100% Renewable Energy Integration in Indonesia

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Abstract
This thesis explores a pathway to decarbonize Indonesia's energy system, focusing on solar power and energy storage. Key findings include:1. Indonesia has abundant space for solar power deployment, including rooftops, reservoirs, mining wastelands, and agricultural land. The potential far exceeds future demand; 2. Offshore floating solar PV in calm seas around Indonesia could generate over 200,000 terawatt-hours annually; 3. Indonesia has 321 terawatt-hours of pumped hydro energy storage (PHES) potential, significantly more than needed for a fully renewable system; 4. A solar-dominated electricity system is feasible for Indonesia, with PHES providing overnight and longer storage. Strong inter-island connections are unnecessary; 5. Introducing gas turbines (using hydrogen or synthetic methane) for 1% of generation reduces costs and storage requirements; 6. The levelized cost of electricity for a 100% renewable system is estimated at 77-102 USD/MWh; 7. Solar anomalies during dry seasons are linked to forest fires, incentivizing their prevention. The research contributes: - Assessment of Indonesia's vast solar and PHES potential; - Global mapping of marine floating solar PV potential; - Presentation of premium PHES sites in Indonesia; - A solar heat map for suitable farm locations; - An alternative decarbonization pathway using solar PV and off-river PHES. The study concludes that Indonesia can achieve affordable, reliable, and emissions-free electricity through gradual transition to renewables, primarily solar power with PHES for storage.

Keywords: Solar energy, energy storage, decarbonization

Application of AI and Remote Sensing for Assessing the Impact of Energy Transition on Biodiversity in Indonesia

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Abstract

The global transition to renewable energy sources, including wind, solar, and electric vehicles (EVs), is heavily dependent on critical minerals such as nickel, cobalt, lithium, manganese, and graphite. Indonesia, with the world's largest nickel production in 2023 and substantial reserves of copper and cobalt, plays a crucial role in meeting this demand. However, the rapid extraction of these minerals in biodiversity-rich regions like Sulawesi and Maluku poses significant risks to the nation's ecological heritage. This research investigates the ecological impacts of Indonesia's expanding critical mineral extraction within the context of the global clean energy transition. Employing advanced AI and remote sensing technologies, we evaluate the potential effects of mining activities on both terrestrial and marine biodiversity indicators, including Protected Areas (PAs), Key Biodiversity Areas (KBAs), ecoregions, forest cover, threatened species, seagrasses, mangroves, and coral reefs. By analysing spatial and temporal patterns of mining activities, we can forecast their consequences for biodiversity in Indonesia's critical mineral regions. Our findings reveal that critical mineral extraction may lead to deforestation, habitat fragmentation, and pollution, thereby disrupting delicate ecological balances and potentially causing irreversible biodiversity loss. Additionally, we note that Indonesia's approach to decarbonization is increasingly uneven, diverging from the globally advocated 'just' transition. This research provides essential, data-driven insights for formulating policies that foster responsible mining practices to advance global sustainability objectives. While Indonesia's commitment to clean energy is noteworthy, our study emphasises the need for a balanced strategy to ensure that the pursuit of sustainability does not compromise biodiversity, given that Indonesia boasts the second highest biodiversity in the world. Our insights are intended to guide policymakers and stakeholders in the responsible management of Indonesia's mineral resources, aligning with both global energy transition goals and environmental conservation efforts.

Keywords: Energy transition, critical mineral, nickel, biodiversity