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RENEWABLE ENERGY INSTITUTE

Southeast Asia
Power Sector Decarbonization

Country Case Study – Indonesia

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Renewable Energy Institute

Renewable Energy Institute is a non-profit organization which aims to build a sustainable, rich society based on renewable energy. It was established in August 2011, in the aftermath of the Fukushima Daiichi Nuclear Power Plant accident, by its founder Mr. Masayoshi Son, Chairman & CEO of SoftBank Corp., with his own private resources. The Institute is engaged in activities such as: Research-based analyses on renewable energy, policy recommendations, building a platform for discussions among stakeholders, and facilitating knowledge exchange and joint action with international and domestic partners.

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The IESR encourages transformation into a low-carbon energy system by advocating a public policy that rests on data-driven and scientific studies, conducting capacity development assistance, and establishing strategic partnerships with non-governmental actors.

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Table of Contents

List of Charts

List of Tables

Introduction

Indonesia is Southeast Asia's demographic and economic heavyweight. In 2022, Indonesia had Southeast Asia's largest population (40% of the region's population)[1], largest economy (35% of the region's gross domestic product)[2], and largest power system (27% of the region's electricity generation).

Until now, coal has fueled Indonesia's growth. In 2022, Indonesia was the world's largest coal exporter (28% of global exports), and coal was the country's main power source (62% of electricity generation).[3] Continued reliance on the most polluting fossil fuel is, however, environmentally unsustainable, and incompatible with Indonesia's 2060 net zero emissions objective.

Because of its market size and heavy dependence on coal power, Indonesia is a meaningful testbed for immature and costly Japanese decarbonization technologies: coal-ammonia cofiring, and carbon capture and storage for electricity generation. Supporters of these technologies claim to accommodate the use of coal power in a more environmentally acceptable way – a fragile promise with the potential to jeopardize the decarbonization of Southeast Asia.

Indonesia is one of the countries at the heart of Japan's two key international decarbonization initiatives focusing on Asia, and especially Southeast Asia: "Asia Zero Emission Community" and "Asia Carbon Capture, Usage and Storage Network". These two initiatives put the emphasis on coal-ammonia cofiring, along with carbon capture and storage. The influence of these initiatives may be seen in a negative light by many as they fail to prioritize the most effective decarbonization solutions: energy efficiency and renewable energy.

Focusing on the power sector, this report first describes Japan's misleading decarbonization strategy towards Southeast Asia and more specifically, its impact in Indonesia. The key initiatives "Asia Zero Emission Community" and "Asia Carbon Capture, Usage and Storage Network" are presented. The ongoing fossil power cofiring projects, as well as carbon capture and storage projects that involve Japanese organizations and located in Indonesia are identified.

Then, the report explores Indonesia's great renewable energy opportunities. It highlights a significant and largely untapped renewable energy potential, a good cost competitiveness of renewable energy against coal and gas power, high-share projections of renewable energy electricity, and the industrial developments made possible by the energy transition.

Finally, this report addresses four major challenges impeding renewable energy growth in Indonesia: weak medium-term decarbonization policies, coal power lock-in, incomplete electricity system reform, and electrical grid expansion.

With this publication, Renewable Energy Institute aims to shift outdated mindsets, particularly those of influential Japanese energy decision makers, who despite robust evidence in favor of renewable energy, continue to advocate fossil power in Indonesia.

Chapter 1

A Critical Assessment of Japan's Decarbonization Initiatives in Southeast Asia

1. Japan's "Asia Zero Emission Community" and "Asia Carbon Capture, Usage and Storage Network": fossil-fuel focused approaches

The Asia Zero Emission Community (AZEC) initiative was first presented at the Policy Speech by Prime Minister KISHIDA Fumio to the 208th Session of the Diet held on January 17, 2022. This is the international strategy of the national Green Transformation Policy, known as the "GX Policy". The Cabinet approved the 'Basic Policy for the Realization of the GX Policy' in February 2023. Under this framework, over ¥150 trillion (approximately $1 trillion) of public and private funds are to be raised to address Japan's energy and climate challenges over the next decade.

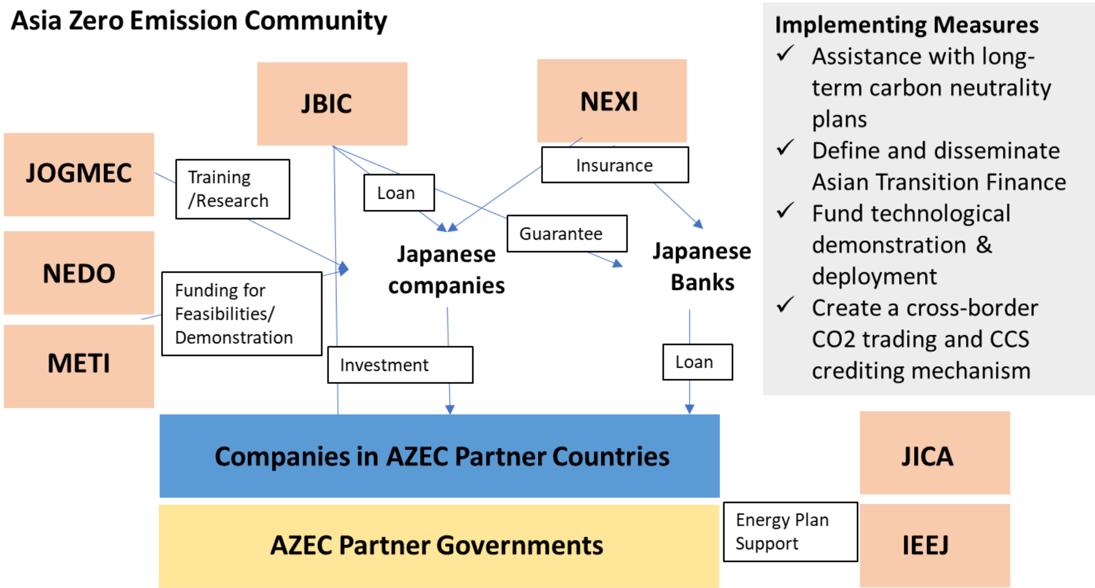
However, the GX Policy includes little information on any alignment with the Paris Agreement goals, and fossil fuels are still a significant proportion of the proposed energy mix.[4] For instance, Japan has not set a coal power phaseout date. Rather, the GX Policy aims at using coal by cofiring it with ammonia beyond 2030. Ultimately, it is anticipated that a significant portion of the nation's electricity will come from fossil fuel power stations that have carbon capture and storage (CCS) installed by 2050.

The essence and distinctiveness of the AZEC initiative is its continued use of fossil fuels while expecting reductions in carbon dioxide (CO_2) with immature future technologies. This strategy is to be widely applied to Southeast Asian countries facing similar challenges to Japan in decarbonization: an uneven distribution of renewable energy (RE) potential and poor connectivity between power grids. The Japanese government defines the approach of AZEC as a realistic path for Asia in decarbonization, with their logic being unconvincing at best.

Under the GX umbrella, the AZEC initiative makes use of Japan's strength and expertise to offer financial, technological, and human resource support. Notably, with an allocation of up to $8 billion until 2030, governmental organizations such as JBIC (Japan Bank for International Cooperation), NEXI (Nippon Export and Investment Insurance), JICA (Japan International Cooperation Agency) and JOGMEC (Japan Oil, Gas and Metals National Corporation) support Japanese businesses to operate, test, and export their technologies in the areas of ammonia, hydrogen, liquefied natural gas (LNG), carbon capture, utilization, and storage (CCUS); it is important to note however that they do also support energy efficiency and RE (Chart 1).

The aim of the AZEC is also to lead in technology standardization and finance. Aligned with this initiative, the Asia Transition Finance Study Group (ATFSG) was launched in October 2021, led by private financial institutions mainly from Japan and Southeast Asia. The Group, led by Mitsubishi UFJ Bank, published the "ATF Guidelines" in September 2022, which refer to the "Technology List" created by Economic Research Institute for ASEAN and East Asia (ERIA) for financial institutions' decision-making. ERIA's Technology List focuses on power sector and upstream reduction measures, and it defines combined-cycle gas turbine (CCGT), ammonia and hydrogen cofiring, and CCS among others as "transition technologies".

Chart 1: Simplified Illustration of AZEC



Notes: "IEEJ" stands for The Institute of Energy Economics, Japan, and "NEDO" for New Energy and Industrial Technology Development Organization.

Source: Created by Renewable Energy Institute based on AZEC Progress Report 2023.

As a component of the GX and AZEC, the Asia CCUS Network (ACN) was created to export CO_2 emissions from Japan to Southeast Asia nations, while at the same time, creating a cross-border CO_2 trading system and a crediting mechanism to offset Japan's emissions. Although there is no clear indication of how much is expected to be exported, during the discussions of the Sixth Strategic Energy Plan, approved in October 2021, government think tank estimates say that 230-280 million tons of CO_2 will be exported overseas from Japan every year, which would equate to approximately a quarter of Japan's current annual CO_2 emissions. The CCS Long-Term Roadmap Final Report, released by the Japanese Ministry of Economy, Trade and Industry (METI) in March 2023, identified ACN as a major program to support international CCS projects.

Many experts have raised concerns with these technologies – especially ammonia cofiring and CCS[5] – as evidenced by a joint statement from a coalition of research institutes that was made public just before the first AZEC Summit in December 2023: "[...] many experts have serious doubts over the lifecycle emissions, cost-effectiveness, technological readiness, and environmental impact. The implementation of these high-cost, unproven technologies could in fact adversely affect the sustainability of power systems, climate goals, and energy security."[6]

It should be noted that AZEC is not a new strategy but represents a sustained Japanese approach towards emerging Asian economies to support their energy supply with fossil fuels. Indeed, Japan has financed 10.9 gigawatts (GW) of coal power capacity, which is one-fifth of the current operating coal power capacity in Indonesia. The entire project cofinancing amounts to $13.4 billion, of which 60% ($8 billion) was guaranteed by a loan supplied by JBIC and JICA. About half of the total financed 10.9 GW project is very new and has either started up after 2022 or is expected to begin operation shortly. A 25-year power purchase agreement (PPA) has been obtained for each of these projects with Perusahaan Listrik Negara (PLN), an Indonesia state-owned vertically integrated utility.

Based on this strong partnership and relations on fossil fuel-based support, Indonesia is a special focus partner for Japan among AZEC partners. The first Senior Officials Meeting of the Asia Zero Emission Community was held in Indonesia in June 2023. During this meeting, agreements were made on the development of a master plan for introducing hydrogen and ammonia, as well as joint formulation of technical standards for CCS. Japan and Indonesia also agreed on the establishment of 'AZEC Japan-Indonesia Joint Task Force' to collaborate on AZEC.

Japanese government entities that have supported coal and LNG development in the country during the past decades have signed several memorandums of understanding (MoUs) with PLN, Pertamina – a state-owned oil and natural gas corporation, and Pupuk Indonesia – a state owned fertilizer and ammonia producing company, to support Japanese firms to cooperate with these entities (Table 1).

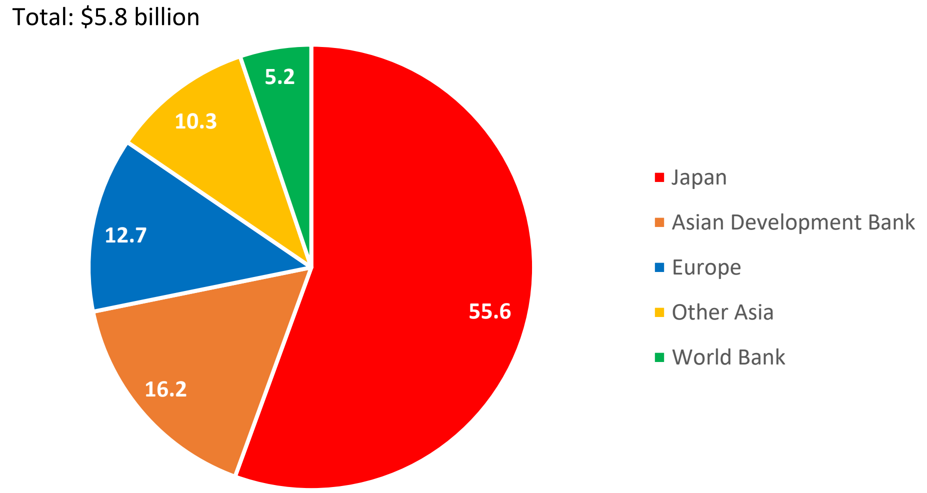
Table 1: Japanese Government Entities and their Roles in the AZEC in Indonesia

Japanese Government entity	Involvement in Indonesia
JICA	• Support PLN and the Ministry of Energy and Mineral Resources on master plan of energy management including CCS, ammonia, hydrogen and fuel procurement, storage battery and others.
JBIC	• MoU with Pupuk Indonesia promoting cooperation in sectors that use hydrogen and ammonia as a fuel source. • MoU signed to promote cooperation between PLN and Japanese companies. • MoU with Pertamina to promote cooperation by Japanese companies in the fields of RE, hydrogen and ammonia value chain projects, CCS and green mobility.
NEDO	• (not specified to Indonesia) R&D carried out under the 'Next Generation Thermal Power Technology Development/Ammonia cofiring Combustion Thermal Power Demonstration Project' and the Green Innovation Fund 'Establishment of Fuel Ammonia Supply Chain'. • Supported ammonia supply chain and hydrogen market research in Indonesia.
JOGMEC	• Provide training on LNG value chain, application of CCS, hydrogen and ammonia production to the Indonesian government and stakeholders. • Conduct CCS research for fuel ammonia production and CO_2-EOR/CCUS-related research and studies in collaboration with relevant Japanese and Indonesian institutions.
NEXI	• As part of the AZEC commitment to provide up to $0.5 billion in support for PLN's decarbonization efforts in Indonesia, as well as opportunities for Japanese companies to introduce their technologies to PLN.

Source: Renewable Energy Institute created from METI and JETRO materials.

The risky inclinations of the AZEC and ACN initiatives in favor of fossil fuel cofiring and CCS are all the more regrettable since Japan has also demonstrated its leadership in financing RE projects in Southeast Asia. Particularly in Indonesia, where Japan, via public institutions (i.e., Ministry of Finance and Ministry of Foreign Affairs) and private financial groups (Mitsubishi UFJ, Sumitomo Mitsui, and Mizuho), accounts for the majority of the provided financial support among the top 10 RE project lenders (Chart 2).

Chart 2: Top 10 RE Project Lenders in Indonesia – Share of Financial Support by Country (%)



Source: BloombergNEF, Country Profiles: Indonesia (accessed February 13, 2024) [subscription required].

2. "Asia Zero Emission Community" related ammonia co-firing projects in Indonesia

The impact of the Japanese government's support in favor of ammonia and CCS technologies is tremendous. About 40 Japanese companies and organizations are working on nearly 60 projects in Japan and throughout Asia in the upstream, midstream, and downstream supply chains; these projects do not include those that are obviously meant for the hard-to-abate sector, like long haul vessels.

In Indonesia, eleven ammonia projects have been identified so far (Table 2). It is interesting that three of the five upstream projects are focusing on the feasibility of green ammonia (based on RE) production. Other than these upstream projects, three projects target the midstream (transportation) and three others the downstream (cofiring projects). For all these projects listed in Table 2, the companies involved received subsidies from different Japanese government entities listed in the previous section.

Table 2: Japanese Firms' Involvement in Ammonia Projects in Indonesia

Japanese firm(s)	Projects	Government support
IHI Corporation	• Small-scale cofiring of ammonia in Gresik gas-fired power plant boiler 1 owned by PLN Nusantara Power, the first ammonia cofiring in a commercial boiler in Southeast Asia. Various technical studies are being carried out in anticipation of further cofiring. • Conducted joint studies with Pupuk Indonesia on green ammonia production in East Java.	Demonstration of ammonia in gas turbines and coal boilers were supported by the Green Innovation Fund (GIF) under NEDO.
Mitsubishi Heavy Industries, Ltd Mitsubishi Corporation	• Feasibility study and field survey on ammonia cofiring at the Suraraya coal-fired power with Mitsubishi Corporation.	The project received a "Subsidy-Based Infrastructure Feasibility Project for Overseas Expansion" to study if this could be formed using yen loans in the future; Received funds for studies on ammonia coal cofiring from GIF under NEDO.
Mitsubishi Corporation	• A joint study with Bandung Institute of Technology (ITB) and PT Panca Amara Utama (PAU) on CCS and CO_2 utilization for clean fuel ammonia production in Central Sulawesi Province. • Together with Pertamina and Pupuk to conduct Joint research on blue/green hydrogen and ammonia value chains.	Supported by JOGMEC.

Toyo Engineering Corporation	• Feasibility study for green ammonia production at the Pupuk fertilizer plant in Aceh Province. - Jointly develop/promote FS/FEED/EPC projects for fuel ammonia production plant and ammonia receiving terminal with JGC Holdings.	Received a "Subsidy-Based Infrastructure Feasibility Project for Overseas Expansion" by METI.
Chiyoda Corporation	• Together with Pupuk Kaltim upgrading and decarbonizing the operation of existing ammonia and urea plants are being implemented through equipment diagnostics.	Received funds for the development and demonstration of new catalysts for ammonia production from GIF under NEDO.
Mitsubishi Heavy Industries, Ltd	• Joint research with Bandung Institute of Technology on clean energy solutions for decarbonization, including ammonia cofiring. - Study on hydrogen cofiring at the existing gas-fired power plant in Tanjung Priok.	Received a "Subsidy-Based Infrastructure Feasibility Project for Overseas Expansion" by METI.
Tokyo Electric Power Services	• Economic estimates of the process of transporting ammonia and hydrogen produced in Indonesia to a nearby natural gas-fired power plant and consuming it as fuel for power generation.	Received a "Subsidy-Based Infrastructure Feasibility Project for Overseas Expansion" by METI.
JERA	• MoU with Pertamina on the collaboration on LNG and hydrogen/ammonia transportation and LNG receiving terminal operation & maintenance, as well as capacity building through benchmarking, training and/or exchange to improve the operational efficiency of LNG handling. - Opened JERA Energi Indonesia office to provide clean energy supply infrastructure in 2023.	Received a "Subsidy-Based Infrastructure Feasibility Project for Overseas Expansion" by METI; Demonstration of ammonia-coal boilers and development and demonstration of new catalysts for ammonia production were supported by GIF under NEDO; Received funds from JICA on 'Information gathering and confirmation study on the electricity sector for low (de)carbonization in Indonesia'.
Tokyo Electric Power Company Holdings, Inc. Yamanashi Hydrogen Company, Inc.	• Joint Development Agreement with Pertamina on pilot scale development of green hydrogen and green ammonia using geothermal power.	Feasibility study adopted by NEDO under the 'International Demonstration Project for Japanese Technologies Contributing to Decarbonization and Energy Transformation'.

Source: Renewable Energy Institute created from METI, Jakarta Japan Club (JJC) and JETRO materials.

So far, these government funded feasibility study reports shed light on the challenges and costs involved in implementing such projects. For example, a downstream project feasibility study conducted by Mitsubishi Heavy Industries and Tokyo Electric Power Services, at the gas-fired Keramasan Power Plant in Indonesia, assessed 100% blue ammonia firing possibilities (Table 3). It outlined two scenarios for cost calculation, considering the installation of an ammonia pipeline and, in the second case, incorporating CCS for ammonia production. The projected costs were considerably (at least four times) higher than the current electricity price in Indonesia for both cases. Additionally, the report estimates a 7-year timeline for commercial operation as not only retrofitting the power station, but ammonia pipeline construction and CO_2 storage facilities are needed. While emission reduction was mentioned, the efficacy of non-green ammonia in reducing CO_2 emissions, especially with CCS, requires verification.

Another feasibility study on cofiring in Suraraya coal-fired power did not disclose detailed cost information, possibly due to high costs. These reports indicate a strong relation to CCS feasibility and CO_2 storage site investigation to consider the whole value chain of ammonia cofiring projects.

Table 3: Keramasan Gas-Fired Power Plant 100% Blue Ammonia Feasibility Study Results

Case #	Current generation cost [A]	Added cost [B]	Future generation cost [A]+[B]	Equipment cost ($ bn)
Case 1: installation of ammonia pipeline	6.6	21.6	28.2	3.59
Case 2: ammonia pipeline + CCS		23.7	30.3	4.32

Note: unless otherwise noted the unit is $ cent per kilowatt-hour.

Source: Mitsubishi Heavy Industries, Tokyo Electric Power Services, Ministry of Economy, Trade and Industry, Indonesia Keramasan Ammonia Power Generation by Retrofitting Gas Power Plant Feasibility Study Report (February 2023).

3. “Asia Carbon Capture, Usage and Storage Network” related CCS projects in Indonesia

Eleven CCUS projects have been identified in Indonesia, seven of which are related to the oil and gas industry and are implemented in gas and oil fields where they hold interests (Table 4). Among these projects, two involve the reinjection of CO_2 into the field, a practice commonly known as enhanced oil recovery (EOR), aimed at boosting gas and oil production, which actively defeats the goal of emission reductions. While others do not explicitly mention EOR, they are considering finding storage fields for CO_2 that will be imported from Japan. Interestingly, only two projects are considering the implementation of CCS in the power sector. This limited interest in fitting CCS to fossil power plants may be attributed to investors' implicit recognition that this method is not an effective solution for decarbonizing electricity generation, despite optimistic claims by governmental bodies. Out of the eleven identified projects, only one of the nine identified projects is carbon capture based on biomass, which has the possibility of genuinely lowering emissions.

The future funding mechanism for projects other than those related to EOR remains unclear. However, it is worth mentioning that a crediting mechanism is taken into consideration to help technological development. ACN released a "Handbook for CCS Carbon Credits" (March 2023), which provided an overview of the potential operation of a CCS crediting system.

In this way, Japan is looking for CO_2 storage sites in other countries like Indonesia and discussing a crediting mechanism to offset CO_2 emissions from its thermal power plants.

Table 4: Japanese Firms’ Involvement in CCS Projects in Indonesia

Japanese firm(s)	Project	Government support
Mitsubishi Corporation INPEX Corporation JX Nippon Oil & Gas Exploration Corporation Mitsui & Co. LNG Japan Ltd. Sumitomo Corporation Sojitz Corporation	• Development plan for the Tangguh LNG project including CCUS project has been approved by SKK Migas (Indonesian upstream oil and gas business supervisory and executive body). The project includes development of a new Ubadari gas field, and the application of CCUS in the existing Vorwata gas field. Total of 25 million tons of CO_2 will be re-injected and stored and production will be increased.	Supported by JOGMEC.
JGC Holdings Corporation JAPAN NUS CO., LTD. J-Power	• Joint feasibility study in Gundih CCS demonstration project with bilateral credits. • Feasibility study with Pertamina to realize a CCS demonstration project to inject and store CO_2 separated in the natural gas production process underground by pipeline transport.	Received funds from METI for JCM feasibility study.

Mitsui Oil Exploration	• Study of underground injection of CO_2 emitted in the Sakakemang field (South Sumatra).	
Japan Petroleum Exploration (JAPEX)	• Joint study on the feasibility assessment of the CCUS project using bilateral credits in the Sukawati oil field. • The field test is conducted to verify the effect of CO_2 EOR and CO_2 geological storage in the field, and to acquire necessary data to study the commercial implementation of CO_2-EOR.	Received funds from METI for JCM feasibility study; Supported by JOGMEC.
Mitsui & Co., Ltd	• Assessment of the potential for underground storage of CO_2 within the Rokan concession, including the Duri and Minas oil fields operated by Plutamina in Central Sumatra, and consideration of the feasibility of establishing a CCUS value chain.	
Marubeni Indonesia	• Joint study with Pertamina on biomass-derived CO_2 capture and storage (BECCS) projects in South Sumatra and other projects.	
Chiyoda Corporation	• South Sumatra feasibility study on the Tanjung Enim CCS project is being conducted Jointly with Plutamina.	Received funds from METI.
Mitsubishi Heavy Industries, Ltd.	• Study of candidate sites for CO_2 storage in Indonesia. • Introduction of CO_2 capture technology to the Indonesian Government / Japanese and Nigerian private companies.	
JERA	• MoU with Pertamina to consider the development of new businesses related to CCUS. • Together with JGC HD and PLN launch a joint study on CCS projects at the Indramayu coal-fired power plant and Tambak Lorok gas-fired power plant.	Received a "Subsidy-Based Infrastructure Feasibility Project for Overseas Expansion".
INPEX	• Revised development plan with CCS added to the development plan of the Abadi LNG project in the Masela field accepted by the Indonesian government.	
Kansai Electric	• Signed MoU with Medco Power to study the feasibility of applying CCS technology to existing thermal power plants in Indonesia.	

Source: Renewable Energy Institute created from METI, Jakarta Japan Club (JJC) and JETRO materials.

So far, Indonesia seems responding positively to Japan's idea. In collaboration with BRIN (National Research and Innovation Agency) and Lemigas (State-owned research center for oil and gas technology development), ACN will conduct a research study titled 'Estimation of Indonesia Basin-Scale CO_2 Storage.' The objective is to estimate the potential storage capacity of CO_2 at the basin level in Indonesia. This effort could indirectly benefit CCS for electricity generation insofar as CO_2 captured at power plants could be stored in identified storage sites.

In January 2024, Indonesia issued a presidential regulation on CCS, allowing CCS operators to set aside 30% of their storage capacity for imported CO_2. Once the Indonesian government has a bilateral agreement with the government from where the emissions originated, the oil and gas contractors could utilize depleted reservoirs for CCS operations. This aligns with Japan's plan to export CO_2, but there are safety and legal concerns associated with Indonesia's presumption that CO_2 storage will grow to be a lucrative industry. Additionally, this will make Japan more dependent on other countries for both the import of fossil fuels as well as the export of CO_2, which raises concerns about morality, cost, and security.

Chapter 2

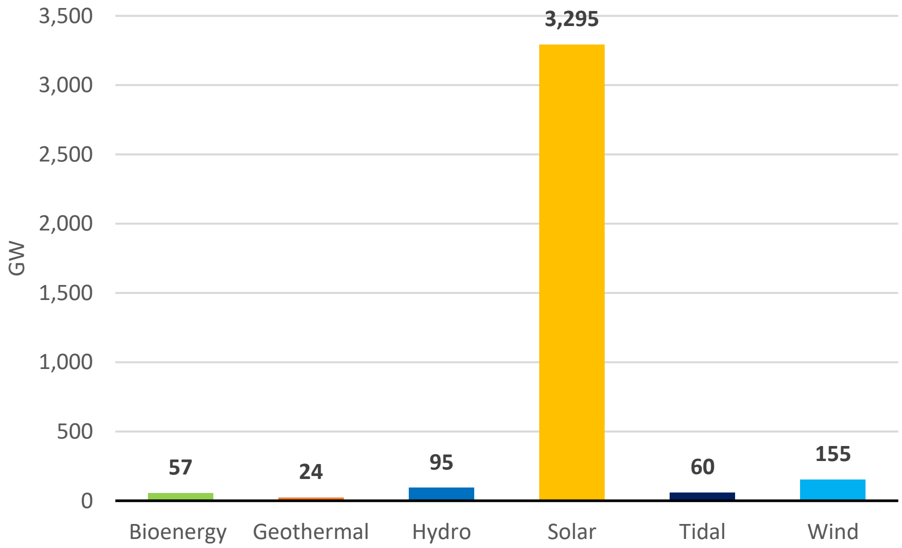
The Correct Narrative: Indonesia's Great Renewable Energy Opportunities

1. A significant, largely untapped renewable energy potential

The Indonesian Ministry of Energy and Mineral Resources (MEMR) estimates the RE potential of its country at 3,686 GW.[7] This is significant. In comparison, Indonesia's total installed capacity was "only" 81 GW in 2022. In other words, the RE potential of Indonesia is amply sufficient to meet the country's electricity consumption – even if it is strongly increasing as the population is growing and the economy keeps dynamically developing.

Most of Indonesia's RE potential comes from solar: 3,295 GW (Chart 3). Though lower, the potential of all the other RE technologies is also abundant (i.e., ranging between 24 GW for geothermal and 155 GW for wind). Thus, Indonesia can enjoy a variety of complementary RE resources.

Chart 3: Indonesia RE Potential by Technology



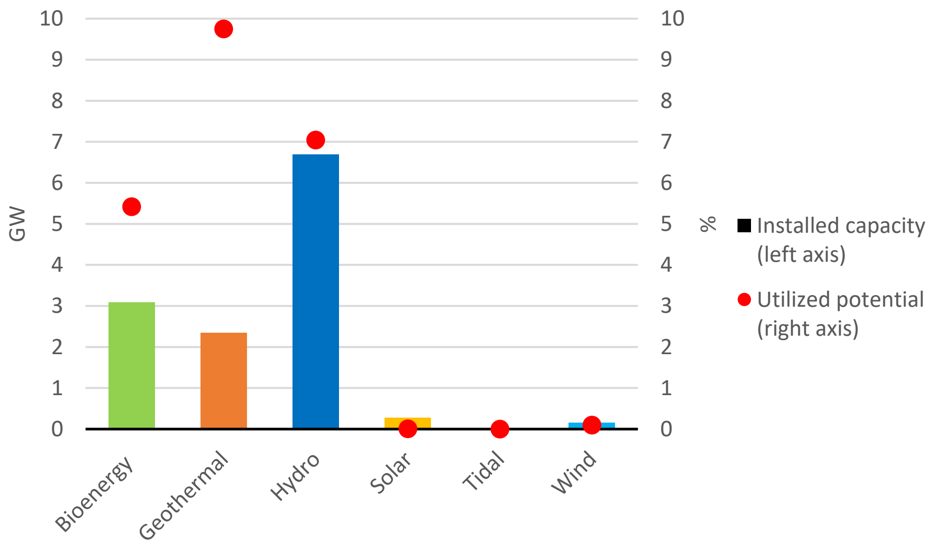
Source: Indonesia Ministry of Energy and Mineral Resources, Indonesia Renewable Energy Potential – February 4, 2023 (accessed January 11, 2024) (in Indonesian).

In addition, to the MEMR's estimates, the Institute for Essential Services Reform (IESR), an Indonesian think-tank in the field of energy and environment, also provides estimates for the technical potential of RE technologies in Indonesia. The IESR estimates that the country's solar potential could be up to 7,715 GW, and those of onshore wind, bioenergy, and micro & small hydro up to 106 GW, 31 GW, and 28 GW, respectively.[8]

Though the IESR's estimates are somewhat different from those of the MEMR, both the IESR and the MEMR estimates concur that the RE potential of Indonesia is massive.

In February 2023, the MEMR noted that with less than 13 GW of RE installed capacity at the end of 2022, only 0.3% of Indonesia's RE potential was utilized (Chart 4). This means that the country's significant RE potential is still largely untapped.

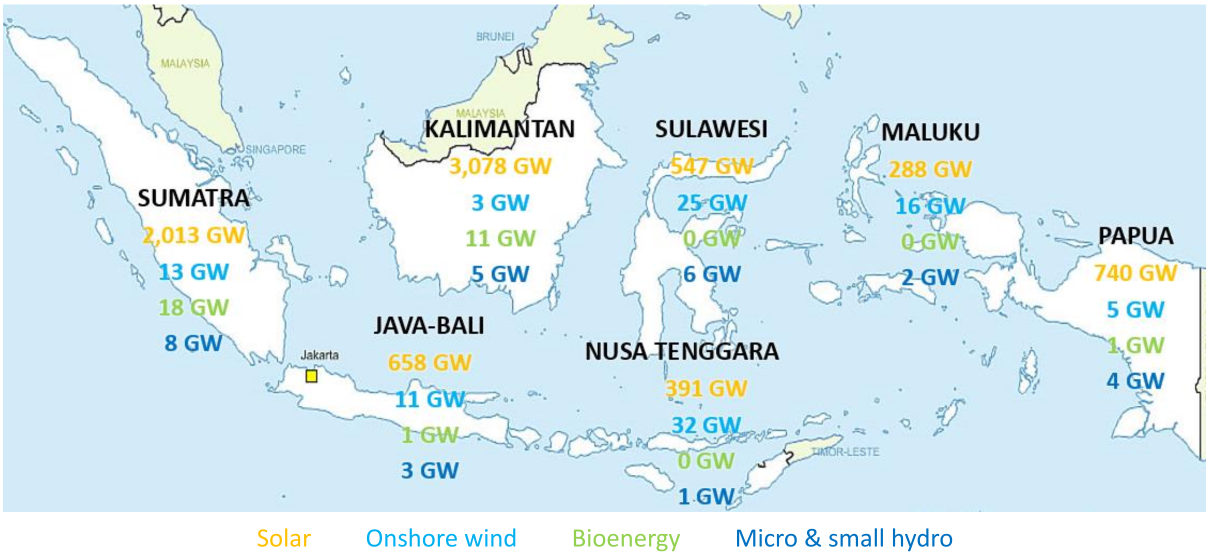
Chart 4: Indonesia RE Installed Capacity 2022 and Utilized Potential



Source: Indonesia Ministry of Energy and Mineral Resources, [Indonesia Renewable Energy Potential]() – February 4, 2023 (accessed January 11, 2024) (in Indonesian).

Based on the IESR's estimates, the potential of solar is widespread across Indonesia (Chart 5). The best wind potentials are in the center of the country in Nusa Tenggara (32 GW) and Sulawesi (25 GW). Most of the bioenergy potential is in Sumatra (18 GW), west of Indonesia. And the highest micro & small hydro potentials are in Sumatra (8 GW) and Sulawesi (6 GW).

Chart 5: Indonesia Map of RE Technical Potential



Source: Institute for Essential Services Reform, [Beyond 443 GW: Indonesia's Infinite Renewable Energy Potentials]() (October 2021).

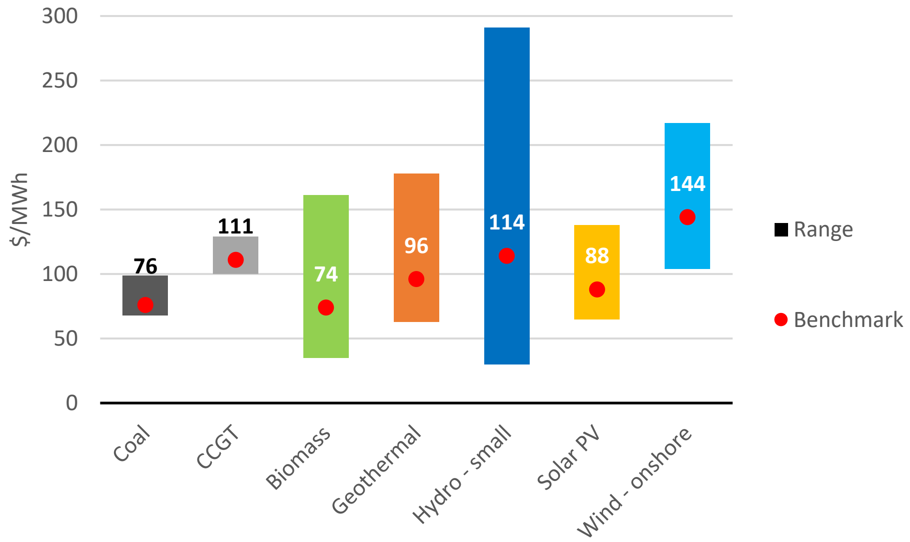
Finally, according to the MEMR, the biggest geothermal potentials are found in Sumatra (9 GW) and Java-Bali (8 GW).[9] Java-Bali hosts Jakarta, the capital of Indonesia and it is the largest power system of the country.

2. Renewable energy cost competitive against fossil power

In 2023, studies separately conducted by BloombergNEF, one of the global authorities on energy economics, and the IESR both concluded that RE is generally cost competitive against fossil power in Indonesia. Under favorable conditions, RE technologies are even outcompeting coal and gas power.

In December 2023, BloombergNEF published its latest levelized cost of electricity (LCOE) update – for the second half of 2023. This analysis shows that, except for onshore wind, the benchmarks for the LCOE of RE technologies range between $74 per megawatt-hour (MWh) and $114/MWh (Chart 6). In comparison the benchmark for the LCOE of coal is $76/MWh and that of CCGT is $111/MWh. This means that clean RE can typically deliver electricity at a similar cost to polluting coal and gas power.

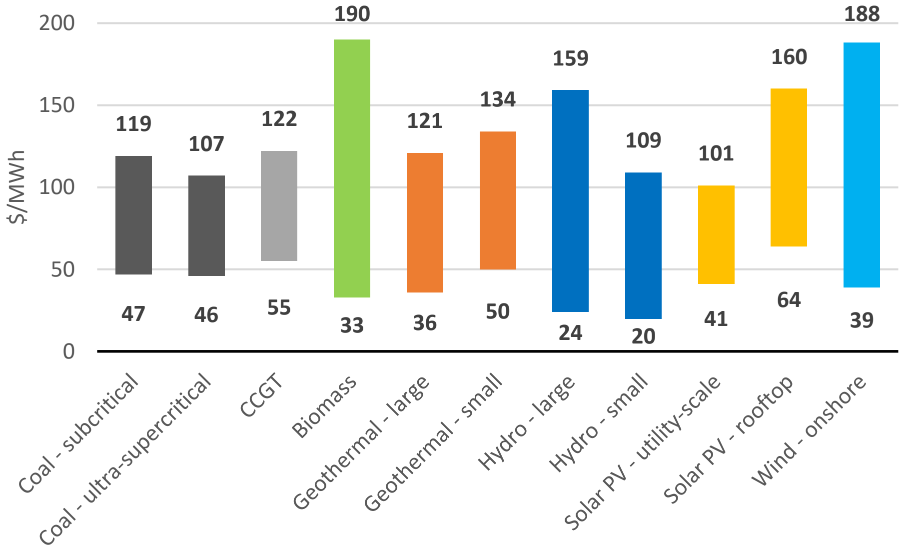
Chart 6: BloombergNEF, Unsubsidized LCOE by Technology Indonesia



Source: BloombergNEF, Levelized Cost of Electricity 2023 H2 (December 2023) [subscription required].

Published a few months earlier, in March 2023, the IESR's study is an insightful complementary piece of information. Though it is a little less recent than BloombergNEF's analysis, the IESR's analysis is more exhaustive. It notably provides broader technological coverage, as well as rich supporting explanations. The IESR's study largely shares the same key conclusions as that of BloombergNEF: in Indonesia, RE is cost competitive with fossil power, and under favorable conditions it is cheaper (Chart 7).

Chart 7: IESR, LCOE by Selected Technology Indonesia



Source: Institute for Essential Services Reform, Making Energy Transition Succeed: A 2023's Update on the Levelized Cost of Electricity and Levelized Cost of Storage in Indonesia (March 2023).

Moving forward, RE will certainly have a clear cost advantage over fossil power in Indonesia. There are two reasons for which this decisive development will take place.

First, there is still room for the cost of RE to be reduced. In particular, the cost of solar photovoltaic (PV) is expected to decrease further. Despite being already cost competitive, the LCOE of solar PV in Indonesia remains relatively high compared to global standards. This is because of the local content requirement (LCR) regulation which requires the use of domestic solar modules.[10] The capability of the Indonesian solar PV manufacturers to produce high-quality solar modules at competitive costs is currently limited. This affects project financing and increases the investment cost. Solutions to this problem exist. For examples, the LCR regulation may be eased by allowing developers to import more materials, and international solar manufacturers may be attracted to set up production facilities in Indonesia thanks to tax benefits.

Second, any option directly targeting fossil power to decarbonize Indonesia's power sector will result in a cost increase of fossil power. These options include carbon pricing (internalizing the negative externalities from polluting fossil power plants), and expensive technologies to reduce the greenhouse gas (GHG) emissions from fossil power plants (e.g., coal-ammonia cofiring and CCS). In September 2023, Indonesia launched its domestic carbon exchange, including an emissions trading system (ETS).[11] This initiative is yet to gain momentum because of a lack of demand for carbon credits, but it is a first step in the right direction. Regarding coal-ammonia cofiring and CCS, their poor track records, and the fact that they necessarily add fossil power costs signal major economic risks for investors. More precisely, in two reports published in October 2023, BloombergNEF estimated that the LCOE of coal power is approximately increased by $20-50/MWh in the case of coal-ammonia cofiring (75%-25%) and by $45-75/MWh in the case of CCS.[12]

3. Reaching high shares of renewable energy electricity is feasible and profitable

In Indonesia, there is a common persistent misbelief among electricity planners, regulators, and power utilities that high shares of RE, especially high shares of solar and wind, imperil grid operations and increase the cost of electricity.[13] Likewise, this outdated mindset is often observed in Japan.

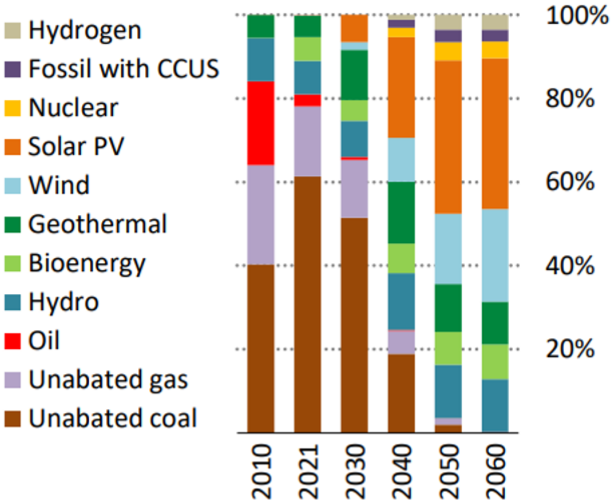
Between May 2021 and October 2022, three landmark studies dedicated to the decarbonization of Indonesia have been published, conducted by: the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA)[14], and the IESR in cooperation with Agora Energiewende and LUT University[15]. All these studies demonstrate that not only it is possible to integrate high shares of RE into power systems operations (i.e., at least 85% of total electricity generation), but also that it is more cost efficient over time.

For the sake of conciseness, in this section the IEA's study is focused on, but the key findings of the IRENA and IESR studies are relatively similar.

In September 2022, the IEA published *An Energy Sector Roadmap to Net Zero Emissions in Indonesia*. In this report, the IEA centers its analysis on a scenario called "Announced Pledges Scenario" (APS) in which Indonesia reaches net zero emissions on an economy-wide basis by 2060.

This analysis finds that in the APS the share of RE in the country's total electricity generation reaches 90% in 2060 (Chart 8). Among, RE technologies solar PV is the leading technology thanks to its excellent potential and cost competitiveness. Conversely the contributions of fossil power plants equipped with CCUS and those using ammonia or hydrogen are marginal (just a little more than 5%).

Chart 8: Indonesia Electricity Generation Mix in APS 2010-2060

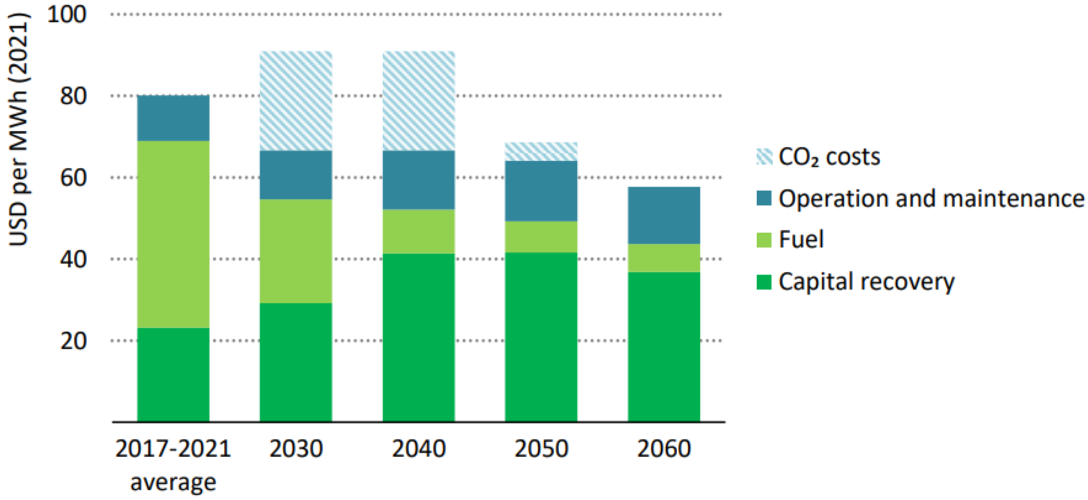


Note: "Hydrogen" includes both hydrogen and ammonia.

Source: International Energy Agency, An Energy Sector Roadmap to Net Zero Emissions in Indonesia (September 2022).

In terms of electricity costs, the IEA projects that in the APS the cost of electricity will first increase from approximately $80/MWh in 2017-2021 to $90/MWh in 2030 due to rising CO_2 prices (which revenues can be used to compensate consumers or to drive growth by lowering other taxes) (Chart 9). Then, the cost of electricity will be broadly stable to 2040 before starting a long-term structural decline thanks to the cost effectiveness of RE relative to fossil fuels. Ultimately, in 2060, the cost of electricity will be below $60/MWh which is affordable.

Chart 9: Indonesia Average Electricity Generation Costs by Category in APS 2017/2021-2060



Note: "CO_2 costs" refer to those associated with a carbon price for emissions from fossil fuel power plants.

Source: International Energy Agency, An Energy Sector Roadmap to Net Zero Emissions in Indonesia (September 2022).

For Indonesia to successfully manage the integration of high shares of RE, expanding and reinforcing the electrical grid is the top priority. This is because the electricity generated in RE resource rich areas needs to be transported to demand centers (e.g., Java-Bali) where it will be consumed. Both transmission and distribution lines should be further developed. Concerning transmission lines more specifically, deployment should take place between islandic power systems (undersea lines) and within islandic power systems.

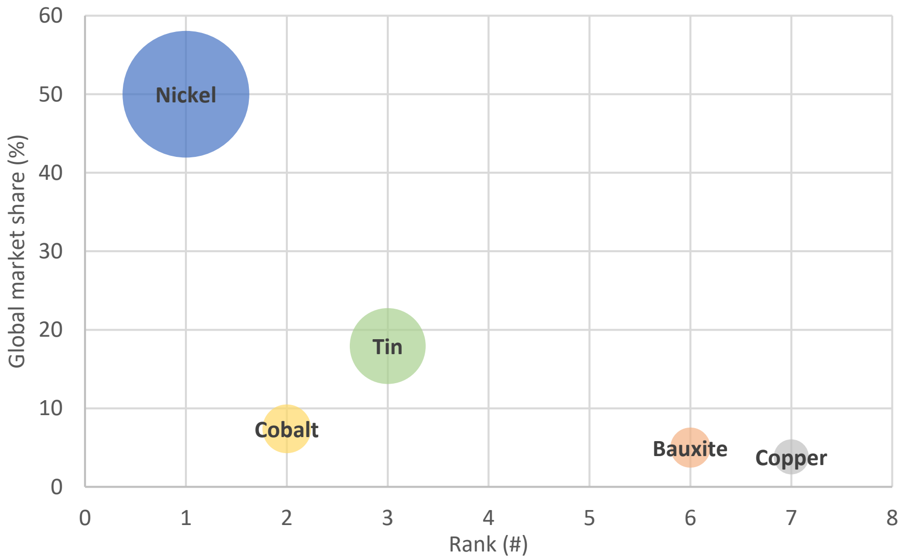
Battery storage is another important solution expected to provide flexibility to Indonesia's power system, especially from the 2030s.

4. Industrial developments made possible by the energy transition

On the one hand, Indonesia is the world's largest coal exporter (global market share of 28% in 2022)[16], but around 85% of its coal exports go to countries with net zero emissions targets (e.g., China, India, Japan, South Korea…), casting doubt over long-term export prospects.[17]

On the other hand, Indonesia is by far the world's largest producer of nickel (50%) (Chart 10). It is also the world's second-largest producer of cobalt (7%), third-largest producer of tin (18%), sixth-largest producer of bauxite (5%) – from which aluminum is derived, and seventh-largest producer of copper (4%). All these materials are critical for making various clean energy technologies such as batteries, solar PV modules, and wind turbines.

Chart 10: Indonesia Key Supplier of Critical Minerals for the Energy Transition 2023



Note: based on mine production.

Source: United States Department of the Interior – United States Geological Survey, Mineral Commodity Summaries 2024 (January 2024).

Thus, the strong growth in clean energy technologies worldwide provides further opportunities for Indonesia to position itself as a reliable supplier of critical minerals while also capturing additional value along supply chains.

As demonstrated by recent events, the country has started seizing this industrial opportunity.

In September 2021, South Korean conglomerates Hyundai and LG began construction of Indonesia's first electric vehicle (EV) battery plant in the Karawang regency, province of West Java.[18] This plant is worth $1.1 billion, and it is expected to have an annual production capacity of 10 gigawatt-hours.

In late 2021 and early 2022, the Indonesian government signed MoUs with several companies to support domestic EV battery manufacturing, including a $10 billion MoU with LG.[19]

Moreover, though Indonesia currently lags its Southeast Asian peers (i.e., Malaysia, Thailand, and Vietnam) in solar PV manufacturing capacity, progress is expected with new projects in the pipeline. The IESR noted in a report published in December 2023, that new manufacturing capacity for polysilicon production, cell manufacturing, and module assembly is planned in the country.[20] An example of these projects is that of the American company SEG Solar which is investing to set up manufacturing in Batang, province of Central Java with annual production capacity of 5 GW of solar cells and 3 GW of solar modules.

It may be briefly noted here that mining is associated with environmental issues, including GHG emissions, impacts on local air quality, water use, water quality, biodiversity, and land use, as well as handling of mining waste.

In Indonesia, nickel deposits cover vast areas, and are often located beneath rainforests with rich biodiversity and carbon stocks. These deposits are generally mined using open-cut methods because laterite ores are formed near the surface and located horizontally in the soil. These methods generate substantial volumes of tailings waste.

Against this backdrop, tailings dewatering techniques such as pressure filtering and thickening agents are being adopted to reduce land use and lower risk of dam failure and acid drainage. For example, in 2022, PT Huafei Nickel Cobalt's laterite nickel ore project decided to use filtration technology to dewater its tailings.[21]

Finally, it is important to stress that for Indonesia to become a real leader of the energy transition, it will need not only to manufacture clean energy technologies, but also manufacture these technologies using RE instead of fossil fuels as it is currently the case (e.g., coal powering nickel smelters). The most effective way to achieve this transformation is to maximize the electrification of the final energy consumption. Hence the necessity of decarbonizing the country's power sector.

Chapter 3

Unleashing the Growth of Renewable Energy in Indonesia: Four Challenges to Overcome

1. Weak medium-term decarbonization policies

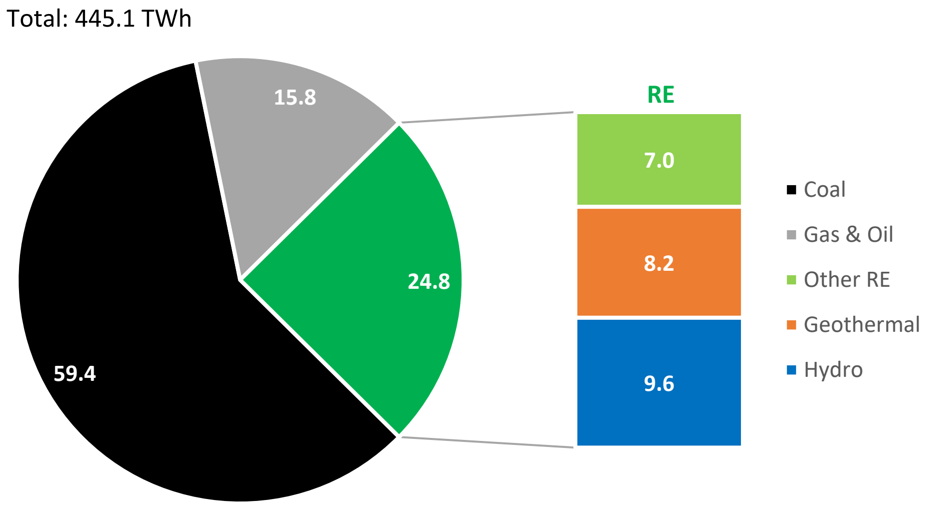
Indonesia has pragmatic long-term decarbonization targets: net zero emissions by 2060 or sooner, and net zero emissions toward 2050 for the power sector.[22] The first challenge, however, is the lack of enabling policies implemented to reach these long-term targets.

For instance, the medium-term target and current support schemes for RE are unaligned with the efforts required to achieve the deep decarbonization of the country's power system.

In Indonesia, the *National Electricity Supply Business Plan* is the basis for implementing the electricity supply business in the public interest. It is prepared based on the MEMR's *General Plan for National Electricity*. The *National Electricity Supply Business Plan* is advanced by PLN.

Based on the latest update of the *National Electricity Supply Business Plan* (for the period 2021-2030), the medium-term target for RE in Indonesia is unambitious: 24.8% by 2030 (Chart 11), against 19.6% in 2022[23] – a mere 5 percentage points increase.

Chart 11: Indonesia Electricity Generation Mix 2030 Projection (%)



Note: "Gas & Oil" is essentially gas.

Source: Perusahaan Listrik Negara, National Electricity Supply Business Plan 2021-2030 (October 2021) (in Indonesian).

Rapidly revising the low RE target of the *National Electricity Supply Business Plan* is a priority. This is one of the key conditions for Indonesia to benefit from the Just Energy Transition Partnership (JETP), one of the nascent international financing initiatives to accelerate the phaseout of coal power in emerging economies. In this framework, Indonesia pledged to pursue a RE share of 44% by 2030.[24]

This new objective should now be reflected in the MEMR's upcoming *General Plan for National Electricity 2023-2060*, and in the next update of the *National Electricity Supply Business Plan* to ensure a compatible planification of the power sector.

About RE schemes, Indonesian policymakers have consistently failed at advancing truly supportive incentives until now.

The RE tariff cap regulation provides tariffs tiered by operational year, technology location, capacity, and ownership type.[25] These tariffs serve as benchmark ceiling prices in tenders or negotiations with PLN. However, the current tariffs may provide unattractive margins for developers limiting investments in new RE projects.[26] In the case of new solar PV projects with an installed capacity exceeding 20 megawatts (MW) located in the Java-Bali power system, the tariff is $69.5/MWh for the first ten years and $41.7/MWh afterwards.[27] This is rather low compared to the LCOE of solar PV in Indonesia.

Rooftop solar PV net-metering is another RE policy that is experiencing a problematic implementation due to controversial system reliability concerns claimed by PLN.[28] As a result, electricity export to the grid is not allowed. This issue is particularly acute for residential customers. This is because, unlike commercial and industrial customers, their consumption is more limited during the daytime. Thus, the surplus solar electricity that is not consumed or stored is curtailed.

Finally, though they indirectly support RE, the importance of carbon pricing mechanisms may be pointed out here. In Indonesia, these mechanisms are not efficient yet. Presently, in its first phase (2023-2024), the mandatory ETS already covers most of the country's coal power capacity (99 facilities).[29] This is a good starting point, but because of a loose emission cap the price of pollution allowances is very low: less than $4 at the end of January 2024.[30] This level of price insufficiently penalizes harmful coal power plants, and it does not significantly contribute to raise the necessary funds to finance decarbonization projects.

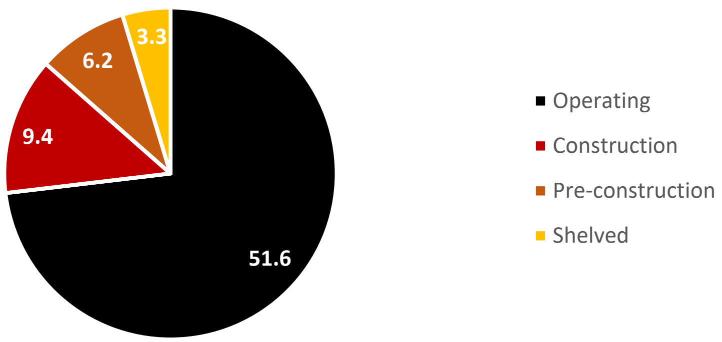
2. Coal power lock-in

Heavy, unsustainable reliance on coal power is the second obstacle to overcome to speed up RE growth in Indonesia. In 2022, the share of coal in the country's electricity generation mix was 61.6%.[31]

From economic and environmental perspectives, phasing out coal power should be a priority for Indonesia. However, four barriers exist:

First, the Indonesian fleet of operating coal power plants (on- & off-grid) is massive 51.6 GW (Chart 12). Worse, it is likely to increase in the short-term as there is still another 19.0 GW of capacity at various stages of development, including 15.7 GW considered to be active (i.e., construction and pre-construction). Given the decarbonization imperative, this is excessive and signals a risk of stranded assets. Coal power overcapacity also limits RE room for growth.

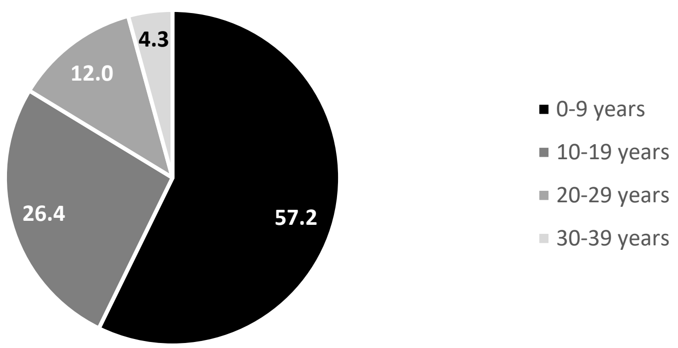
Chart 12: Indonesia Coal Power Capacity Status 2023 (GW)



Source: Global Energy Monitor, Global Coal Plant Tracker: Data Dashboard (January 2024).

Second, the fleet of operating coal power plants is young. More than half of the installed capacity is less than 10 years old, and more than 80% is below 20 years old (Chart 13). On the contrary, less than 5% of installed capacity is over 30 years. This means that an accelerated phaseout of coal power in Indonesia requires voluntary political action.

Chart 13: Indonesia Operating Coal Power Capacity by Age 2023 (%)



Source: Global Energy Monitor, Global Coal Plant Tracker: Data Dashboard (January 2024).

Third, coal power plants are often locked-in investments for decades due to long-term (i.e., 25-30 years) PPAs between PLN and independent power producers (IPPs).[32] Early termination of such deals can be costly for PLN.[33] Furthermore, with increasing shares of low marginal costs RE, coal power plants need to be operated flexibly. Breaching some of the technical clauses in the PPAs, such as availability factor and heat rate, results in penalties for PLN.[34] Therefore, in its own financial interest PLN may prefer to stick to coal power, even if it is not desirable for the country.

Fourth, coal power is still unfairly subsidized in Indonesia. In the framework of the Domestic Market Obligation, PLN secures thermal coal supplies for electricity generation at fixed prices (e.g., approximately $40 per ton for coal which energy content is ≤6,000 kilocalories per kilogram gross as received (kcal/kg GAR)).[35] These fixed prices are currently lower than the market prices (e.g., in January 2024, the price of HBA 2 coal which energy content is 4,200 kcal/kg GAR was $59 per ton).[36] This makes coal power artificially more cost competitive against RE.

In this negative context, the establishment of new international financing initiatives to accelerate the phaseout of coal power in emerging economies, such as the JETP and the Energy Transition Mechanism (ETM), is a chance for Indonesia.

The JETP is a financing initiative in which developed countries fund a coal-dependent developing country to support its own path to phase-out coal and transition towards clean energy.[37] The JETP also addresses the social consequences of implementing such plans (e.g., ensuring training and alternative job creation for affected workers and new economic opportunities for affected communities). The JETP funding can go through grants, loans, or investments.

Launched by the Asian Development Bank in 2021, the ETM is a program that aims at helping confront the issue of climate change by reducing GHG emissions in Asia-Pacific.[38] Concessional and commercial capital is to be used to accelerate the retirement or repurposing of fossil fuel power plants and replace them with clean energy alternatives.

In November 2022, a JETP was announced between developed countries and Indonesia.[39] In November 2023, this JETP's Comprehensive Investment and Policy Plan was officially launched to mobilize $21.7 billion.[40] These funds will support the acceleration of emissions reduction in Indonesia's power sector. Into more detail, the plan is to accelerate and reduce peak emission in the power sector by 2030 (250 million tons of CO_2 equivalent) and to reach net-zero emissions in the power sector by 2050. To achieve these goals, actions to be taken include early retirement of coal power plants and increasing the share of RE electricity to 44% by 2030. It should be noted that off-grid coal power plants are excluded from this plan. These plants are called "captive power plants" and are owned by industries to produce electricity for their own uses.

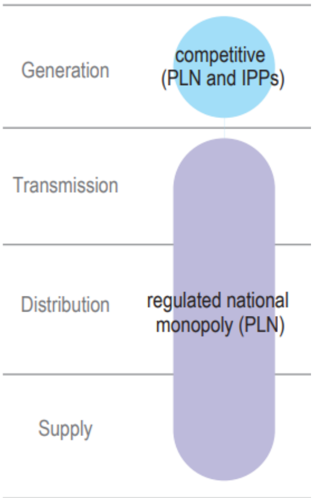
Under the ETM, options for the early retirement of coal power plants are explored. Pelabuhan Ratu (969 MW) and Cirebon-1 (660 MW) have been chosen as the first ETM early retirement projects. The Pelabuhan Ratu coal power plant is set to retire eight years earlier than planned in 2037, and the Cirebon-1 seven years ahead of schedule in 2035.[41]

3. Incomplete electricity system reform

Incomplete electricity system reform is the third hurdle to address to speed up RE growth in Indonesia. The country's electricity system is characterized by a lack of competition and inadequate regulations. Unless conservative policy makers and the state-owned vertically integrated utility PLN suddenly become forward-thinking, IPPs and consumers will keep having to play key roles in shifting paradigm.

In Indonesia, competition exclusively takes place in the electricity generation segment between PLN and IPPs (Chart 14). PLN controls most of the generation assets. The transmission, distribution, and supply segments are regulated and integrated under the helm of the monopoly PLN. Such a power system structure hinders the emergence of new participants and new business models.

Chart 14: Indonesia Simplified Power System Structure



Source: BloombergNEF, Country Profiles: Indonesia (accessed January 23, 2024) [subscription required].

Nonetheless, these unfavorable conditions have not totally deterred daring IPPs to invest in the country's electricity generation segment. For instance, the participations of the Japanese companies INPEX, ITOCHU, and Kyushu Electric Power in the Sarulla geothermal power project (330 MW) in the province of North Sumatra may be highlighted.[42]

Moreover, even if the supply segment is regulated, an increasing number of businesses are actively requesting RE to meet their electricity consumption. These actions drive change and speed up RE growth. For example, 121 member companies belonging to the RE100 initiative, a global corporate RE initiative bringing together businesses committed to 100% RE electricity, have operations in Indonesia.[43] Among these companies, the Japanese company AEON is moving forward with the installation of a rooftop solar PV system at its BSD City mall in the city of Tangerang, province of Banten (Java-Bali power system).[44]

In this regard, in Indonesia some corporate clean power procurement options exist such as RE certificate, net-metering, and onsite PPA (Table 5). The country's power market structure does not allow for offsite PPA. However, the American company Amazon signed Indonesia's first corporate offsite PPA with PLN in November 2022 (210 MW from four new solar PV projects in the Java-Bali power system).[45]

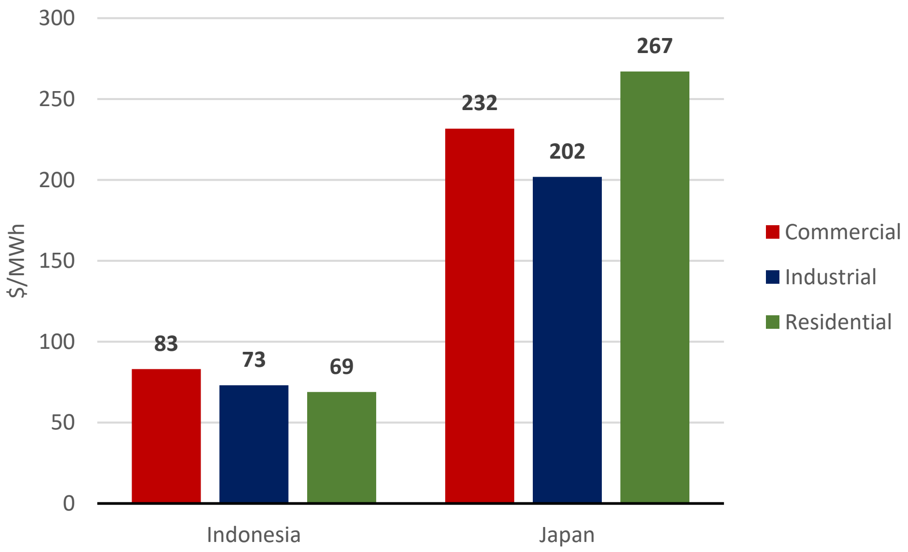
Table 5: Indonesia Corporate Clean Power Procurement Options

RE certificate	Net-metering	Onsite PPA	Offsite PPA
✓	✓	✓	O

Source: BloombergNEF, Southeast Asia Power Market Outlook 2023 H2 (December 2023) [subscription required].

Finally, it will be important to revise retail electricity prices, which are currently too low to stimulate all the necessary infrastructure investments for the decarbonization of the country's power system (e.g., power plants, electrical grid…). In Indonesia in 2022, commercial, industrial, and residential electricity prices ranged between $69/MWh and $83/MWh, roughly three to four times less than in Japan (Chart 15). The levels of prices observed in Indonesia are just sufficient to cover the LCOE of new power plants. Retail electricity prices should, however, cover not only the cost of electricity generation, but also the costs of transmission, distribution, and supply, and allow a profit for investors.

Chart 15: Indonesia and Japan Average Retail Electricity Prices by Consumer Type 2022



Source: BloombergNEF, Global Power & Fuel Prices – Updated November 29, 2023 (accessed February 2, 2024) [subscription required].

Stopping coal power subsidies which contribute to making electricity prices artificially low should help put an end to this vicious circle. It would also ease the burden on the public budget and open fiscal space to help finance RE projects.

Revising retail electricity prices should, however, be done in a socially acceptable way to protect vulnerable consumers.

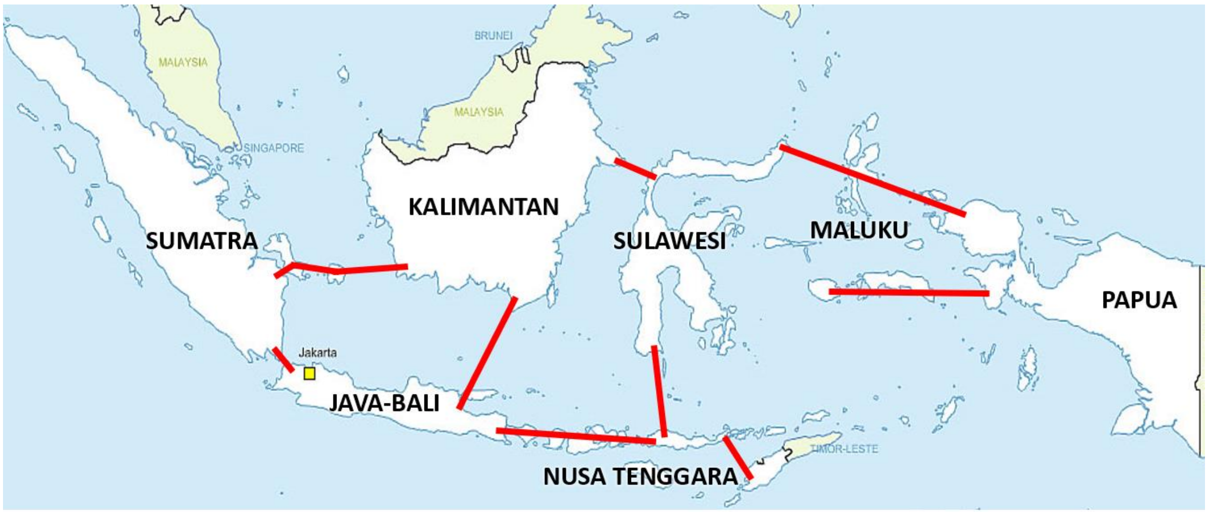
4. Electrical grid expansion

Indonesia is an archipelago consisting of thousands of islands, and PLN operates hundreds of standalone electricity networks across the country.[46] Another striking fact is that many of the large cities located on the same island still operate on independent and isolated grids. This atomicity of relatively small, poorly interconnected electrical grids is the fourth and last difficulty that needs to be solved for the integration of high shares of RE.

In Indonesia, electrical grid expansion needs to take place at three different levels: within regions, between regions, and with neighboring countries. In this section, the focus is on electrical grid expansion between regions and with neighboring countries.

Regarding electrical grid expansion between regions, it is important to note that none of the country's seven main power systems are interconnected yet. The Indonesian government, however, promotes the vision of a national Supergrid that would interconnect the country's main power systems with high-voltage submarine cables (Chart 16). The first step towards the realization of this vision should be the completion of the interconnection between the power systems of Sumatra and Java-Bali planned for 2029.[47]

Chart 16: Indonesia Simplified Vision of the National Supergrid – Inter-Regional Interconnections



Source: Indonesia Ministry of Energy and Mineral Resources, Indonesia Supergrid – January 28, 2022 (accessed January 25, 2024) (in Indonesian).

About electrical grid expansion with neighboring countries, it may first be noted that Indonesia has been trading electricity cross-border with Malaysia since 2009. The interconnected power systems are those of Kalimantan (Indonesia) and Sarawak (Malaysia). On an annual basis between 2009 and 2021 (latest year for which data is available), Indonesia has always been net importer of electricity from Malaysia (maximum net imports of 1.7 terawatt-hour (TWh) in 2019).[48]

The existing experience of trading electricity cross-border between Indonesia and Malaysia will certainly be valuable for the Brunei, Indonesia, Malaysia, and the Philippines power integration project. Announced in August 2023, this project first aims at studying the feasibility of cross-border electricity trade amongst the four countries (the results of this study are expected by 2025).[49] This is the second multilateral power trading project in Southeast Asia after the Laos, Thailand, Malaysia, and Singapore power integration project.[50]

A few weeks later, another positive development took place with the signature of a MoU on cross-border electricity trade between Indonesia and Singapore. In this framework, the Energy Market Authority of Singapore granted conditional approvals to five projects to import a total of 2 GW of low-carbon electricity (probably mostly solar PV) from Indonesia.[51] This MoU builds upon another MoU signed in March 2023. In this previous MoU the two countries had agreed on facilitating investments for the development of upstream and downstream RE manufacturing industries and capabilities in Indonesia, including solar PV and battery energy storage systems, leveraging investments for electricity export projects to Singapore.[52]

Conclusion

Based on its national domestic decarbonization strategy, the “GX Policy”, Japan is promoting two international decarbonization initiatives, the “Asia Zero Emission Community” and the “Asia Carbon Capture, Usage and Storage Network”, excessively relying on immature decarbonization options: coal-ammonia cofiring, and carbon capture and storage for electricity generation.

Indonesia is one of the key countries targeted by these initiatives to serve as a testbed. The successful implementation of these technologies is far from guaranteed. Given that Indonesia is a heavyweight in Southeast Asia, failures in this country may jeopardize the entire region’s decarbonization process. In other words, the stakes are high.

In Indonesia, several projects related to fossil power cofiring, and carbon capture and storage involving Japanese organizations are already ongoing. Misallocation of resources in favor of these risky and costly projects and to the detriment of the most effective decarbonization solutions, energy efficiency and renewable energy, is a major threat to Indonesia’s decarbonization efforts. This is all the more regrettable given that great opportunities for renewable energy exist in Indonesia.

Indeed, Indonesia is blessed with excellent renewable energy potential, which can be exploited economically. In particular, prospects for solar photovoltaic are very promising. Moreover, Indonesia is well-positioned to play a leading role in the manufacturing of important clean energy technologies, such as batteries.

However, to accelerate renewable energy growth in Indonesia, four challenges should be overcome: weak medium-term decarbonization policies, coal power lock-in, incomplete electricity system reform, and electrical grid expansion. For each of these challenges, some recent positive developments have been witnessed, inviting cautious optimism. For example, within the framework of the Just Energy Transition Partnership, Indonesia pledged to increase the share of renewable energy in its electricity generation mix to 44% by 2030 (against 20% in 2022, and a previous target of only 25%), or the announcement of the Brunei, Indonesia, Malaysia, and the Philippines multilateral power trading project.

Undoubtedly, on the supply-side, renewable energy should thus be Indonesia’s top priority to successfully progress towards its 2060 net zero emissions objective. Therefore, it is now of utmost importance that Indonesian and Japanese stakeholders share this common understanding and work in unison to accelerate renewable energy growth, instead of wasting precious time and capital on coal-ammonia cofiring, and carbon capture and storage – two technologies which have poor track records.

List of Abbreviations

ACN: Asia CCUS Network
APS: Announced Pledges Scenario
ATFSG: Asia Transition Finance Study Group
AZEC: Asia Zero Emission Community
CCGT: combined-cycle gas turbine
CCS: carbon capture and storage
CCUS: carbon capture, utilization, and storage
CO_2: carbon dioxide
EOR: enhanced oil recovery
ERIA: Economic Research Institute for ASEAN and East Asia
ETM: Energy Transition Mechanism
ETS: emissions trading system
EV: electric vehicle
GHG: greenhouse gas
GW: gigawatt
GX Policy: Green Transformation Policy
IEA: International Energy Agency
IEEJ: Institute of Energy Economics, Japan
IESR: Institute for Essential Services Reform
IPP: independent power producer
IRENA: International Renewable Energy Agency
JBIC: Japan Bank for International Cooperation
JETP: Just Energy Transition Partnership
JICA: Japan International Cooperation Agency
JOGMEC: Japan Oil, Gas and Metals National Corporation
kcal/kg GAR: kilocalories per kilogram gross as received
LCOE: levelized cost of electricity
LCR: local content requirement
LNG: liquefied natural gas
MEMR: Ministry of Energy and Mineral Resources
METI: Ministry of Economy, Trade and Industry
MoU: memorandum of understanding
MW: megawatt
MWh: megawatt-hour
NEDO: New Energy and Industrial Technology Development Organization
NEXI: Nippon Export and Investment Insurance
PLN: Perusahaan Listrik Negara
PPA: power purchase agreement
RE: renewable energy
Solar PV: solar photovoltaic
TWh: terawatt-hour

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