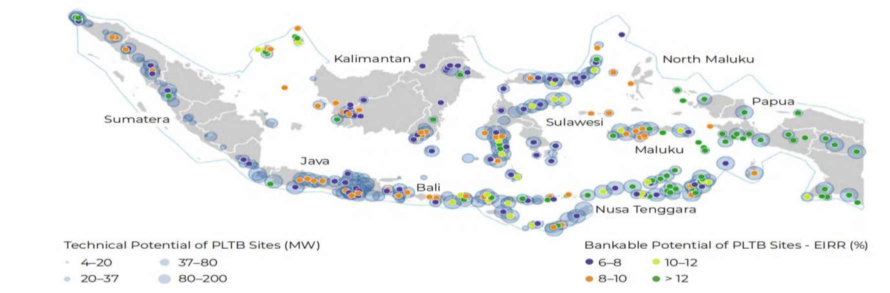
Hydropower Reserve & Installation - Indonesia has utilized only 7% of its 95 GW hydropower potential, with 6.78 GW installed by 2023. Despite being the top renewable source, growth is slow. The government targets 10 GW by 2030 and 72 GW by 2060, positioning hydropower as key for industrial decarbonization

Spatial Distribution - Indonesia's hydropower potential is unevenly distributed across islands, offering regional decarbonization opportunities. Sumatra supports nearby industrial parks; Java aids grid stability for energy hubs; Sulawesi's hydropower serves nickel smelting and EV processing in Morowali and Weda Bay.

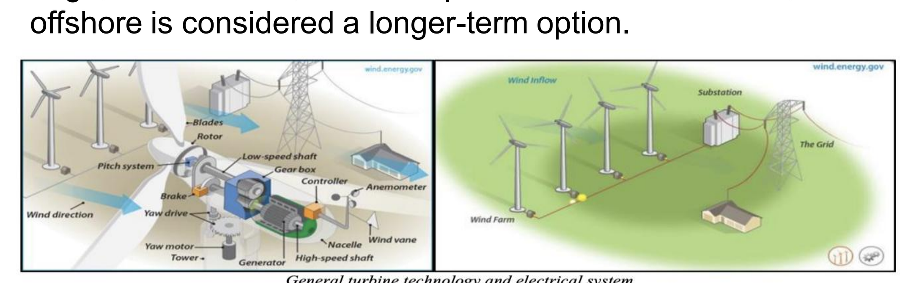


Wind

Vast untapped resource – Indonesia holds ~246 GW of technical wind potential, of which ~167 GW across 203 sites is judged economically attractive, with the best winds in East Nusa Tenggara, South Papua and Maluku.



Focus on on-shore turbines – Current strategy favours large, three-bladed, variable-speed on-shore machines; offshore is considered a longer-term option.



General turbine technology and electrical system

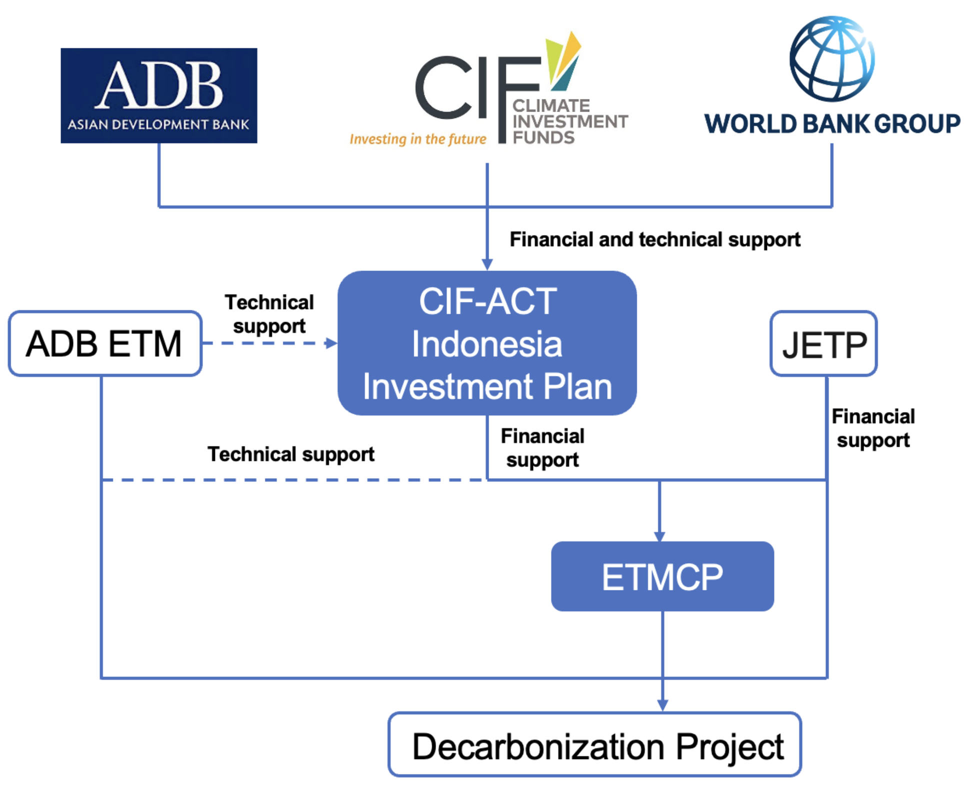
Industrial-park pilots – The Weda Bay Industrial Park already runs a 5 MW demonstration project (2 × 2.5 MW turbines); total renewable capacity planned in the park exceeds 2 GW, showcasing captive-power opportunities for heavy industry.

Challenge for Wind Energy Development in Indonesia

Category	Description	Consequences	Urgency
Wind Data Availability	• Limited availability of accurate long-term wind data. • High level of uncertainty of mesoscale models. • Financial burden of investments for wind measurements	Wind data underpins a wind farm's economics, its challenges make Indonesian projects high-risk, driving up financing costs or sending investors elsewhere.	Short term solution required
Spatial data and Process	• Absence of a clear Indonesian guideline of wind farm construction • Lack of spatial data for location and lay out • Lack of standardization in the development process	Lacking spatial data and standardised processes delays site selection and project timelines, while complicating bid comparisons.	Short term solution required
Financing & Bankability	• Poor existing fiscal and non-fiscal regulation • Perception of wind project investments in Indonesia as 'risky and slow'	Weak incentives and unfair PPAs make wind projects in Indonesia seem too risky, driving up costs or deterring investors.	Short term solution required
Procurement Mechanism	• Uncertain and unclear PLN procurement process of wind projects, bringing considerable risks for the developers	Lack of transparent PLN processes adds uncertainty, discouraging long-term investment.	Short term solution required

Financial Strategy

CIF-ACT&ADB ETM : The Climate Investment Funds–Accelerating Coal Transition (CIF-ACT) Indonesia Investment Plan and the Asian Development Bank's Energy Transition Mechanism (ADB ETM), both of which are primarily driven by multilateral funding through multilateral climate funds and development banks



JETP: The Just Energy Transition Partnership (JETP) led by the G7 and the International Partners Group (IPG), which is primarily backed by governments of G7 nations, other developed economies, development institutions, and private sector actors;

ETMCP: The Energy Transition Mechanism Country Platform (ETMCP), which is led by the Ministry of Finance of Indonesia.