AZEC PROGRESS REPORT 2025

Economic Research Institute for ASEAN and East Asia (ERIA)

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AZEC
Asia Zero Emission Community

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Introduction

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1 Introduction

1.1 Background and Purpose of the Report

Asian countries face the triple challenge of achieving economic growth, ensuring energy security, and pursuing decarbonisation. Energy consumption in the region continues to rise, driven by industrialisation, urbanisation, and population growth. At the same time, the global imperative to accelerate climate action is prompting countries across Asia to advance their decarbonisation efforts. However, the diversity of industrial structures, social contexts, geographical conditions, and stages of development, makes the implementation of effective decarbonisation strategies inherently complex. Recent surges in energy prices and growing geopolitical uncertainties have further compounded these challenges.

In response, the Asia Zero Emission Center was launched within the Economic Research Institute for ASEAN and East Asia (ERIA) in August 2024, following an invitation from the Asia Zero Emission Community (AZEC) Leaders' Meeting in December 2023. The centre serves as a regional platform to facilitate knowledge sharing, conduct research on decarbonisation policies and projects, and support AZEC partner countries in formulating visions, roadmaps, and policy frameworks for promoting energy transitions.

In addition, three key sectoral initiatives – the AZEC Initiative to Promote Zero Emission Power, the AZEC Initiative to Create Sustainable Fuel Markets, and the AZEC Initiative to Establish Next Generation Industry – were agreed at the second AZEC ministerial meeting. AZEC leaders requested the centre to report on the status of research activities and regional cooperation efforts to ensure steady progress in implementing these initiatives.

Based on this context, this report provides a comprehensive overview of the progress to date in advancing sectoral initiatives and enabling mechanisms in AZEC partner countries. It also identifies common challenges and presents policy recommendations to further promote effective and inclusive energy transitions in the region. This report reflects the most recent discussions with partner governments at the AZEC Leading Action Forum (LEAF), held in May 2025.

1.2 Asia Zero Emission Community

1.2.1 History

AZEC is a regional platform for cooperation for carbon neutrality and net-zero emissions, involving 11 partner countries: Australia, Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam.

The First AZEC Ministerial Meeting took place in Tokyo on 4 March 2023. Partner countries shared ideas and perspectives on the challenges and opportunities of decarbonisation, and jointly committed to accelerating a clean, sustainable, just, affordable, and inclusive energy transition towards carbon neutrality and net-zero emissions in Asia, building on the mutual trust cultivated over the years.

At the AZEC Leaders' Meeting on 18 December 2023, ERIA was invited to establish the Asia Zero Emission Center. The centre was tasked with conducting studies on policies and projects, and with supporting AZEC partner countries in formulating visions, roadmaps, and policy frameworks to advance decarbonisation. The centre was formally launched on 21 August 2024, in conjunction with the Second AZEC Ministerial Meeting in Jakarta. At the same meeting, agreement was reached to launch three sectoral initiatives.

The Second AZEC Leaders' Meeting took place on 11 October 2024. The Action Plan for the Next Decade was formally adopted to guide and strengthen future decarbonisation efforts. The plan outlines specific directions and strategic priorities for each sectoral initiative, reinforcing the AZEC framework as a long-term platform for regional cooperation for carbon neutrality. In this way, AZEC and ERIA have been, and will continue to be, closely collaborating to monitor and promote decarbonisation activities in AZEC partner countries.

1.2.2 Principles and areas of cooperation

AZEC partner countries underscore the significance of the AZEC principles, which emphasise the importance of achieving a triple breakthrough: addressing climate change, promoting inclusive economic growth, and achieving energy security simultaneously.

They also embrace the concept of 'one goal, various pathways', acknowledging that there are various and practical pathways towards carbon neutrality and net-zero emissions. These pathways must consider each country's unique circumstances, existing targets or policies, and developmental challenges, including, but not limited to, geographic, economic, technological, institutional, social, and equity factors.

Aligned with these principles, AZEC partner countries will share information, hold discussions, and take coordinated action through the AZEC platform in areas that include but are not limited to the following:

- The development, demonstration, and deployment of decarbonisation strategies, plans, businesses, and technologies, including energy efficiency, renewables, hydrogen, ammonia, energy storage, bioenergy, and carbon capture, utilisation, and storage (CCUS).
- Financial support for investments in decarbonisation infrastructure, including power grids and the development of clean energy supply chains, such as those for critical minerals and materials.
- The development, harmonisation, and securing of interoperability standards for decarbonisation technologies, and the strengthening of human resource capacity in this area.

1.3 Overview of Decarbonisation Efforts in AZEC Partner Countries

As part of the above-mentioned areas of cooperation, a wide range of public and private sector efforts are underway across AZEC partner countries. This section provides an overview of current trends in decarbonisation activities in each partner country.

Australia

Australia is pursuing the orderly retirement of ageing coal plants whilst scaling up utility-scale solar and wind to reach 82% renewable generation by 2030. This transition is supported by grid upgrades, renewable energy zones, and battery storage initiatives. To promote renewable hydrogen, Australia has introduced a hydrogen production tax incentive, enhanced the Hydrogen Headstart Programme, and released the 2024 National Hydrogen Strategy, which focuses on sectors such as ammonia, green metals, heavy transport, and power generation. Carbon management technologies are seen as vital to achieving net zero, with two commercial carbon capture and storage (CCS) projects already operating and a strong regulatory environment being developed to attract investment. Recognising net zero as both a necessity and an opportunity, the government has committed AUD22.7 billion over the next decade to build clean energy industries, including green metals and low-carbon fuels. Additional funding of up to AUD30 million supports sustainable aviation fuel (SAF) and ammonia bunkering pilots, highlighting growing momentum in alternative fuels for transport.

Brunei Darussalam

Brunei is advancing its energy transition through three key levers: improving resource efficiency, increasing renewables, and deploying low-carbon solutions. It aims to reach 30% renewable energy in installed capacity by 2035, supported by net metering, technical guidelines, and government-led tenders for large-scale solar projects. To integrate more variable renewables, Brunei is enhancing grid infrastructure, deploying storage systems, and promoting sector-specific electricity efficiency targets.

Cambodia

Alongside hydropower as a key energy source, Cambodia is advancing renewable energy integration through updated rooftop solar policies and the rollout of a national renewable energy certificate (REC) mechanism. The deployment of microgrids and reinforcement of the national grid are extending electrification, including in rural areas, whilst natural gas and liquefied natural gas (LNG) are being explored as alternatives to coal. Feasibility studies on biomass further signal Cambodia's transition towards a cleaner, more diversified energy mix.

Indonesia

Indonesia is pursuing an ambitious clean energy transition by leveraging diverse renewable energy resources and using natural gas as a transition fuel. Key initiatives include expanding geothermal energy, with multiple large-scale projects underway, as well as scaling up bioenergy and waste-to-energy initiatives. Grid expansion and early coal retirement are being pursued with international support. In transport, Indonesia is both a major biofuel producer and adopter, scaling up usage through its mandatory

B40 biodiesel blend and exploring SAF deployment. Efforts to establish zero-emission fuel bunkering are progressing at key ports. Industrial parks are integrating decarbonisation measures such as solar photovoltaic (PV), REC adoption, and monitoring of greenhouse gas (GHG) emissions, signalling momentum towards green manufacturing ecosystems.

Japan

Japan is pioneering decarbonisation technologies with large-scale ammonia co-firing demonstrations, CCS trials, and hydrogen-fuelled marine engine development. It is integrating renewables into electricity markets through the transition from feed-in-tariff (FIT) to feed-in premium (FIP), expanding procurement diversity via various power purchase agreements (PPAs) and non-fossil certificates. Grid upgrades and nuclear restarts form parts of Japan's comprehensive approach to a resilient, low-carbon power system. Institutional support is advancing through the GX Decarbonisation Power Supply Act and the promotion of a transition finance framework. Japan collaborates with AZEC partners to share best practices and technical expertise, supporting the region's collective energy transition.

Lao PDR

Lao PDR plays a pivotal role in the regional energy landscape as a major hydropower exporter and active participant in ASEAN Power Grid (APG) projects. Beyond hydropower, it is expanding solar and wind capacity and exploring long-term opportunities for hydrogen production and export. To improve rural electrification, the country is promoting microgrid deployment. In transport, Lao PDR is encouraging electric vehicle adoption and piloting biofuel initiatives.

Malaysia

Malaysia is advancing industrial decarbonisation and hydrogen market development. Its Hydrogen Economy and Technology Roadmap outlines the adoption of hydrogen across multiple sectors, whilst CCUS pilots and carbon dioxide (CO_2) storage planning aim to establish a regional hub. Demand for green electricity is growing, especially with the expansion of data centres, supported by procurement via green tariffs and PPAs. In manufacturing, decarbonisation initiatives include the electrification of processes and the integration of solar and energy efficiency measures in key industrial clusters. Malaysia is promoting transition-aligned investment by leveraging national taxonomies and government-backed incentives.

Philippines

The Philippines has implemented a moratorium on new coal plants and began retiring or repurposing 5 gigawatts (GW) of coal capacity in 2023. Renewable expansion is being driven by the FIT scheme and domestic REC markets, alongside grid modernisation and microgrid deployment across the archipelago. Natural gas development is advancing under new legislation, whilst a market-based transaction led by the Asian Development Bank (ADB) exemplifies innovative financing for coal transition. In transport, initiatives include SAF adoption, biofuel mandates, and port decarbonisation plans, reflecting growing cross-sectoral climate ambition.

Singapore

Singapore is positioning itself as a regional hub for clean energy trade and institutional development. Its liberalised electricity market, REC exchange, and participation in multilateral power trade under the APG enable renewable procurement despite limited domestic potential. The country is leading maritime decarbonisation with ammonia and biomethanol bunkering trials. The National Hydrogen Strategy outlines long-term plans for hydrogen imports, storage, and utilisation. In parallel, Singapore is strengthening mandatory climate reporting and expanding its sustainable finance ecosystem through taxonomies, sustainability-linked loans, and blended finance to mobilise private investment in clean energy.

Thailand

Thailand is expanding corporate access to renewables through preparations for direct and virtual PPAs and the launch of the utility green tariff. Hydrogen and ammonia co-firing pilots are underway in thermal power plants. In transport, the country is pioneering SAF trials and developing zero-emission ships. The Eastern Economic Corridor is a flagship zone for industrial decarbonisation, integrating smart infrastructure, CCUS, and circular economy practices. Thailand is seeking multiple pathways to decarbonise the automotive sector, including fiscal incentives for both vehicle usage and manufacturing, as well as next-generation fuel and industrial transformation.

Viet Nam

Viet Nam is positioning itself as a regional leader in renewables, with the revised Eighth National Power Development Plan (PDP8) targeting around 700 GW of capacity by 2050. Offshore and nearshore wind potential is notable, with projects underway under the AZEC framework. The country has established a direct PPA scheme for large consumers and leads the region in international renewable energy certificate (I-REC) issuance. Nuclear power plans have been revived, with a target of 6.4 GW by 2030. In the industrial sector, several parks are adopting on-site solar, private grid links, I-RECs, and smart energy management systems. Under the national green transformation policy, Viet Nam aims to convert 40%–50% of existing industrial parks into eco-industrial parks by 2030.

Building on the initiatives of ERIA's Asia Zero Emission Centre and recent developments within AZEC, this report provides a comprehensive overview of the latest market trends, policy developments, and relevant projects across AZEC partner countries in key sectors, including zero-emission thermal, sustainable fuel, next-generation industry, and market enablers. It also compiles policy recommendations from various reports and studies, with the aim of accelerating progress in these areas.

02

Energy and Climate Trends and Policy Developments

2 Energy and Climate Trends and Policy Developments

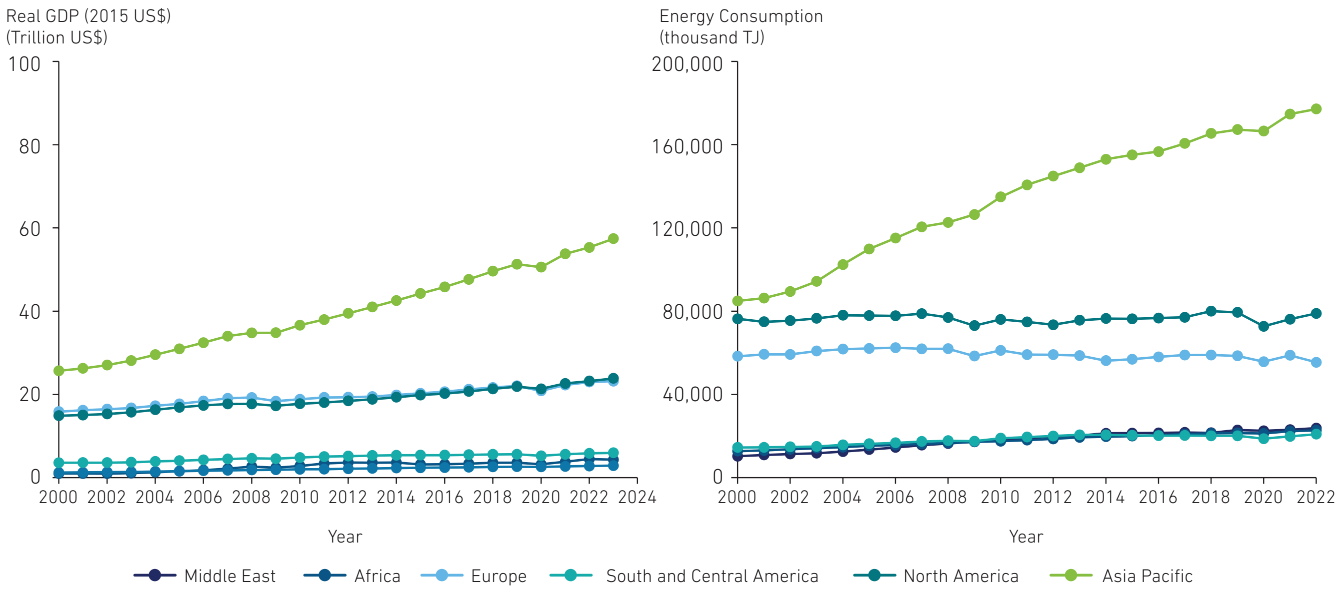
2.1 Energy Trends

2.1.1 Global trends

The global energy landscape is experiencing transformative shifts and heightened uncertainty, driven by strong economic growth in emerging economies, the ongoing post-pandemic recovery, escalating geopolitical tensions, and accelerating momentum towards decarbonisation.

Over the last 2 decades, global primary energy consumption has exhibited a consistent upward trend. A temporary decline was observed in 2020 due to widespread COVID-19 lockdowns, but growth resumed in 2021 (Figure 2-1). This trend is closely tied to economic expansion, with the rapid development of the Asia-Pacific region serving as a key driver of rising energy demand. It is expected to persist, with energy consumption in advanced economies remaining steady due to modest growth, whilst that in the Asia-Pacific region continues to rise, fuelled by sustained economic development.

Figure 2-1: Gross Domestic Product and Energy Consumption Growth by Region, 2000-2022



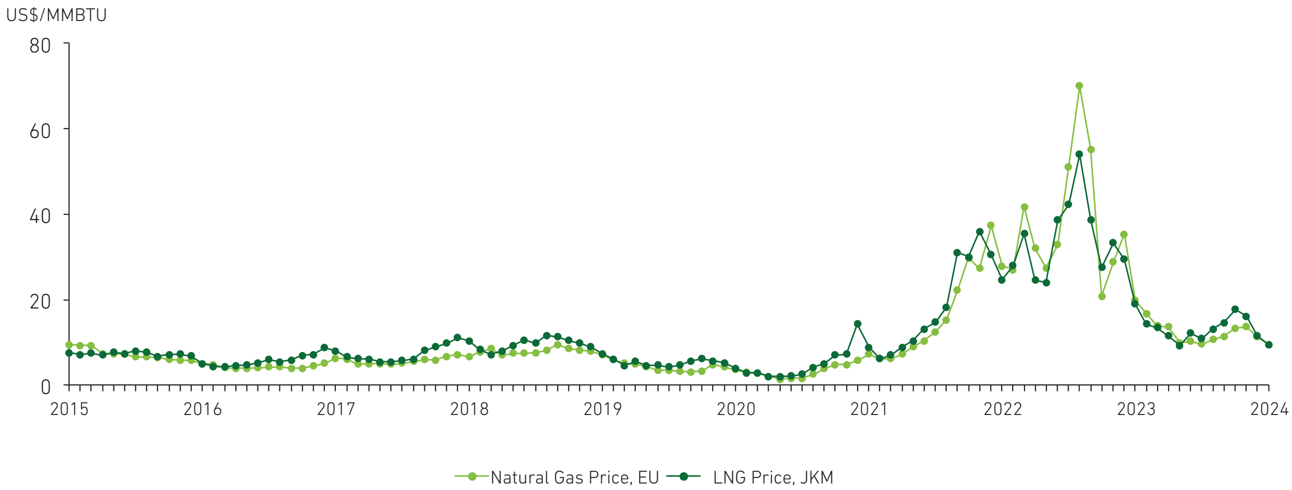
TJ = terajoule.

Note: Primary energy consumption represents the total energy used by a country before any conversion losses, including fossil fuels, nuclear, and renewables. For non-fossil electricity (nuclear, hydro, wind, solar, geothermal, and biomass), it is calculated on an input-equivalent basis, reflecting the amount of fossil fuel that would have been required to produce the same electricity in a standard thermal power plant. Coal includes peat and oil shale, where relevant. The Asia-Pacific grouping follows the member's list of the United Nations Economic and Social Commission for Asia and the Pacific.

Source: International Energy Agency (2025), World Bank Group (2025).

Energy consumption is on the rise, whilst the environment for energy procurement is becoming increasingly uncertain. Growing geopolitical tensions have had a significant effect on global energy prices and the stability of energy supply. Figure 2-2 illustrates the global natural gas and LNG price trends over the last 10 years. Prices were relatively stable before COVID-19, but in 2022, geopolitical tensions drove gas prices to record highs. Disruption to the global natural gas supply chain became a key catalyst for electricity price spikes in several countries.

Figure 2-2: Natural Gas and LNG Price Trends, 2015-2024



EU = European Union, JKM = Japan-Korea Marker, LNG = liquefied natural gas, MMBTU = Million Metric British Thermal Units

Note: The natural gas value represents the benchmark prices that are representative of the global market, determined by the largest exporter of the commodity. Prices are period averages in nominal US dollars. JKM price are taken from monthly data under from the Chicago Mercantile Exchange Group (Investing.com), with the first day of each month used as reference.

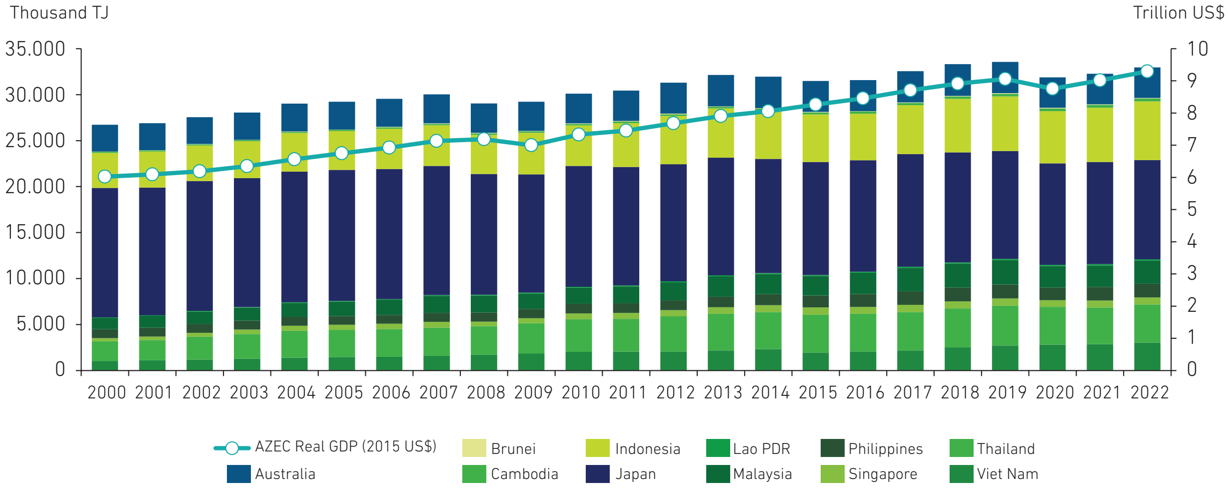
Source: International Monetary Fund (2025), Investing.com (2025)

These geopolitical tensions and surging electricity prices have caused modifications in energy policy in many countries. Short-term measures have aimed to stabilise energy prices, whilst long-term measures have focused on securing stable energy supplies. Short-term actions have included tax cuts and other measures to reduce energy costs, as well as the temporary restarting of fossil fuel power plants or the postponement of their scheduled closures. In the longer term, countries are working to diversify natural gas procurement sources and accelerate the transition to renewable energy.

2.1.2 Regional trends

Reflecting the global pattern, energy consumption in AZEC partner countries has risen over the past 2 decades. Figure 2-3 shows that this trend has been driven primarily by increasing demand in ASEAN Member States. In Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, and Thailand, consumption has roughly doubled, whilst Cambodia and Viet Nam have recorded more than sixfold increases.

Figure 2-3: Primary Energy Consumption by AZEC Partner Countries, 2000–2022



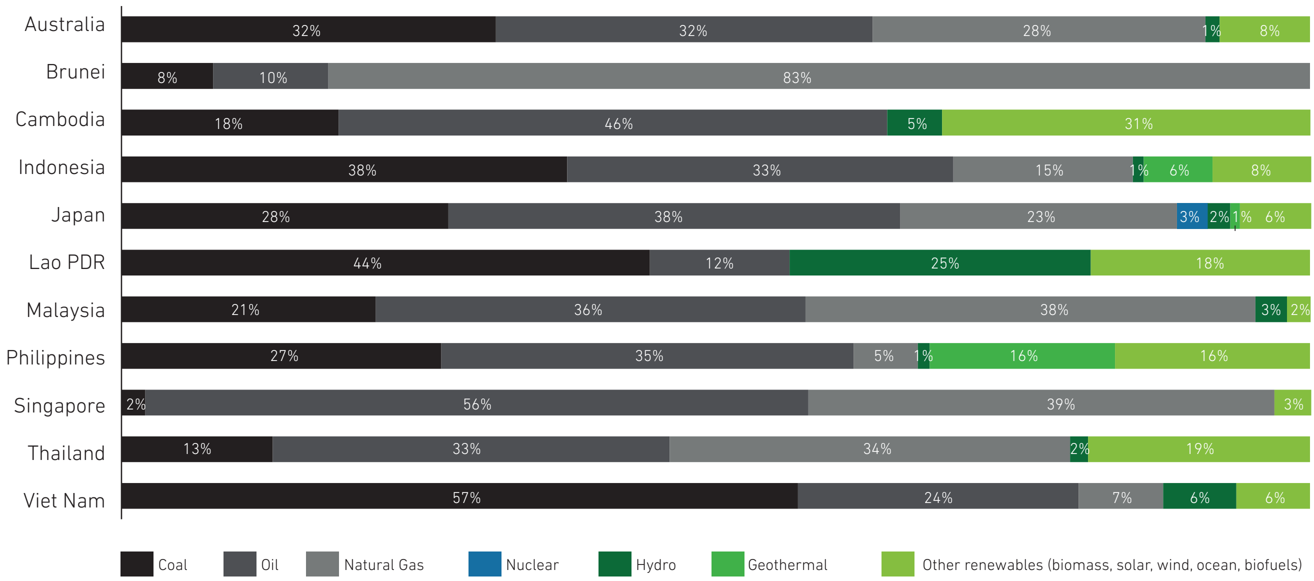
GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, TJ = terajoule.

Note: Primary energy consumption represents the total energy used by a country before any conversion losses, including fossil fuels, nuclear, and renewables. For non-fossil electricity (nuclear, hydro, wind, solar, geothermal, and biomass), it is calculated on an input-equivalent basis, reflecting the amount of fossil fuel that would have been required to produce the same electricity in a standard thermal power plant. Coal includes peat and oil shale, where relevant. The Asia-Pacific grouping follows the members list of the United Nations Economic and Social Commission for Asia and the Pacific.

Source: International Energy Agency (2025), World Bank Group (2025).

The composition of the energy mix across AZEC partner countries (Figure 2-4) reveals the scale of the decarbonisation challenge in the region. Coal, oil, and natural gas dominate, whilst renewable energy remains marginal in most countries, highlighting the need for a significant acceleration of the energy transition to align with global decarbonisation goals. Many fossil fuel power plants in Southeast Asia are relatively new and have not yet reached the end of their amortisation periods, which adds to the difficulty of transitioning away from them.

Figure 2-4: Primary Energy Consumption by Source in AZEC Partner Countries, 2020



Brunei = Brunei Darussalam, Lao PDR = Lao People's Democratic Republic.

Note: Primary energy consumption refers to energy in its raw form, before any transformations, most significantly the generation of electricity

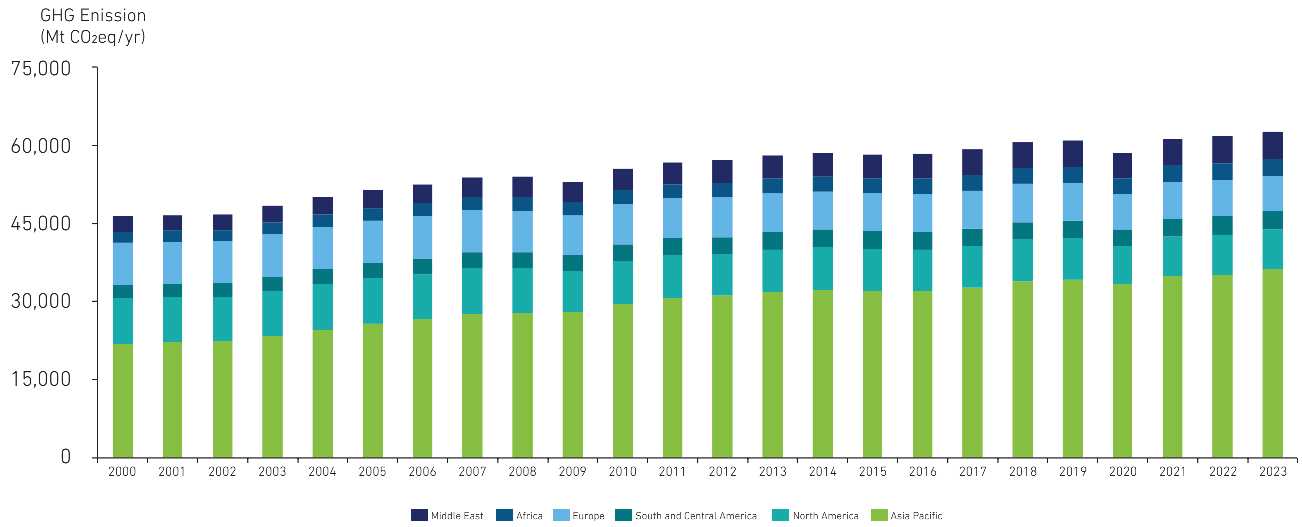
Source: Economic Research Institute for ASEAN and East Asia (2023).

2.2 Climate Trends

2.2.1 Global trends

Total energy consumption has been increasing globally, leading to a corresponding rise in GHG emissions (Figure 2-5). Although emissions temporarily fell during the COVID-19 pandemic, they resumed their upward trajectory in 2021, mirroring the recovery in energy consumption.

Figure 2-5: GHG Emissions by Region, 2000-2023



MtCO2eq/yr = metric tonnes of carbon dioxide equivalent per year.

Source: European Commission (2024).

2.2.2 Regional trends

Table 2-1 summarises the near-term nationally determined contribution (NDC) targets for 2030 set by each AZEC partner country. The level of ambition and the conditionality of these targets vary significantly, reflecting differing national circumstances. Many emerging economies have adopted conditional NDCs that depend on international support for their transition efforts, underscoring the critical role of global cooperation frameworks in accelerating decarbonisation.

Table 2.1: Nationally Determined Contribution Targets of AZEC Partner Countries by 2030

Country	Reference Year	Target	Conditionality
Australia	2005	43% reduction in GHG emissions	Unconditional
Brunei Darussalam	BAU projection from 2015	20% reduction in GHG emissions	Unconditional
Cambodia	BAU projection from 2010	41.7% reduction in GHG emissions	Conditional

Country	Reference Year	Target	Conditionality
Indonesia	BAU projection from 2010	31.89% reduction in GHG emissions	Unconditional
	BAU projection from 2010	43.2% reduction in GHG emissions	Conditional
Japan	2013	46% reduction in GHG emissions	
Lao PDR	BAU projection from 2000	60% reduction in GHG emissions	Unconditional
Malaysia	GDP 2005	45% reduction in economy-wide carbon intensity	Unconditional
Philippines	-	2.71% reduction in GHG emissions	Unconditional
	-	72.29% reduction in GHG emissions	Conditional
Singapore	-	Reduction of up to 60 $MtCO_2e$	Unconditional
Thailand	BAU projection from 2005	40% reduction in GHG emissions	Unconditional
	BAU projection from 2005	30% reduction in GHG emissions	Conditional
Viet Nam	BAU projection from 2014	15.8% reduction in GHG emissions	Unconditional
	BAU projection from 2014	43.5% reduction in GHG emissions	Conditional

BAU = business as usual, GDP = gross domestic product, GHG = greenhouse gas, MtCO2e = million tonnes of carbon dioxide equivalent.

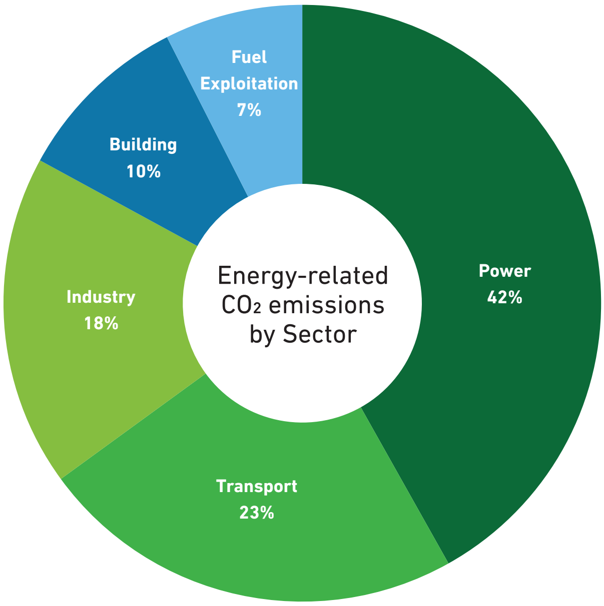
Note: The table summarises only the nationally determined contribution targets for 2030.

Source: United Nations Climate Change (2020).

2.2.3 Sectoral trends

Figure 2-6 illustrates the proportion of CO_2 emissions by sector, encompassing power, transport, industry, buildings, and fuel exploitation. Amongst these, power generation (42%), transport (23%), and industry (18%) are the largest sources of CO_2 emissions.

Figure 2-6: Carbon Dioxide Emissions by Sector, 2023



CO_2 = carbon dioxide

Note: Power refers to power and heat generation plants (public and autoproducers); industry combustion covers industrial manufacturing and the production of cement, iron and steel, aluminium, chemicals, solvents, etc.; buildings refer to small-scale, non-industrial stationary combustion; transport includes mobile combustion (road, rail, shipping, and aviation). Only CO_2 emissions are calculated for these sectors.

Source: European Commission (2024).

Considering that these three sectors are the major sources of emissions, AZEC has launched targeted initiatives: the AZEC Initiative to Promote Zero-Emission Power, the AZEC Initiative to Create Sustainable Fuel Markets, and the AZEC Initiative to Establish Next-Generation Industry. The Asian Zero Emission Centre monitors and reports on the progress of regional cooperation efforts to ensure steady implementation of these initiatives (Section 1.1). Accordingly, this report focuses on the three sectors, as well as market enablers, outlining the current progress and challenges faced by AZEC partner countries. It also serves as a basis for future discussions to enhance cooperation and accelerate related activities.

AZEC Zero Emission Power Initiative

03

3 AZEC Zero Emission Power Initiative

3.1 Overall

The power sector is the largest source of GHG emissions and remains one of the highest priorities for decarbonisation.

AZEC Sectoral Initiatives towards carbon-neutrality/net-zero emissions – AZEC Initiative to promote Zero Emission Power (AZEC Zero Emission Power Initiative)

Purpose

AZEC partner countries are taking steps to contribute to global efforts, including tripling renewable energy capacity globally by 2030. However, considering that many AZEC partner countries are currently dependent on fossil fuel thermal power plants and most of their thermal power generation fleets are still relatively young, decarbonising the power sector, particularly thermal plants is one of the focal points in tackling climate change while ensuring access to affordable energy and addressing energy security. This initiative aims at maximizing introduction of renewable energy and promoting zero emission thermal power generation in AZEC partner countries through a range of approaches as follows:

Possible areas of cooperation

- To publicise updated decarbonisation roadmaps towards net zero emissions including power sector which aligns with the reality of each country.
- To support development of policies and measures to promote clean energy by sharing other countries' examples, such as through improvement of enabling environments for demand side sector to procure renewables, and regulations for hydrogen, ammonia, biomass, biogas Carbon Dioxide Capture, Utilisation and Storage (CCUS).
- To facilitate efforts to use existing power generation systems effectively, such as introducing the concept of 'Hybrid Dam' meaning advanced dam systems which strengthen flood control operations and promote hydropower generation.
- To promote zero emission thermal power generation, particularly to decarbonise coal power generation through a range of options, such as using biomass, biogas, hydrogen, and ammonia; repurposing to flexible sources; early retirement together with converting to zero emission power; switching to low or zero-emission power generation; and retrofitting with Carbon Dioxide Capture and Storage (CCS)/ CCUS.
- To support use of carbon intensity-based emission calculation methodology for hydrogen and ammonia and to exchange knowledge in technology and safety standards of hydrogen and ammonia.
- To support development of CCS legislation, including dissemination of the CCS guidelines published by the Japan Organization for Metals and Energy Security (JOGMEC) JOGMEC), and sharing knowledge of cross border CO_2 transport.

- To enhance replacement of diesel by distributed renewable based power and expansion of energy access.
- To study national and regional electricity grid system to advance grid reinforcement to accommodate renewable energy, including contribution to the ASEAN Power Grid.
- To study institutional design for promoting the use of Distributed Energy Resources (DER) with cybersecurity in ASEAN.

Global trends

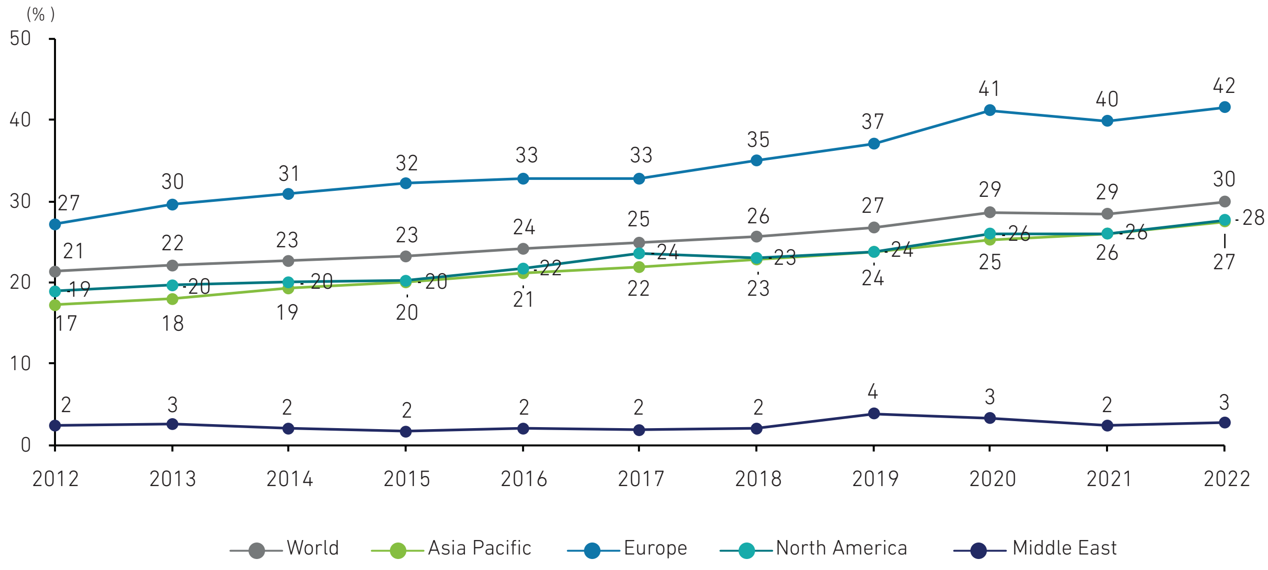
Decarbonising the power sector requires each country to develop a pathway tailored to its specific circumstances, considering its current energy mix and the most viable power generation options. This includes increasing the share of renewable energy and upgrading the power grid to align with national energy targets.

- The power sector provides the electricity that underpins each country's economy. It has evolved to ensure stable and affordable power by optimising the energy mix based on locally available resources.
- Increasing the share of renewable energy has long been a central focus of global decarbonisation in the power sector. Each country must pursue this transition in a manner consistent with its natural resource endowment, whilst making optimal use of all available energy options, including, but not limited to, decarbonising existing coal-fired thermal power plants. To meet rising energy demand and accommodate the variable nature of renewable energy, strengthening power grids has become a critical challenge across countries.
- In terms of the energy mix portfolio, future targets can vary considerably, even amongst leading countries in regions such as Europe.

Renewable energy

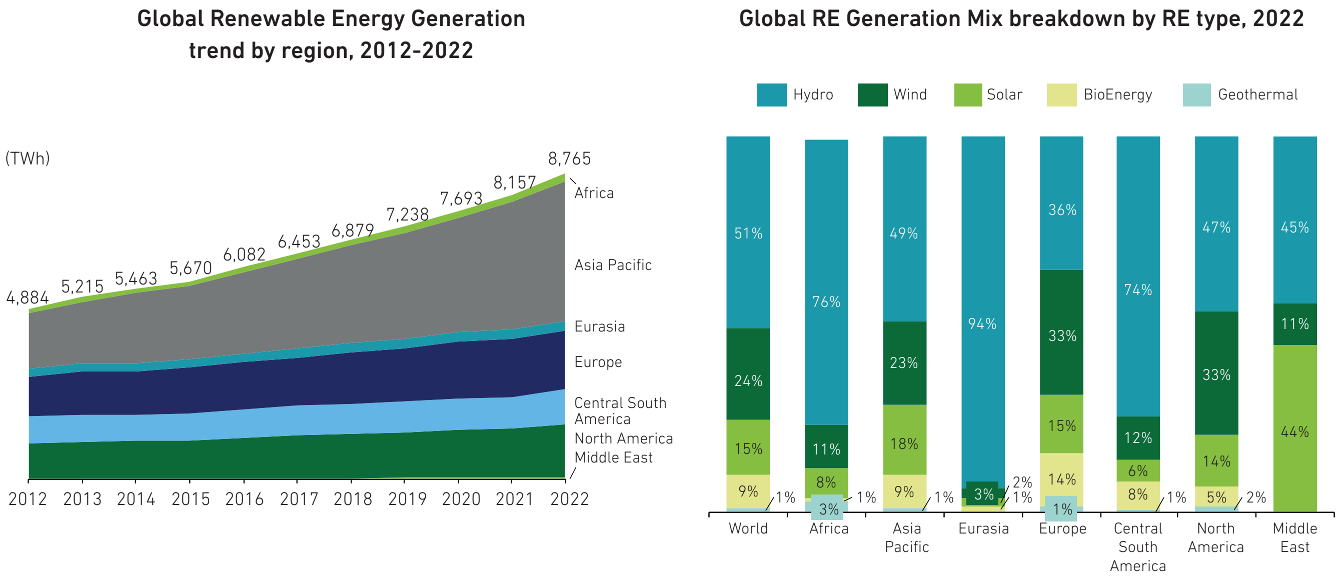
Globally, renewable energy has increased both in absolute terms and as a share of total electricity generation (Figure 3-1 and Figure 3-2). By 2022, the global share of renewable energy had reached 30%. However, due to various factors, including geographical conditions, the share of renewables varies significantly by region. A breakdown by renewable energy type reveals a wide diversity in energy profiles.

Figure 3-1: Global Renewable Energy Share by Region (Generation Basis) 2012-2022



Source: International Energy Agency (2025).

Figure 3-2: Global Trends in Renewable Energy Generation by Type

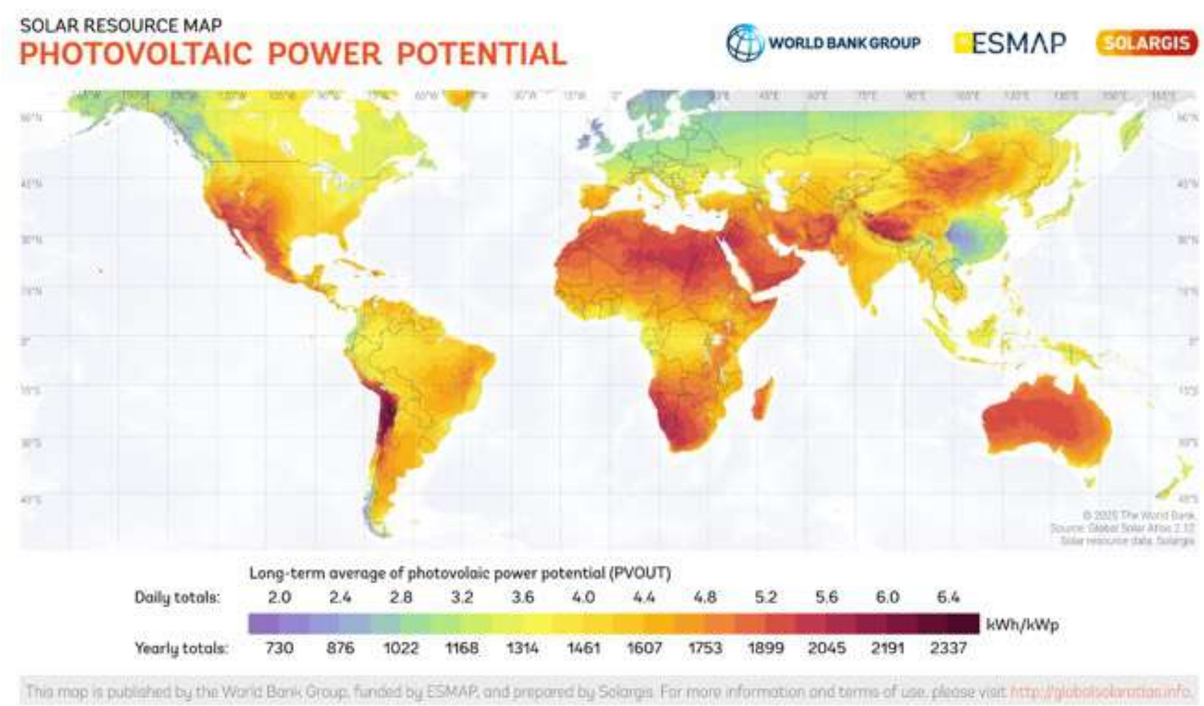


RE = renewable energy, TWh = terawatt-hour.

Source: International Energy Agency (2025).

Figure 3-3 and Figure 3-4 show that solar radiation and wind speeds vary significantly across the globe. These variations, largely shaped by geological and climatic factors, help explain the differing renewable energy conditions across regions.

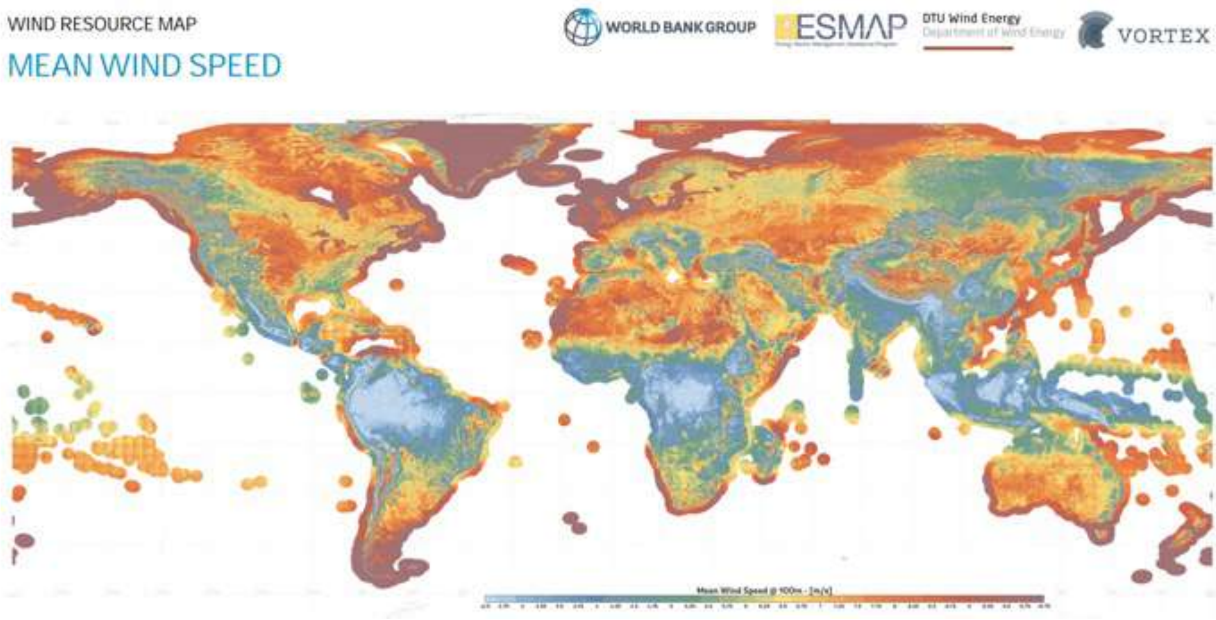
Figure 3-3: Global Solar Photovoltaic Power Potential Map



kWh = kilowatt-hour, kWp = kilowatt-peak.

Source: World Bank Group (2025).

Figure 3-4: Global Wind Speed (Wind Power Potential) Map

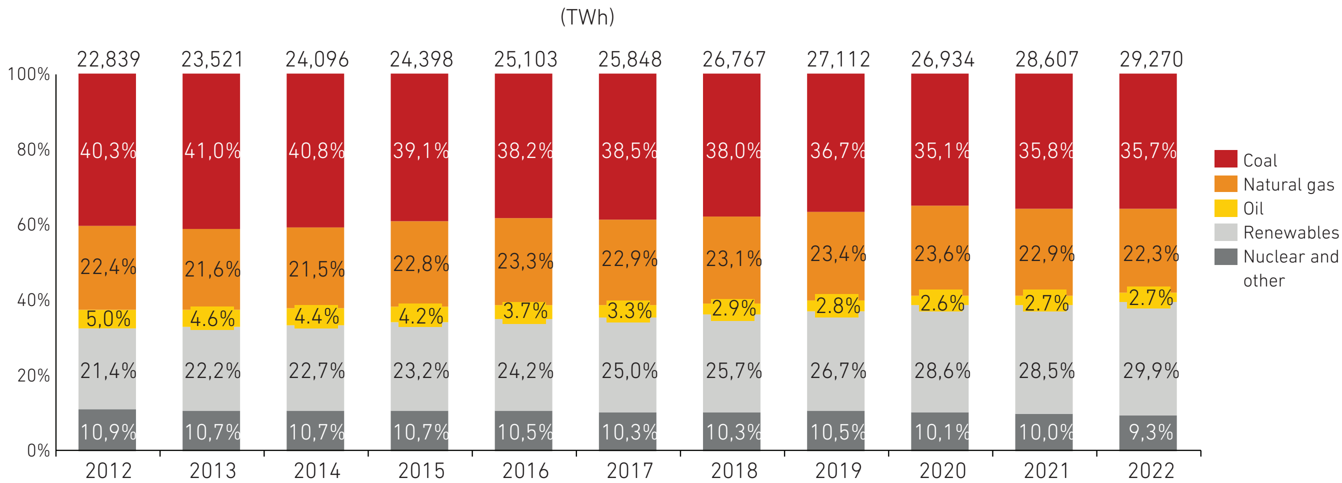


Source: Technical University of Denmark & World Bank Group (2025).

Zero-emission thermal

Figure 3-5 shows that globally, fossil fuel power generation, particularly coal, has been steadily declining. Many countries, including several AZEC partner countries, have adopted a 'No New Coal' policy, committing to halt the construction of new unabated coal-fired power plants. Nevertheless, coal-fired plants continue to play an essential role in providing baseload power in many AZEC countries.

Figure 3-5: Global Power Generation Mix, 2012–2022 (Fossil Fuel Breakdown)



TWh = terawatt-hour

Source: International Energy Agency (2025).

Nuclear

Nuclear power remains an important option in the context of decarbonisation, although global attitudes towards it vary, shaped largely by safety and security concerns.

The United States (US) has integrated nuclear power into its decarbonisation strategy. The 2022 Inflation Reduction Act introduced tax credits for both existing and new reactors, whilst the 2024 ADVANCE Act supports the deployment of advanced nuclear technologies through streamlined licensing, public–private partnerships, and enhanced regulatory certainty.

China is expanding its nuclear fleet aggressively, constructing 27 reactors and planning up to 150 new units by 2035, to reduce coal reliance, enhance energy security, and advance self-sufficiency in nuclear technologies.

In Europe, perspectives are divided. France remains firmly pro-nuclear, deriving roughly 70% of its electricity from nuclear power and announcing plans in 2022 to build new reactors. In contrast, Germany completed its nuclear phase-out in 2023.

Power grid

Investment in grid modernisation is rapidly increasing. This includes deploying smart metres, sensors, and automation technologies to enhance grid reliability and enable real-time power flow management.

The accelerated rollout of variable renewables, such as wind and solar, is placing increasing strain on power grids. To manage this variability and the rise of distributed generation, networks are incorporating energy storage systems, demand-response mechanisms, and regional interconnections, whilst updating market structures and planning regulations.

Global investment in grid infrastructure reached approximately US$310 billion in 2023, reflecting the need to meet rising electricity demand. Notable projects include grid-resilience grants and new high-voltage lines in the US, China's expansion of its ultra-high-voltage transmission network, and Europe's development of offshore wind connectors and smart-grid enhancements.

AZEC Trends

The market trends for the topics discussed in the global context are examined in greater detail in the following subsections. This section provides a broader, macro-level overview of trends in the power sector across AZEC partner countries.

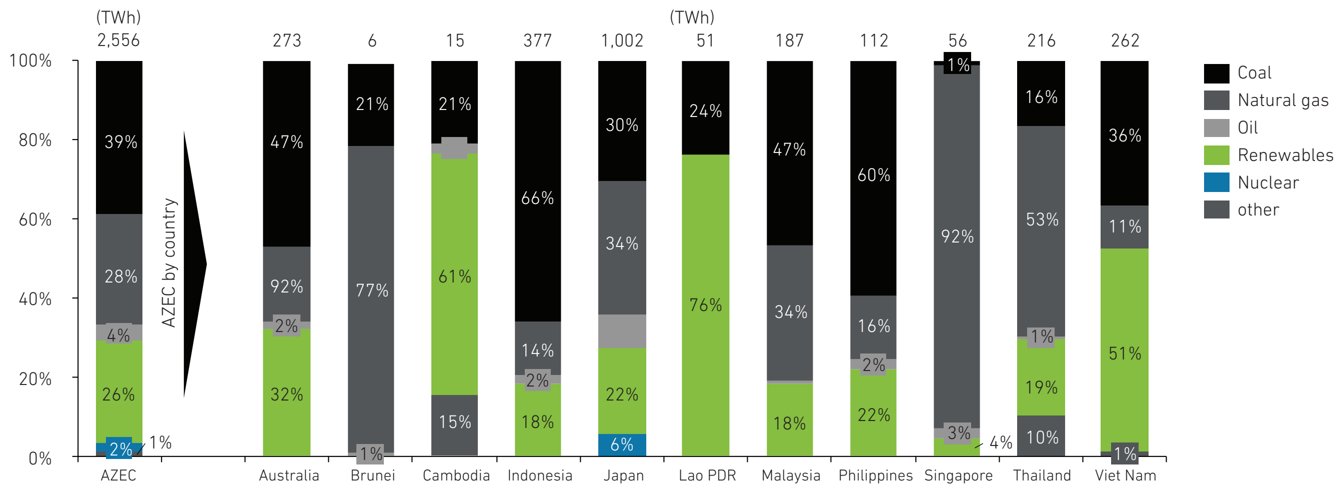
Many ASEAN countries have experienced sustained economic growth supported by affordable fossil fuels. Their fossil fuel-based thermal power plants tend to be younger than those in developed countries. Planning the energy transition in these countries requires consideration of their economic structures, natural resource availability, and the current state of their power infrastructure.

- The share of coal-generated electricity amongst AZEC partner countries stands at 38.5%. Australia, Indonesia, Malaysia, and the Philippines are particularly reliant on coal, with coal accounting for more than 40% of their electricity generation. Many coal-fired power plants in the region are relatively new; their premature retirement could lead to significant downsides, including financial strain from stranded assets. This challenge is compounded by the region's strong economic growth outlook and rising energy demand (Section 2).

- The current share of renewable energy in electricity generation across AZEC partner countries is 26%, although this varies widely between countries. High levels of renewable generation are driven by hydropower in Viet Nam and Lao PDR and by solar power in Australia and Japan.
- Countries such as Brunei Darussalam, Singapore, and Thailand depend heavily on LNG alongside renewables. Japan remains the only AZEC partner country currently utilising nuclear power.
- Despite diversity in power generation mixes, all AZEC partner countries aim to reduce GHG emissions from the power sector. The strategies being considered include, but are not limited to, the following:

1. Increasing the share of renewable energy in future power generation plans.
2. Reducing emissions from existing coal and LNG thermal power plants through hydrogen, ammonia, or biomass co-firing, early retirement, or conversion to natural gas (C2G transition).
3. Considering the adoption or reintroduction of nuclear power.
4. Strengthening power grids to support growing electricity demand and an increasingly complex power generation mix.

Figure 3-6: Power Generation Mix in AZEC Partner Countries 2022

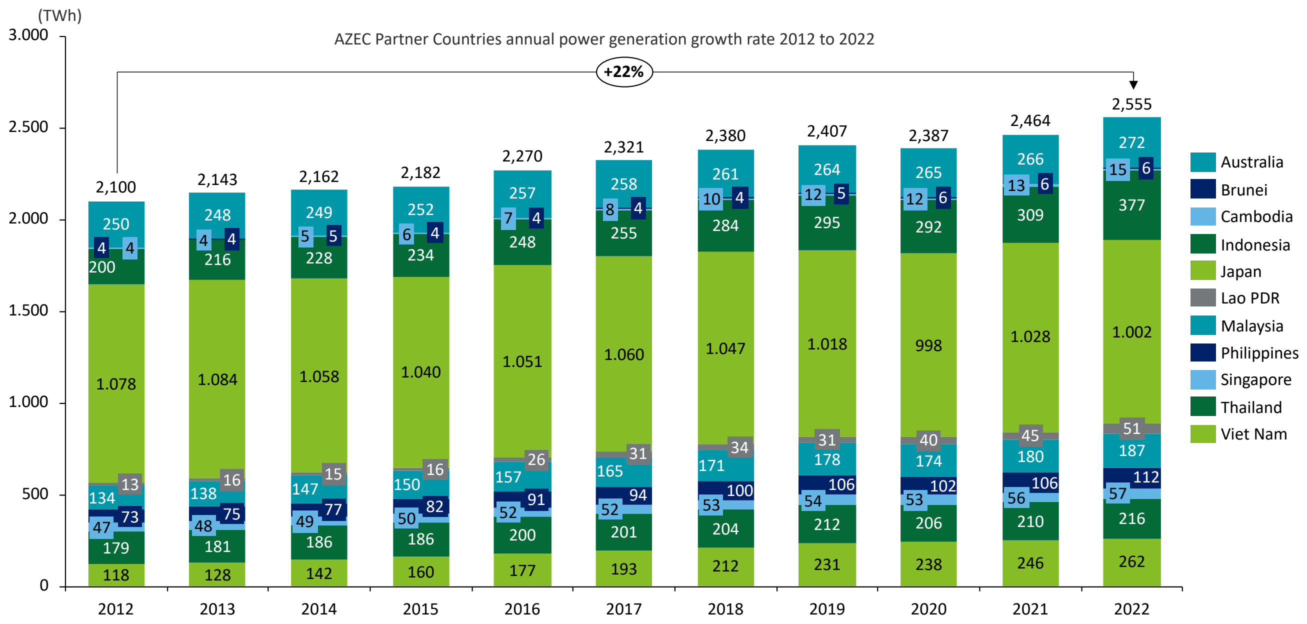


Brunei = Brunei Darussalam, Lao PDR = Lao People's Democratic Republic, TWh – terawatt-hour.

Source: Energy Market Authority (Singapore), Energy Policy and Planning Office (Thailand), Institute of Energy Economics, Japan, International Energy Agency (2025).

- An examination of power generation trends over the past 10 years (Figure 3-7) shows that AZEC partner countries have experienced a 22% increase in generation, largely driven by economic growth. This upward trend is expected to continue, making it essential for the transition to zero-emission power to occur in parallel with efforts to meet rising energy demand.

Figure 3-7: Power Generation Trend in AZEC Partner Countries, 2012-2022

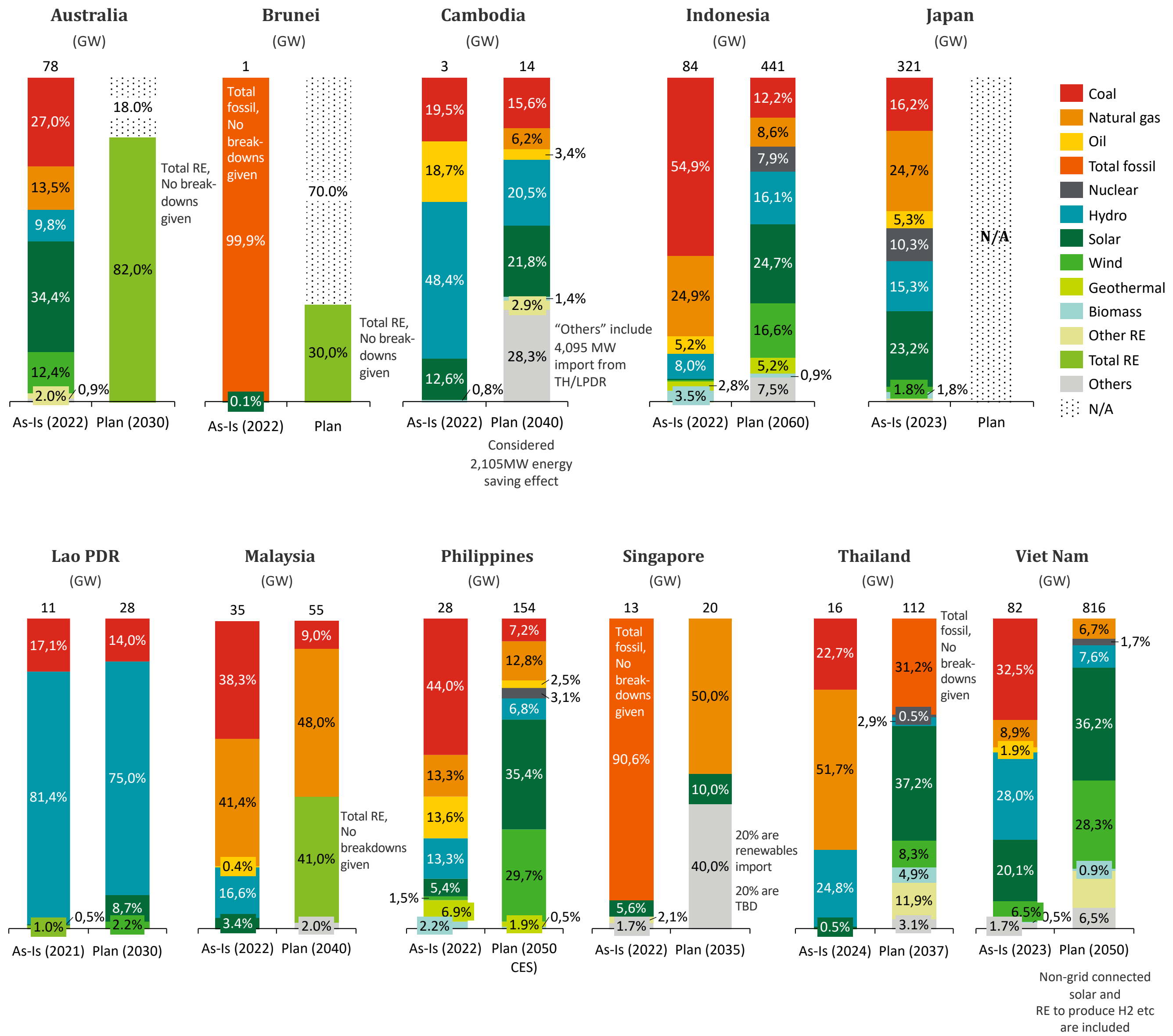


Brunei = Brunei Darussalam, Lao PDR = Lao People's Democratic Republic, TWh = terawatt-hour.

Source: Energy Market Authority (Singapore), Energy Policy and Planning Office (Thailand), Institute of Energy Economics, Japan, International Energy Agency (2025).

- Most AZEC partner countries have established future installed capacity targets in their national power development plans as part of broader initiatives to achieve net-zero emissions.
- Common features of these national energy plans include increasing the share of renewable energy and reducing dependence on fossil fuels.
- Many countries are planning to scale up battery energy storage systems to better manage the variability of solar and wind power. Several countries are considering the use of technologies such as hydrogen, ammonia, and biomass combustion, as well as CCUS, to limit CO_2 emissions from future fossil fuel–based power generation.
- Indonesia, Japan, the Philippines, Thailand, and Viet Nam plan to incorporate nuclear power into their energy portfolios, both to reduce CO_2 emissions and to enhance supply stability. Increased imports of renewable energy, supported by APG projects, are expected to strengthen regional energy security.

Figure 3-8: Installed Capacity Mix in AZEC Partner Countries (As-Is and Plan)



Brunei = Brunei Darussalam, CES = clean energy scenarios, GW = gigawatt, H2 = hydrogen, Lao PDR = Lao People's Democratic Republic, MW = megawatts, N/A = not available, RE = renewable energy, TH/LPDR = Thailand/Lao People's Democratic Republic.

Note: Other renewable energy includes battery energy storage systems, bioenergy (excluding biomass), tidal, etc. 'Others' includes imported energy, hydrogen, ammonia, etc.

Source: Economic Research Institute for ASEAN and East Asia, United Nations Economic and Social Commission for Asia and the Pacific, International Renewable Energy Agency, Directorate General of New Renewable Energy and Energy Conservation (Indonesia) (2025).

3.2 Renewables

3.2.1 Market trends

AZEC trends

Global energy prices have been rising, particularly caused by higher gas prices, a trend that has impacted AZEC partner countries. In the private sector, businesses face not only increased energy procurement costs but also challenges in securing sufficient renewable energy to meet their corporate emissions targets. Investment in renewable energy is actively underway across AZEC partner countries, although progress varies significantly between countries. The general trend shows rising supply and falling costs for renewable energy, although certain sources, such as biomass, still require improved economic viability.

- Whilst AZEC partner countries have not experienced electricity price spikes as severe as those in some other regions, rising fuel costs, particularly for coal and LNG, have affected the ASEAN region.
- Global multinational corporations (MNCs) are facing both escalating electricity prices and growing pressure to procure renewable energy.
- In the ASEAN region, access to renewable energy remains a significant challenge.
- On the supply side, all AZEC partner countries have set targets in their national power plans to increase renewable energy capacity or generation. However, differing geological conditions result in varied renewable energy potential across the region (Figure 3-3 and Figure 3-4).

3.2.2 Key policies and regulations

AZEC partner countries are actively introducing policies and regulations to set targets and promote renewable energy expansion.

Supply side

Sustained investment in renewable energy requires a stable and supportive business environment for operators. This includes regulatory frameworks and incentive schemes such as competitive purchase-price mechanisms.

Table 3-1: Renewable Energy Supply Policies by Energy Type in AZEC Partner Countries

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
Australia	Total RE	45.6 GW	82.0%	The Australian government has set a target to achieve 82% renewable electricity in the national electricity market by 2030. All companies engaged in renewable energy-related businesses in Australia are required to procure RECs. The Clean Energy Regulator has introduced subsidies for households and small businesses
	Solar	34.4% 26.8 GW	N/A	
	Wind	12.4% 9.7 GW	N/A	

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
	Hydro	9.8% 7.6 GW	N/A	installing renewable energy generation systems, such as solar and wind, of 100 kW or less, as well as small-scale solar batteries. Several state governments, including South Australia, actively promote investment in wind, solar, and hydroelectric power plants. Victoria, New South Wales, the Australian Capital Territory, South Australia, and Queensland offer solar FIT programmes to support small-scale renewable generation. Up to US$20 billion is being invested through Rewiring the Nation to upgrade and expand Australia's power grid, including the establishment of renewable energy zones. Under the Capacity Investment Scheme, the Australian government is underwriting 32 GW of new capacity through renewable energy generation and energy storage projects.
	Biomass	N/A	N/A	N/A
	Geothermal	N/A	N/A	N/A
Brunei Darussalam	**Total RE**	**0.001 GW**	**N/A**	Brunei Darussalam issued its first request for proposal in 2021 to invest in, build, and operate a large-scale solar farm under a public–private partnership arrangement, requiring the successful bidder to enter into a long-term PPA with the national utility. The Department of Energy has introduced a net-metering scheme that allows residential and commercial customers with solar PV systems to sell excess electricity back to the national grid, receiving credits to offset their electricity bills. Brunei Darussalam's long-term energy strategy identifies the expansion of PV deployment as a key priority. Recognising the inherent variability of PV, the strategy includes specific development plans for grid-connected solar power generation. The Brunei National Climate Change Policy 2022, through Strategy 4 on renewable energy, sets a national target to increase the share of renewable energy to 30% of total installed capacity by 2035.
	Solar	0.1% 0.001 GW	N/A	

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
	Wind	N/A	N/A	N/A
	Hydro	N/A	N/A	N/A
	Biomass	N/A	N/A	N/A
	Geothermal	N/A	N/A	N/A
Cambodia	**Total RE**	**2.1 GW**	**6.7 GW (2040)**	Installed capacity is planned under the Power Development Master Plan 2022–2040. No FIT or net-metering scheme is in place. However, Cambodia allows partial rooftop solar projects, classified as Category 2, to export surplus electricity to the national grid. The tariff for this excess supply is determined based on the 2023 Solar Guidelines.
	Solar	12.6% 0.4 GW	21.8% 3.2 GW	N/A
	Wind	N/A	N/A	N/A
	Hydro	48.4% 1.7 GW	20.5% 3.0 GW	N/A
	Biomass	0.8% 0. 1GW	1.4% 0.2 GW	N/A
	Geothermal	N/A	N/A	N/A
Indonesia	**Total RE**	**12.6 GW**	**460.4 GW (2060)**	Installed capacity targets are set out in Indonesia's National Electricity Plan. To support renewable energy development, the government has issued guidelines for PPAs under Regulation No. 5/2025, which outline the procedures for power companies to sell green electricity to the state-owned utility, Perusahaan Listrik Negara (PLN). Independent power producers are eligible for various incentives, including reductions in corporate tax and import duties, as well as financing support and collateral backed by government-appointed state-owned enterprises.
	Solar	0.4% 0.3 GW	24.7% 109 GW	
	Wind	0.2% 0.2 GW	16.6% 73 GW	
	Hydro	8.0% 6.7 GW	16.1% 71 GW	
	Biomass	3.5% 2.9 GW	0.9% 4 GW	

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
	Geothermal	2.8% 2.4 GW	5.2% 23 GW	Policy direction favours increasing the purchase price of electricity generated from renewable energy, although no fixed tariff is guaranteed. Indonesia applies ceiling tariffs for prices from a range of renewable energy sources, including solar, wind, biomass, geothermal, and hydropower. In addition to the National Energy Plan, the National Energy General Plan sets the following capacity targets for renewable energy by 2050: - Solar PV: 113 GW - Wind power: 27 GW - Hydropower: 68 GW - Biomass and bioenergy (combined): 27 GW - Geothermal: 23 GW For biomass power generation, the maximum purchase price is determined by output and regional location.
Japan	**Total RE**	**137.5 GW (2023)**	**N/A**	Japan transitioned from a FIT scheme to a FIP scheme in April 2022. The FIP applies to solar, wind, biomass, geothermal, and hydroelectric power. Japan's *Outlook for Energy Supply and Demand in FY2040* sets the following generation estimates for 2040: - Solar PV: 23%–29% of total generation - Wind power: 4%–8% - Hydropower: 8%–10% - Biomass power: 5%–6% - Geothermal power: 1%–2%
	Solar	23.2% 74.7 GW	N/A	The government aims to expand the adoption of perovskite solar cells, targeting 20 GW of capacity by 2040.
	Wind	1.8% 5.6 GW	N/A	The government aims to accelerate the development of floating offshore wind power in exclusive economic zones.
	Hydro	15.3% 49.3 GW	N/A	The government aims to promote small- and medium-sized hydropower projects led by local governments.
	Biomass	1.8% 5.9 GW	N/A	N/A

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
	Geothermal	0.2% 0.5 GW	N/A	Measures include government-led drilling surveys and streamlined, one-stop licensing procedures. The government plans to accelerate the social implementation of next-generation geothermal technologies.
Lao PDR	**Total RE**	**9.1 GW (2021)**	**23.8 GW (2030)**	Installed capacity plan as per the SDG 7 Roadmap for Lao PDR No FIT or net-metering scheme is in place. Tariffs for electricity generated from renewable energy sources are determined through negotiations between producers and the state-owned utility, Electricité du Laos. The implementation of a FIT system for renewable energy is still under discussion. The Renewable Energy Development Strategy (2011) sets plans to ensure grid access and promote third-party power sales.
	Solar	0.5% 0.6 GW	8.7% 2.4 GW	In addition to the SDG 7 Roadmap, Lao PDR has also published its NDC, which includes a target to increase the total installed capacity of solar and wind power to 1 GW by 2030.
	Wind	N/A	2.2% 0.6 GW	
	Hydro	81.4% 8.9 GW	75.0% 20.8 GW	N/A
	Biomass	1.0% 0.1 GW	0.1% 0.04 GW	The NDC sets a goal of increasing total installed biomass capacity to 300 MW.
	Geothermal	N/A	N/A	N/A
Malaysia	**Total RE**	**137.5 GW (2023)**	**N/A**	Installed capacity plan as per National Energy Policy 2022–2040 The SEDA introduced enhancements to the existing FIT application process through the launch of FIT 2.0 on 17 October 2024, featuring a two-phase tariff system. In the first phase, a fixed FIT rate is offered for the initial 10 years. In the second phase, eligible companies may bid within tariff floor and ceiling rates set by SEDA for the remaining 11 years of the Renewable Energy Power Purchase
	Solar	3.4% 1.2GW	N/A	
	Wind	N/A	N/A	
	Hydro	16.6% 5.7GW	N/A	
	Biomass	N/A	N/A	

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
	Geothermal	N/A	N/A	Agreement. The FIT scheme covers biogas, biomass, hydro, and solar energy. In addition to the National Energy Policy, Malaysia has also published the *National Energy Transition Roadmap*, which sets the following plans for 2050: - Solar power to account for 58% (59 GW) of total generation capacity. - Wind power generation to account for 29% of total generation capacity. - Hydropower generation capacity to account for 11% of total generation capacity. - Biomass power generation capacity to reach 1.4 GW. Under the Green Investment Tax Allowance, biomass power generation is eligible for a tax incentive allowing 70% of statutory income to be offset for 5 years. Deputy Prime Minister Fadillah Yusof announced that independent energy producers will be allowed to sell electricity directly to consumers starting in September 2024. This third-party access initiative, originally scheduled for 2025, is expected to stimulate competition in the energy market, potentially reducing electricity costs and improving service quality.
Philippines	**Total RE**	**8.3 GW**	**114.8 GW (2050)**	**Installed capacity plan as per Philippine Energy Plan 2023–2050 Clean Energy Scenario** The existing legal framework, such as the Renewable Energy Act of 2008, emphasises the role of PPAs in promoting renewable energy deployment. To support renewable energy development, the act provides several preferential measures, including a 7-year corporate tax exemption (typically 30%), a 10-year exemption on import duties for equipment, 0% value-added tax, and investment tax deductions.

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
				The Green Electricity Allocation Program, under which the Department of Energy signs contracts directly with power producers, has already been introduced. FIT rates for renewable energy technologies in the Philippines are set as fixed prices for 20 years, with specific degression rates applied after the first or second year of operation. The FIT scheme covers solar, wind, biomass, and hydro. The Philippines' Smart and Green Grid Plan outlines plans for the rapid expansion of the transmission grid to accommodate large-scale renewable energy capacity and enable connections to new supply sources. It also provides for the establishment of third-party access rights to the transmission network.
	Solar	5.4% 1.5 GW	35.4% 54.7 GW	N/A
	Wind	1.5% 0.4 GW	29.7% 45.9 GW	N/A
	Hydro	13.3% 3.7 GW	6.8% 10.5 GW	N/A
	Biomass	2.2% 0.6 GW	0.5% 0.7 GW	N/A
	Geothermal	6.9% 2.0 GW	1.9% 3.0 GW	N/A
Singapore	**Total RE**	**1.0 GW**	**2.0 GW (2035)**	**Installed Capacity Plan as per the Singapore Green Plan 2030** The Singapore Green Plan 2030 aims to increase solar power generation capacity to 2 GWp by 2030, targeting approximately 3% of the country's projected electricity demand for that year. Singapore views FITs as potentially distortive to energy markets, as they may lead to increased costs for consumers. As an alternative, the government has implemented the simplified credit treatment scheme and the enhanced central intermediary scheme – programmes similar to net-metering – designed to benefit consumers who adopt solar energy solutions.
	Solar	5.6% 0.7 GW	10.0% 2.0 GW	

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
	Wind	N/A	N/A	N/A
	Hydro	N/A	N/A	N/A
	Biomass	N/A	N/A	N/A
	Geothermal	N/A	N/A	N/A
Thailand	**Total RE**	**4.1 GW (2024)**	**73.3 GW (2037)**	**Installed Capacity Plan as per the Alternative Energy Development Plan 2024–2037** For renewable energy–based power generation, there is an 8-year corporate income tax exemption with no cap. The National Energy Policy Council has announced plans to pilot direct PPAs. Thailand has established a FIT scheme covering solar, wind, and biogas.
	Solar	0.5% 0.08 GW	37.2% 41.8 GW	The Long-Term Low GHG Emission Development Strategy sets a plan for solar and wind power combined to account for 65% of total electricity generation by 2060.
	Wind	0.2% 0.03 GW	8.3% 9.4 GW	
	Hydro	24.8% 4.0 GW	4.8% 5.4 GW	The Alternative Energy Development Plan 2015–2036 identifies hydropower as an alternative energy source.
	Biomass	N/A	4.9% 5.5 GW	The plan refers to biomass as an alternative energy source.
	Geothermal	0.002% 0.0003 GW	0.02% 0.02 GW	N/A
Viet Nam	**Total RE**	**45.4 GW (2023)**	**693.8 GW (2050)**	**Installed capacity plan as per the Power Development Plan VIII (PDP8, Apr 2025 revised version)** Corporate income tax reductions are granted to new renewable energy power generation projects. For renewable energy projects, import duties are waived on goods that become fixed assets for use in the project. The Ministry of Industry and Trade has introduced new FITs for solar and wind projects commissioned after the 2020 and 2021 deadlines, allowing renewable energy projects that missed the earlier FIT deadlines to be included.

Country	RE Type	RE Installed Capacity		Key Policies and Regulations
		Current (2022)	Plan	
	Solar	20.0% 16.6 GW	36.2% 295.6 GW	The PDP8 targets an increase in rooftop solar power capacity of 2.6 GW by 2030, with total permitted generation capacity expected to reach 170 GW by 2050.
	Wind	6.5% 5.3 GW	28.3% 230.5 GW	Wind power generation is expected to grow to approximately 30 GW by 2030 and over 130 GW by 2050.
	Hydro	28.0% 23.1 GW	7.6% 62.0 GW	The PDP8 anticipates that, by 2050, hydropower will account for less than 10% of total electricity generation, down from the current 25%. Small hydropower projects are eligible for green bonds.
	Biomass	0.5% 0.4 GW	0.9% 7.0 GW	The plan also sets a target for biomass and ammonia combustion power generation to contribute 4.5%–6.6% of total electricity generation by 2050.
	Geothermal	N/A	0.06% 0.5 GW	N/A

C2G = coal to gas, FIP = feed-in premium, FIT = feed-in-tariff, GW = gigawatts, GWp = gigawatt peak, Lao PDR = Lao People's Democratic Republic, NDC = nationally determined contribution, PDP8 = Power Development Plan VIII, PPA = purchase power agreements, PV = photovoltaic, RE = renewable energy, SDG = Sustainable Development Goal, SEDA = Sustainable Energy Development Authority Malaysia.

Note: The percentage of installed capacity refers to the share of each energy source in relation to the total installed capacity of each country.

Sources: International Energy Agency, ASEAN Centre for Energy, Sustainable Energy Development Authority (Malaysia), Energy Market Authority (Singapore), Department of Energy (Philippines), Ministry of Economy, Trade and Industry (Japan), Climate Investment Funds, Asian Development Bank.

Demand side

Global companies committed to procuring renewable energy are actively utilising PPAs and RECs. Discussions are underway to develop systems that expand procurement options for such consumers.

- Global technology MNCs have been actively exploring investment opportunities in data centres across AZEC partner countries.
- Given the substantial energy requirements of data centres, particularly those supporting artificial intelligence (AI) applications, investors and the public are exerting increasing pressure on these companies to manage energy use responsibly and shift to clean energy, especially renewables.
- These companies typically procure renewable energy either directly, through PPAs with renewable energy operators, or indirectly, via the purchase of energy attribute certificates (EACs). However, ASEAN countries offer limited options for procuring sufficient volumes of renewable energy.
- The scale of investment these companies are planning in ASEAN is prompting governments in the region to accelerate policy discussions and develop additional renewable energy procurement mechanisms, including, but not limited to, direct PPAs and EAC frameworks.

Table 3-2: Renewable Energy Procurement Options

		Objective	Scheme Overview	
Green Tariff		Obtain physical RE supply	Power customer to purchase 100% RE from Public Power Grid SOE with relative authorities' approved premium tariff rate, and EACs also often provided for the purchase. Consumers do not need PPA negotiation with RE developer.	
Onsite PPA			Power customer to sign PPA (long-term, usually 10-25 yrs) directly with RE developer	RE developer to install, operate and maintain RE (e.g. rooftop solar) at the customer's property (e.g. factory) for onsite use.
Offsite PPA	Direct PPA			Power customers use RE developer's RE with direct private grid, or through national grid (sleeve PPA).
	Virtual PPA	Do not obtain physical RE But obtain incentive for purchasing RE		RE developer sell RE into the wholesale market, and the customer pays or receives the difference between the market price and a fixed price. EACs will be provided to the customer.
EACs (incl. i-REC)			Energy Attribute Certificate (EAC) represents proof that one megawatt-hour (MWh) of renewable energy has been generated and added to the grid.RE customers can obtain EACs from marketplace, direct purchase from RE generators, or bundled purchase with RE (e.g. Green Tariff/Virtual PPA)	

PPA = power purchase agreement, SOE = state-owned enterprise.

Source: Authors' collection from various documents (2025).

- In ASEAN, of the various renewable energy procurement options available globally, direct PPAs and I-RECs have attracted attention. These options are well-suited to the needs of large global industrial and commercial MNCs in the region:

  1) Direct PPAs are preferred for their flexibility and more competitive renewable energy pricing compared with schemes such as green tariffs, which typically carry a premium.
  2) I-RECs are internationally recognised, making it easier for MNCs to adopt and report them under their global environmental, social, and governance commitments.

Table 3-3: Available Renewable Energy Procurement Options in AZEC Partner Countries

Country	Renewable Energy Procurement Objective	Type of Procurement Option and its Condition
Australia	Obtain a physical supply of renewable energy	**Green tariff** The Green Power Programme allows consumers to purchase renewable energy directly from their energy retailer, with costs ranging from AUD0.5.5 to AUD0.8 per kilowatt-hour (kWh). For example, Origin Energy operates wind and solar farms to supply green energy and issues large-scale generation certificates (LGCs) to purchasers. More than 360,000 households and businesses participate in the programme. **On-site power purchase agreement (PPA) and direct PPA** Australia does not have a single national PPA law. Nevertheless, federal climate and energy targets, the renewable energy target, and existing market rules collectively provide a framework that broadly permits and incentivises PPAs for both utility-scale and on-site projects. As of 2023, Australian corporates had contracted more than 1,700 megawatts (MW) of renewable capacity through PPAs.
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Energy attribute certificates** There are two main types of EACs: LGCs and small-scale technology certificates (STCs). These certificates incentivise entities that generate or install renewable energy systems. Both LGCs and STCs are managed through the REC Registry, which records their location and ownership. The prices of LGCs and STCs fluctuate based on market demand.
Brunei Darussalam	Obtain a physical supply of renewable energy	**Green tariff** Brunei Darussalam currently has no mechanism that allows electricity consumers to purchase renewable energy directly through their utility provider. **On-site PPA and direct PPA** No specific PPA regulation exists to facilitate the adoption of renewable energy by electricity users, including for grid-distributed projects under the large-scale solar programme.
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Energy attribute certificates** Although Brunei Darussalam is still in the early stages of developing a regulatory framework for renewable energy, it adopted the I-REC(E) standard in June 2022 to ensure that its RECs are internationally recognised and trusted.

Country	Renewable Energy Procurement Objective	Type of Procurement Option and its Condition
Cambodia	Obtain a physical supply of renewable energy	**Green tariff** Cambodia has not yet implemented any regulation or framework for a green tariff programme that allows electricity users to purchase renewable energy directly from utility providers. The country has only recently begun laying the groundwork through the Environmental Code and the 2023 Solar Guidelines, which primarily focus on promoting renewable energy generation on the supply side. **On-site PPA and direct PPA** Cambodia currently does not allow on-site or direct PPAs between private renewable energy producers and consumers. However, in some individual cases, applications may be submitted, subject to approval by the Electricity Authority of Cambodia (EAC).
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Energy attribute certificates** In February 2025, Cambodia introduced Regulation Prakas No. 0039 to establish a formal REC mechanism, enabling consumers to verify their renewable energy usage and meet sustainability commitments. RECs will be issued by Electricité du Cambodge, the national electricity utility, whilst the Ministry of Mines and Energy and the Electricity Authority of Cambodia will oversee policy, verification, and fee approvals. The government prioritises export-oriented factories in REC applications to align with international environmental standards.
Indonesia	Obtain a physical supply of renewable energy	**Green tariff** No green tariff programme is available in Indonesia. Instead, the government is focusing on supporting renewable energy development through the FIT programme. **On-site PPA and direct PPA** There is no regulation governing PPA contracts between regular electricity consumers, such as businesses, and power producers.

Country	Renewable Energy Procurement Objective	Type of Procurement Option and its Condition
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Energy attribute certificates** Indonesia has adopted both the I-REC and its own domestic REC, issued by Perusahaan Listrik Negara (PLN), to encourage the use of renewable energy. As of 2024, the domestic REC market is expanding rapidly, recording a 75% increase driven by government initiatives and greater uptake in the business sector. Since its launch in 2020, domestic REC usage has exceeded 5 TWh, with more than 296 customers by the end of 2023. These domestic RECs are backed by various renewable sources, including the Kamojang Geothermal Power Plant and the Bakaru Hydroelectric Power Plant. PLN uses an electronic tracking system to ensure the proper issuance and verification of RECs.
Japan	Obtain a physical supply of renewable energy	Under the Sophisticated Energy Supply Structure Act, Japan mandates that large electricity retailers procure at least 44% of their power from non-fossil sources by 2030. This requirement has driven the development of non-fossil certificates (NFCs) and corporate PPAs as key compliance tools. **Green tariff** Japan's NFC system, similar to a green tariff, enables consumers to support clean energy by purchasing certificates linked to non-fossil power sources, primarily renewables and nuclear. Whilst the actual electricity supply is mixed, NFCs certify the buyer's contribution to cleaner energy. As of 2023, the average contract price of NFCs derived from the FIT scheme and traded on the Japan Electric Power Exchange (JPEX) is approximately JPY0.4 per kWh. **On-site PPA and off-site PPA** On-site PPAs are governed by the Electricity Business Act. However, on-site self-consumption arrangements are exempted if no resale to third parties occurs. The Ministry of Economy, Trade and Industry (METI) and the Ministry of the Environment (MOE) actively promote on-site PPAs as effective decarbonisation tools for businesses, with the MOE's 2025 solar promotion guide identifying them as model solutions. For off-site PPA, the Electricity Business Act provides for two legal structures: • Direct off-site PPAs link a generator directly to a customer. As of February 2024, METI guidelines require that only wholly owned or affiliated generation assets may be used and that power must be consumed at a single demand site.

Country	Renewable Energy Procurement Objective	Type of Procurement Option and its Condition
		• Indirect off-site PPAs involve a licensed retailer: the generator sells power to the retailer, who then resells it to the corporate customer via the grid. By law, any power delivered over the general grid to an end-user must be handled by a registered retailer. Consequently, most corporate PPAs in Japan are either bilateral contracts with a retailer or tripartite agreements.
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Virtual PPAs** Virtual PPAs (VPPAs) are permitted under the Electricity Business Act, as no physical electricity is sold directly to the end user. NFCs may be bundled with the VPPA or purchased separately via the certificate market. METI supports VPPAs as part of its broader initiative to promote user-driven renewable energy procurement. **Energy attribute certificates** In Japan, RECs are primarily represented by NFCs, which allow consumers to claim the environmental benefits of non-fossil power sources. In addition to NFCs, Japan also operates related schemes such as the J-Credit system, which certifies activities that reduce GHG emissions, including energy efficiency measures and carbon sequestration through forestry.
Lao PDR	Obtain a physical supply of renewable energy	**Green tariff, on-site PPA, and direct PPA** Lao PDR has no formal framework for green tariffs, on-site PPAs, or direct PPAs that would allow private consumers to procure renewable energy directly from producers.
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Energy attribute certificates** In 2021, Lao PDR approved the use of the I-REC system, enabling businesses to procure I-RECs to offset their emissions. As no local entity manages the system, the Green Certificate Company serves as the default issuer.
Malaysia	Obtain a physical supply of renewable energy	**Green tariff** Malaysia's Green Electricity Tariff (GET) programme, issued by Tenaga Nasional Berhad (TNB), allows customers to use electricity from renewable sources without installing any equipment. Both residential and non-residential customers may subscribe, with a minimum subscription of 100 kWh. In return, participants receive Malaysia renewable energy certificates (mRECs), which can enhance their eco-friendly brand image.

Country	Renewable Energy Procurement Objective	Type of Procurement Option and its Condition
		On-site PPA and direct PPA SEDA regulates PPAs by providing standardised contract formats for renewable energy power purchase agreements. On-site solar PPAs are now widely adopted, particularly amongst commercial and industrial consumers. For example, global semiconductor company STMicroelectronics signed a 21-year PPA to source 50 GWh of renewable energy annually from a solar farm, supporting its carbon-neutral commitment.
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Virtual PPA and EACs** In 2022, the Energy Commission and TNB launched the Corporate Green Power Programme, enabling corporates to procure renewable energy via VPPAs. Participating companies include Australian data centre operator AirTrunk and Japanese food oils manufacturer ISF. Malaysia participates in the I-REC system and has developed its mREC, benchmarked to I-REC standards to ensure international recognition. The mREC programme is managed by TNBX, which oversees the registration, issuance, and retirement of certificates. Under the GET programme, subscribers receive green electricity from TNB along with mRECs as proof of renewable energy consumption.
Philippines	Obtain a physical supply of renewable energy	**Green tariff** The Philippines launched the Green Energy Option Program under the Renewable Energy Act of 2008 (Republic Act No. 9513). The programme allows eligible electricity consumers to choose renewable energy as their power source. Qualified consumers, primarily from the business sector, must have a minimum annual electricity consumption of at least 100 kilowatt-hours. **On-site PPA and direct PPA** The Philippines has no dedicated legal framework specifically regulating PPAs, particularly on the demand side for renewable energy. There are no detailed regulations outlining how PPAs should be structured or managed.

Country	Renewable Energy Procurement Objective	Type of Procurement Option and its Condition
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Energy attribute certificates** The Philippines adopted the I-REC system in 2017, primarily used by corporations seeking to meet international sustainability targets. In 2024, the country implemented a domestic REC system under its renewable energy market, enabling participants to trade RECs. As of December 2024, over 285 entities, including power generators, retail electricity suppliers, and distribution utilities, had joined the programme. The trading price for RECs is capped at PHP241.56 per MWh.
Singapore	Obtain a physical supply of renewable energy	**Green tariff** Singapore does not have a formal green tariff programme but offers alternatives such as RECs and carbon credits. In 2018, the country launched the Open Electricity Market (OEM), allowing homeowners to choose their electricity provider. Through this programme, many retailers offer green electricity plans that enable consumers to use renewable energy and earn RECs. **On-site PPA and direct PPA** Although Singapore has no dedicated regulation specifically governing PPAs, it has established a supportive environment for renewable energy adoption. Key enablers include the liberalised electricity market, which allows consumers to choose their providers; guidelines from the Energy Market Authority (EMA) ensuring safe and compliant rooftop solar installations; and the SolarNova Programme, which aggregates solar demand across public sector buildings. Collectively, these factors help facilitate the use of PPAs in Singapore.
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Virtual PPA** Whilst there is no specific regulation for VPPAs, Singapore's favourable market conditions have enabled many companies to enter into long-term VPPA contracts to procure renewable energy and pursue their GHG reduction targets. **Energy attribute certificates** Singapore's REC market has been expanding rapidly, reaching a value of US$60 million in 2024. This growth has been partly driven by the OEM, which supports green energy consumption. In 2021, EMA updated the Code of Practice for RECs (SS 673) to enhance the credibility and transparency of REC transactions.

Country	Renewable Energy Procurement Objective	Type of Procurement Option and its Condition
Thailand	Obtain a physical supply of renewable energy	**Green tariff** In 2024, Thailand began implementing the utility green tariff (UGT) for the business sector, available in two types. UGT 1, a 'non-specific source' tariff (currently using hydropower from Electricity Generating Authority of Thailand [EGAT]), is designed to provide green electricity to small businesses. UGT 2, a 'source-specific' tariff, targets large businesses and offers a longer contract term of 10 years. Under UGT 1, power consumers are charged THB4.21 per kWh, comprising the standard electricity rate plus a green premium. Registration is completed through a PPA with one of the country's electricity providers (EGAT, Metropolitan Electricity Authority [MEA], or Provincial Electricity Authority [PEA]). Of a total of 2 billion units of renewable energy, 600 million units have been sold. Buyers include electronics, chemical, and petrochemical companies. **On-site PPA and direct PPA** Whilst on-site PPAs are already common in Thailand, the country is preparing to implement a regulatory framework for direct PPAs by 2025, allowing businesses to purchase renewable energy directly from producers through the national grid. This preparation, approved by the National Energy Policy Council, includes a pilot project launched in 2024 to help the business sector, particularly data centres, transition to renewable energy.
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Virtual PPA and EACs** Thailand is exploring the technologies, business models, and regulatory frameworks needed to implement virtual PPAs and RECs. The Energy Regulatory Commission launched its sandbox programme in 2019. In 2025, the second phase of the sandbox includes participation from leading energy provider Gulf Energy Development, which is supplying renewable electricity to Pandora, allowing the company to claim RECs. This reflects ongoing progress in the development of VPPA and REC mechanisms in the country.

Country	Renewable Energy Procurement Objective	Type of Procurement Option and its Condition
Viet Nam	Obtain a physical supply of renewable energy	**Green tariff** Viet Nam has no green tariff programme that allows electricity consumers to purchase renewable energy from utility providers. **On-site PPA and direct PPA** As in Thailand, on-site PPAs, particularly for rooftop solar power projects, are widely adopted in Viet Nam. However, the existing regulation (Decree No. 135/2024/ND-CP) primarily focuses on developing rooftop solar systems for self-production and self-consumption. For direct PPAs, in 2025, the government approved Decree 57/2025/NC-DP, a legal framework under Viet Nam's Electricity Law, which allows large electricity consumers, with a minimum monthly consumption of 200,000 kWh, to purchase electricity directly from renewable energy generators (wind, solar, biomass). The framework supports two models: the private wire model, and the grid-connected model, which is managed by the Electricity of Viet Nam, the national electricity provider, and requires renewable energy generators to have a processing capacity of at least 10 MW.
	Do not obtain a physical supply of renewable energy but obtain an incentive for purchasing renewable energy	**Energy attribute certificates** Viet Nam actively participates in the I-REC system, which has experienced rapid growth in recent years. In 2024, more than 8 million MWh of I-RECs were issued, driven largely by competitive certificate pricing, making Viet Nam the top I-REC issuer in Southeast Asia.

Sources: Clean Energy Regulator (Australia), Ministry of Economy, Trade and Industry (Japan), Climate Investment Funds, Tenaga Nasional Berhad (Malaysia), Energy Market Authority (Singapore), Department of Climate Change, Energy, the Environment and Water (Australia), World Bank Group, Department of Energy (Philippines), Asia Pacific Energy Policy Portal, Asia Pacific Energy Research Centre.

Box 3-1

Policy Implications Drawn from Research on Renewable Energy by ERIA

As all AZEC partner countries aim to significantly increase their renewable energy capacity, comprehensive policy support, spanning both supply and demand sides, will be essential.

ERIA has conducted extensive research on this topic. This box highlights several key perspectives as an introduction.

Supply-Side Measures

Ensuring a stable and sufficient supply of renewable energy is critical.

- Continued measures to bridge the price gap between green electricity and fossil fuel-based electricity may be necessary. Given recent developments, such as rising biomass prices, policymakers should explore support mechanisms to mitigate cost increases and secure profitability for renewable energy suppliers. This will also require stable government funding.
- Introducing power-wheeling schemes could encourage greater private sector involvement in power generation, helping meet growing electricity demand and accelerate the transition to green energy.

Demand-Side Measures

Supporting flexible renewable energy procurement for end users is equally important.

- Expanding direct and virtual power purchase agreements could facilitate large-scale renewable energy procurement by high-demand users, such as data centre operators, ensuring a stable renewable supply.
- Promoting the use of international renewable energy certificates (I-RECs) can better serve the needs of multinational corporations, as I-RECs enjoy broader acceptance than country-specific energy attribute certificates.

Market Mechanisms

In addition to the above, a well-functioning electricity exchange market is vital for managing the complexities of renewable energy integration.

- Expanding market options and carefully designing trading systems can attract both renewable energy generators and consumers.
- Establishing capacity and ancillary markets will help maintain grid stability as renewable energy penetration increases.

3.3 Zero-emission Thermal

3.3.1 Market trends

Whilst the global phase-out of coal-fired power plants is progressing, many ASEAN countries continue to rely on fossil fuel–based power generation as a low-cost and stable source of electricity.

AZEC trends

- As of 2022, AZEC partner countries relied on coal-fired power for 38% of total generation and natural gas–fired power for 28%, together accounting for 66% of total electricity supply. Coal-fired power plants in ASEAN are relatively new. As of January 2025, announced, pre-approved, or approved construction plans for coal-fired capacity include 4,860 MW in Indonesia, 3,400 MW in Lao PDR, and 2,925 MW in the Philippines.
- AZEC partner countries, particularly those in ASEAN, have strong economic growth potential, which will drive significant increases in electricity demand. This demand is unlikely to be met solely through renewable energy deployment. Whilst the retirement of thermal power plants remains a key element in ASEAN's pathway to net zero, a gradual transition incorporating such as the following decarbonisation methodologies for existing thermal plants is critical:
  1. Hydrogen, ammonia, and biomass combustion technologies
  2. Coal-to-gas (C2G) conversion and repurposing for other uses
  3. CCUS
- Natural gas–fired power occupies a key transitional role in the AZEC region's power sector. It emits less CO_2 than coal whilst maintaining reliability and stability in the electricity supply. For ASEAN countries, natural gas serves as a practical solution to balance environmental goals with economic needs.

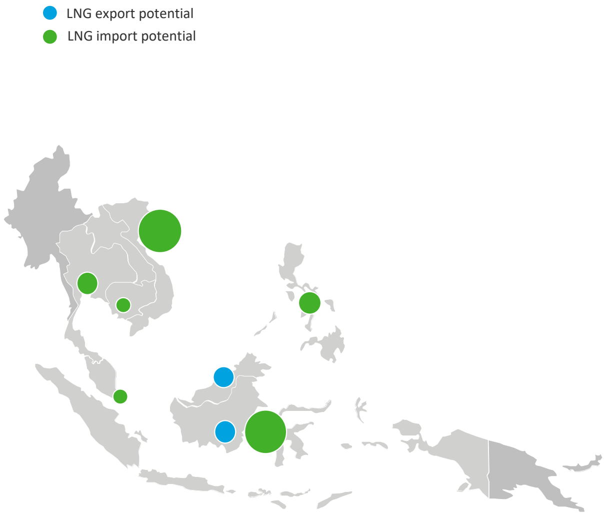
In addition to pursuing C2G initiatives, many ASEAN countries plan to expand natural gas–fired power capacity under their national power development plans. However, countries such as the Philippines, Thailand, and Viet Nam, historically reliant on domestic gas resources, now face the risk of gas depletion. Similarly, LNG-exporting countries such as Indonesia and Malaysia may experience domestic shortages due to rising internal and external demand. As a result, the need for LNG imports is increasing throughout the ASEAN region. As shown in Figure 3-9 and Table 3-4, infrastructure to support a regional LNG supply chain, including LNG terminals and pipelines, is already operational or under development, aiming to meet future demand.

Figure 3-9: Natural Gas Export and Import Potential of the Association of Southeast Asian Nations

LNG Export Potential

# of Liquefaction Terminals
(Both in operation and under construction)

Brunei	**1**
Cambodia	-
Indonesia	**5**
Lao PDR	-
Malaysia	**5**
Philippines	-
Singapore	-
Thailand	-
Vietnam	-



LNG Import Potential

# of Regasification Terminals
(Both in operation and under construction/planned)

Brunei	-
Cambodia	1
Indonesia	**14**
Lao PDR	-
Malaysia	2
Philippines	**9**
Singapore	1
Thailand	**4**
Vietnam	**19**

Source: Author, based on PwC Japan (2023).

Table 3-4. Global Major Gas Pipelines (Selection of Routes Related to the Association of Southeast Asian Nations)

Pipeline Name		Start of Operation	Pipeline Route	Transit Countries								
				BN	KH	ID	LA	MY	PH	SG	TH	VN
Myanmar–Thailand	Phase 1	N.A.	Yadana (Myanmar)–Ratchaburi (Thailand)								√	
	Phase 2	N.A.	Yatagun (Myanmar)–Ratchaburi (Thailand)								√	
	Phase 3	N.A.	Zawtika (Myanmar)–(Thailand)								√	
Malaysia–Singapore	Phase 1	N.A.	(Malaysia)–Senoko (Singapore)					√		√		
	Phase 2	N.A.	(Malaysia)–Tembusu (Singapore)					√		√		
PM3–Ca Mau Gas Pipeline		2007	PM3 CAA Mining area (Malaysia)–Ca Mau (Viet Nam)					√				√
PGU Project		N.A.	Kertih (Malaysia)–Segamat (Malaysia)					√				
		N.A.	Segamat (Malaysia)–Kangar (Malaysia)					√				
Malaysia–Indonesia	Phase 1	2007	Dumai (Indonesia)–Melaka (Malaysia)			√		√				
	Phase 2	Under Construction	Pauh (Malaysia)–Arun (Indonesia)			√		√				
West Natuna–Duyong–Kelteh		2002	West Natuna B (Indonesia)–Duyong Field (Malaysia)–Kelteh (Malaysia)			√		√				
West Natuna–Singapore		2001	West Natuna (Indonesia)–(Singapore)			√				√		

Pipeline Name		Start of Operation	Pipeline Route	Transit Countries								
				BN	KH	ID	LA	MY	PH	SG	TH	VN
Indonesia–Singapore		2003	Grissik (Indonesia)–(Singapore)			√				√		
SSWJ (South Sumatra–West Java)	Phase 1	N.A.	Pagardewa (Indonesia)–Labuhan Maringgai (Indonesia)			√						
			Labuhan Maringgai (Indonesia)–Cilegon (Indonesia)			√						
			Cilegon (Indonesia)–Serpong (Indonesia)			√						
	Phase 2	N.A.	Grissik (Indonesia)–Muara Bekasi (Indonesia)			√						
East Natuna–JDA–Erawan		N.A.	East Natuna (Indonesia)–JDA (Malaysia/Thailand)–Erawan (Thailand)			√		√			√	
East Natuna–Sabah–Palawan–Luzon		N.A.	East Natuna (Indonesia)–Sabah (Malaysia)–Palawan (Philippines)–Luzon (Philippines)			√		√	√			

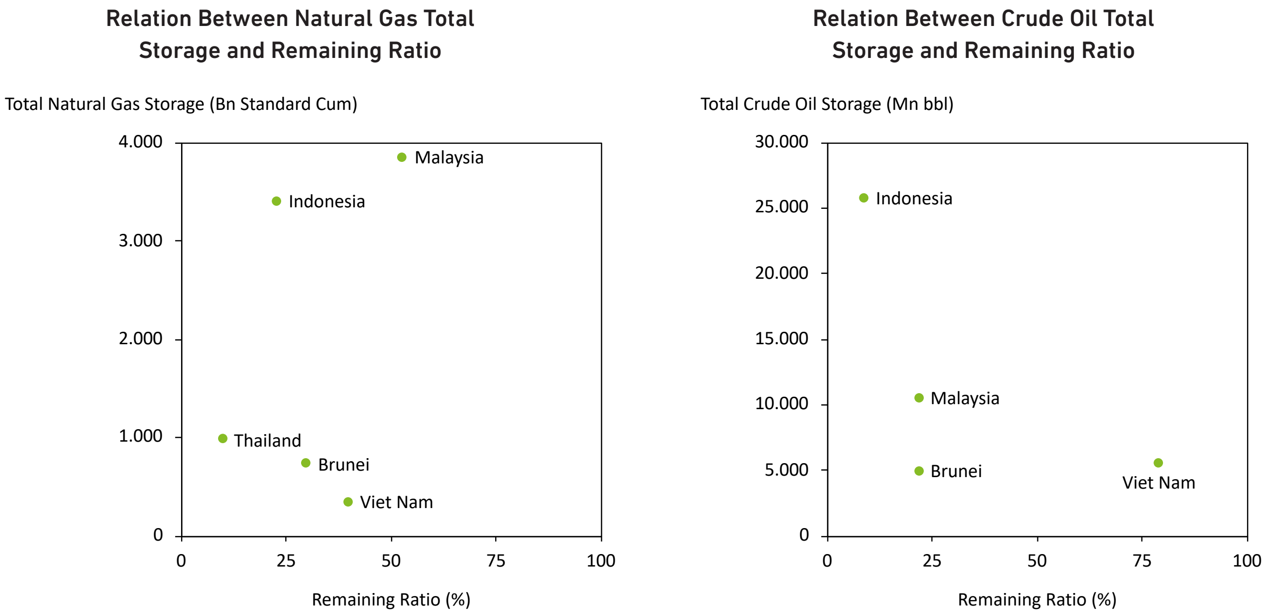
BN = Brunei Darussalam, KH = Cambodia, ID = Indonesia, LA = Lao People's Democratic Republic, MY = Malaysia, PH= Philippines, SG = Singapore, TH = Thailand, VN = Viet Nam.

Source: Author, based on PwC Japan (2023).

- When considering CCUS, it is important to note that capturing CO_2 from thermal power plants is just one of several key applications. Carbon capture is increasingly applied in hard-to-abate sectors such as manufacturing, particularly in cement production, as well as in fossil-based hydrogen with CCUS and ammonia production. Natural gas terminals are emerging as potential sites for CO_2 capture, where LNG cold energy can be utilised to enhance the efficiency of CO_2 liquefaction.
- As part of broader strategies to reduce emissions from industrial complexes and maritime transport, onboard carbon capture systems (OCCSs) have emerged as a promising solution. An OCCS involves the installation of CO_2 capture equipment directly on ships, allowing the capture of emissions generated from fuel combustion during operation. The captured CO_2 is temporarily stored on board and later transferred to green port facilities equipped with CO_2 receiving and handling infrastructure. Amongst AZEC partner countries, Japan and Singapore are at the forefront of research and pilot implementation in this area.

In terms of CO_2 storage potential, the focus is on depleted oil and gas fields, as well as deep saline aquifers. Many ASEAN countries face the risk of gas depletion, opening up opportunities to repurpose these fields for carbon storage. Countries such as Australia, Indonesia, and Malaysia possess substantial deep saline aquifer resources, which are being considered as viable storage sites for CCUS solutions.

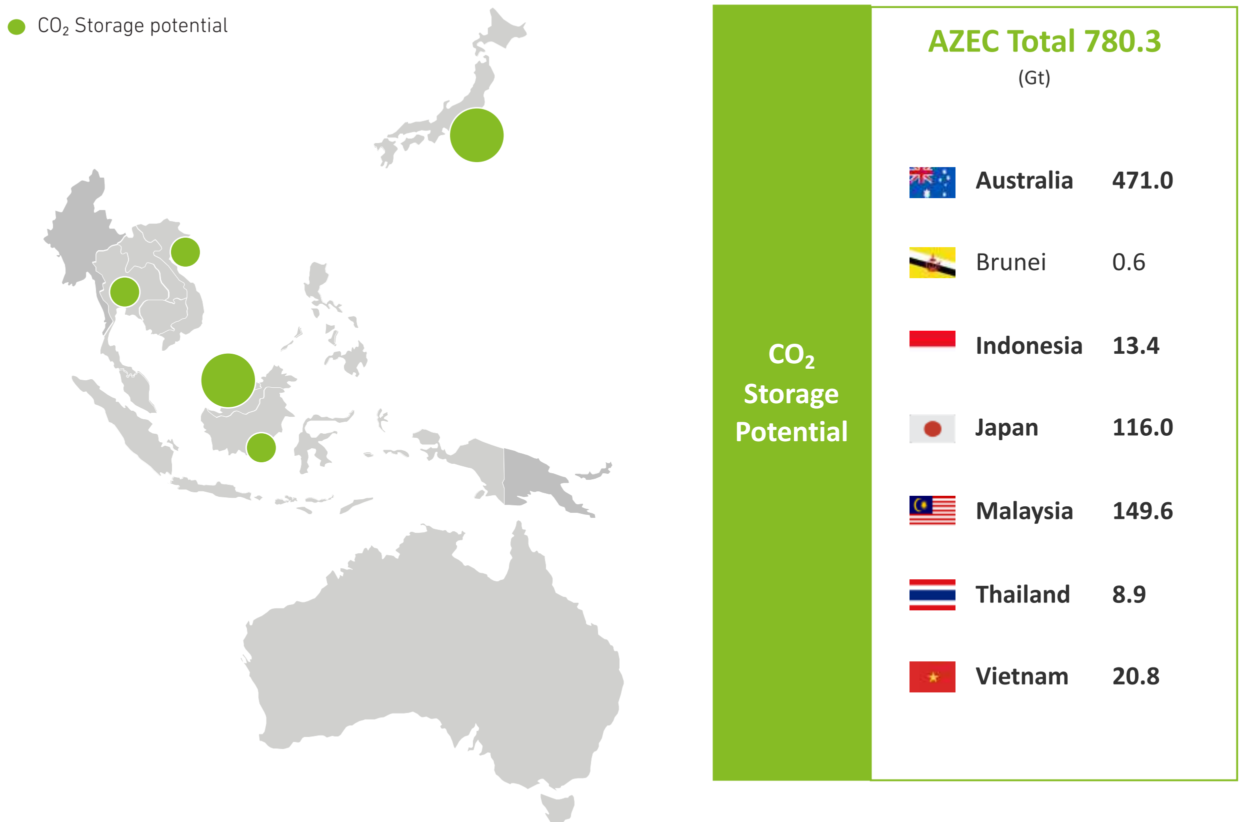
Figure 3-10: Natural Gas and Oil field Depletion



Bn Standard Cum = billion standard cubic metres, Mn bbl = million barrels.

Source: Author, based on PwC Japan (2023).

Figure 3-11: Carbon Dioxide Storage Pontential



Source: Author, based on PwC Japan (2023).

3.3.2 Key policies and regulations

To maximise the use of existing thermal power plants whilst maintaining a stable power supply and promoting decarbonisation, discussions are underway on policies to support fuel transitions from coal to natural gas, hydrogen, ammonia, and biomass combustion, as well as the application of CCUS.

- **Coal/Gas mix policies**
  Future policy directions for AZEC partner countries vary according to national circumstances:
  - o Australia, Malaysia, and Singapore are committed to phasing coal out of the power sector.
  - o The Philippines are expected to maintain coal and gas plant capacities at levels similar to the present, but both countries are committed to decarbonising thermal power generation and have expressed long-term intentions to phase out coal.
  - o Indonesia and Thailand, faced with increasing power demand, plan to expand coal and gas capacity. However, their share of total installed capacity is expected to decline, and decarbonisation efforts are already embedded in national planning.
- **Decarbonisation pathways**
  - o Hydrogen and ammonia combustion are gaining significant attention in Indonesia, Japan, Malaysia, Singapore, Thailand, and Viet Nam.
  - o In Indonesia and Malaysia, biomass co-firing with coal is also being explored as a decarbonisation option and is reflected in their national power plans.
- **C2G conversion and repurposing**
  - o These approaches are particularly valued in Cambodia and Thailand.
  - o Malaysia and Viet Nam have initiated individual projects or discussions on C2G, although national policies are not yet in place.
- **CCUS**
  - o Widely considered a critical solution, especially where other efforts may fall short of achieving zero-emission goals.
  - o Countries actively exploring or supporting CCUS in the electricity sector include Japan, Malaysia, Singapore, Thailand, and Viet Nam.
  - o In Indonesia, CCUS applications in the power sector have been discussed by the International Energy Agency (IEA).

Table 3-5: Decarbonisation Policies of Thermal Power Plants in AZEC Partner Countries

Country	Thermal Power Installed Capacity		Decarbonisation Policy
	Current (2022)	Plan	
Australia	Coal 27.0% 21.1 GW	N/A	Installed Capacity Plan as per Climate Change Act 2022 **No New Coal** At COP29, held in Baku, Azerbaijan, in November 2024, Australia committed to the 'Call to Action to No New Coal' campaign. **Early retirement** Discussions are underway on the early retirement of existing coal-fired power plants. For example, Origin Energy has announced its intention to close the Eraring Power Station on 19 August 2027. **CCUS** Australia's approach to carbon management technologies, including CCS, is to ensure that appropriate policy and regulatory settings are in place to enable industry investment in potential projects. The country already has a mature regulatory system and a range of CCS projects at various stages of development, including two operational dedicated geological storage projects. Australia is exploring the feasibility of and implementing on-board CCS systems for ships. These systems aim to capture CO_2 emissions directly from vessels, thereby reducing the carbon footprint of maritime transport. **Hydrogen** Australia's updated 2024 National Hydrogen Strategy identifies a specific focus on renewable hydrogen, leveraging the country's strengths and competitive advantages. It sets a production target of 15 million tonnes of renewable hydrogen per year by 2050, with a stretch target of 30 million tonnes. For exports, the strategy targets 0.2 million tonnes per year by 2030, with a stretch potential of 1.2 million tonnes.
	Gas 13.5% 10.6 GW	N/A	
Brunei Darussalam	Fossil 99.9% 1.2 GW	N/A	**C2G** Brunei Darussalam's energy strategy targets oil and gas production of 650,000 barrels of oil equivalent per day by 2035. The country actively encourages foreign investment in upstream gas development by offering favourable conditions for exploration and production activities.

Country	Thermal Power Installed Capacity		Decarbonisation Policy
	Current (2022)	Plan	
Cambodia	Coal 19.5% 0.7 GW	(2040) 15.6% 2.3 GW	Installed capacity plan as per Power Development Master Plan 2022–2040.' **C2G** Although Cambodia's Power Development Plan does not include provisions for expanding gas-fired power generation, the government announced in November 2023 the cancellation of the country's largest planned coal-fired power plant. This project will be replaced by a natural gas facility. Cambodia also plans to invest US$1.34 billion in a 900 MW LNG-fired power plant, which will include a jetty, storage tank, and regasification unit. The facility is expected to be operational by 2027. **Hydrogen** Whilst there is limited reference to hydrogen use for decarbonising thermal power plants, Cambodia intends to adopt hydrogen or other zero-carbon fuels as long-term alternatives to natural gas in the transport sector.
	Gas 0%	(2040) 6.2% 0.9 GW	
Indonesia	Coal 54.9% 46.0 GW	(2060) 12.2% 54.0 GW	Installed capacity plan as per the National Electricity Plan **Early retirement** Indonesia has secured funding through the Just Energy Transition Partnership to kickstart its coal-fired power plant retirement programme, with over US$1.5 billion allocated for the initiative. The programme is scheduled to begin after 2025 and aims to reduce coal-based power generation capacity by 1.7 GW by 2040. In parallel, ADB launched the Energy Transition Mechanism in 2021 to support early coal retirement through blended financing solutions. In 2022, a memorandum of understanding was signed between ADB, MEMR, and plant stakeholders to retire the Cirebon-1 coal plant (660 MW) by 2035, 7 years ahead of its original closure date of 2042. **Hydrogen, ammonia, and biomass combustion** On 26 February 2025, PLN, in collaboration with Japan-based IHI Corporation, conducted an ammonia co-firing test at a coal-fired power plant in Labuan. This initiative supports the national electricity plan target of using green ammonia as a primary fuel in coal-fired power plants by 2045. In addition to hydrogen and ammonia, Indonesia plans to utilise biomass co-firing with coal as part of its strategy to decarbonise coal power generation. The plan highlights the development of renewable-based hydrogen production from renewable energy facilities.
	Gas 24.9% 20.8 GW	(2060) 8.6% 38.0 GW	

Country	Thermal Power Installed Capacity		Decarbonisation Policy
	Current (2022)	Plan	
			CCUS In March 2023, MEMR finalised Ministerial Regulation MEMR 2/2023, establishing ASEAN's first CCUS regulatory framework. In 2024, Indonesia enacted Regulation No. 14/2024, allowing CCS operators to allocate up to 30% of their storage capacity for imported CO_2 from overseas sources. Although the regulation does not yet cover electricity generation, the potential use of CCUS in the power sector is being explored by the International Energy Agency. According to Indonesia's latest PDP, by 2060, 12% of coal-fired capacity will be equipped with CCS and/or use biomass co-firing. **Natural gas** Indonesia has introduced several initiatives to support the use of natural gas, including a subsidy policy to offset high gas prices for power plant operators. The country has committed to investing in energy projects, particularly those involving natural gas, to reduce reliance on LNG imports.
Japan	Coal (2023) 16.2% 52.2 GW	N/A	Japan's *Outlook for Energy Supply and Demand in FY2040* sets the following generation estimates for 2040: - Thermal power: 30%–40% of total generation
	Gas 24.7% 79.4 GW	N/A	**End new construction of domestic unabated coal power plants** At the COP28 climate summit, Japan announced that it would end the construction of new unabated coal-fired power plants, joining other Group of Seven members in committing to phase out such plants as part of broader efforts to decarbonise the energy sector. **Hydrogen, ammonia, and biomass combustion** Japan formulated its national Basic Hydrogen Strategy in 2017. Leveraging the Green Innovation Fund, the country has carried out research and development of innovative technologies to commercialise hydrogen and its derivatives. In October 2024, the Hydrogen Society Promotion Act came into effect, under which the Japanese government plays a key role in supporting the development of a large-scale supply chain for low-carbon hydrogen and its derivatives. Stable combustion and reduced oxides of nitrogen emissions with 20% ammonia co-firing have already been achieved at the Hekinan Thermal Power Station. The large-scale demonstration, conducted at a 1 GW power plant, was completed in 2024.

Country	Thermal Power Installed Capacity		Decarbonisation Policy
	Current (2022)	Plan	
			CCUS Japan's Green Growth Strategy and 7th Strategic Energy Plan emphasise the importance of CCUS in decarbonising the power sector. In coal-fired power plant applications, multiple pilot projects are underway, including the Osaki CoolGen Project. Japan is actively developing and deploying onboard CCS systems for ships as part of its strategy to decarbonise the maritime sector and reach carbon neutrality by 2050. Mitsui O.S.K. Lines, Ltd. has announced plans to equip its LR1 product tanker *Nexus Victoria* (75,000 DWT class) with the Filtree System, an onboard CO_2 capture unit with an oxides of sulphur scrubber. The system was scheduled to be installed by the end of 2024.
Lao PDR	Coal 17.1% 1.9 GW	(2030) 14.0% 3.9 GW	Installed capacity plan Under the Sustainable Development Goal 7 Roadmap for Lao PDR **Hydrogen** Although limited, information is available on power plant decarbonisation.
	Gas 0%	-	Lao PDR's National Hydrogen Strategy identifies hydrogen and ammonia as alternative clean energy sources.
Malaysia	Coal 38.3% 13.2 GW	(2040) 9.0% 4.9 GW	Installed capacity plan under the National Energy Policy 2022–2040
	Gas 41.4% 14.3 GW	(2040) 48.0% 26.4 GW	**No new coal and Early retirement of Coal-fired Power Plants** The Malaysian government has announced plans to phase out coal-fired power plants, targeting a 50% reduction by 2035 and full retirement by 2044. **Hydrogen, ammonia, and biomass combustion** TNB is leading multiple pilot projects to introduce combustion technologies using renewable-based hydrogen and ammonia in its power plants. The Hydrogen Economy and Technology Roadmap identifies hydrogen as a potential new energy source to drive the transition away from fossil fuels, whilst helping create new industries. The road map aims to achieve production of 2.5 million tonnes per year of renewable-based hydrogen by 2050. In addition to hydrogen and ammonia, Malaysia also focuses on biomass. Under the NETR, the country aims to achieve a 15% biomass co-firing rate in coal-fired power plants by 2027.

<table>
<tr><th rowspan="2">Country</th><th colspan="2">Thermal Power Installed Capacity</th><th rowspan="2">Decarbonisation Policy</th></tr>
<tr><th>Current (2022)</th><th>Plan</th></tr>
<tr><td></td><td></td><td></td><td>C2G and repurposing
In 2023, the TNB's chief executive officer recommended repowering plants scheduled for retirement before 2030 with natural gas.

To promote investment in the natural gas sector, the Malaysian government has implemented various initiatives, including tax incentives such as pioneer status, the investment tax allowance, and benefits in special economic zones. The government has also taken steps to liberalise the natural gas market through third-party access, allowing private companies to import and distribute gas. However, the market remains in a transitional phase, as natural gas prices, particularly for the power sector, continue to be regulated.

CCUS
In 2023, the NETR set a goal to achieve up to 80 million tonnes per annum of carbon storage capacity by 2050 and introduced tax incentives to promote CCS activities. The NETR and the CCUS Act 2025 provide a regulatory framework for CCUS across a wide range of applications. For thermal power generation, pilot projects involving state-owned oil firm Petronas and state-owned utility TNB are exploring CCUS retrofits for gas-fired power plants.

In Sarawak state, CCS projects operate under a separate legal framework. A notable initiative is the Kasawari project, which is anticipated to become the world's largest offshore CCS facility, capturing around 3.3 million tonnes of CO_2 per year.</td></tr>
<tr><td rowspan="2">Philippines</td><td>Coal
44.0%
12.4 GW</td><td>(2050 CES)
7.2%
11.1 GW</td><td rowspan="2">Installed capacity plan under the Philippine Energy Plan (PEP) 2023–2050 – clean energy scenario

No new coal and Early retirement of Coal-fired Power Plants
Since late 2020, the DOE has suspended applications for new coal-fired power plants.

In 2023, the DOE also initiated the early retirement or repurposing of 5,000 MW of coal-fired capacity, such as for storage facilities or renewable energy projects, as part of its energy transition plan.

Hydrogen
The DOE considers hydrogen as an alternative clean energy source and, through Ministerial Circular No. 2024-01-0001, has announced a policy framework introducing incentives to encourage investment in the hydrogen sector.</td></tr>
<tr><td>Gas
13.3%
3.7 GW</td><td>(2050 CES)
12.8%
19.7 GW</td></tr>
</table>

Country	Thermal Power Installed Capacity		Decarbonisation Policy
	Current (2022)	Plan	
			Natural gas In 2025, the Philippines enacted the Natural Gas Industry Development Act (Republic Act No. 12120) to boost the natural gas sector. The law supports the conversion of fossil fuel facilities to natural gas and encourages its procurement. It offers incentives, such as tax exemptions and fiscal benefits, to attract both foreign and local investment, underpinned by a clear regulatory framework.
Singapore	Fossil 90.6% 11.7 GW No coal/gas detail specified	(2035) 50.0% 10.0 GW	Installed capacity plan under the Singapore Green Plan 2030 **No new coal and Early retirement of Coal-fired Power Plants** Singapore joined the Powering Past Coal Alliance at COP26 and has committed to phasing out unabated coal from its electricity mix by 2050. Financial measures reinforce this commitment: since 2019, major banks have ceased funding new coal plant investments, whilst the Monetary Authority of Singapore has developed policies to encourage banks to support early retirement projects for coal-fired power plants. **Natural gas** In 2024, Singapore launched FEF, allocating US$5 billion to support energy transition infrastructure, with a focus on securing low-carbon energy supplies. Projects eligible for FEF support include the development of undersea cables for importing low-carbon electricity. **CCUS** In 2022, Singapore introduced the Low-Carbon Energy Research Funding initiative to invest in CCUS research and development. In October 2024, the Energy Market Authority announced plans to initiate feasibility studies on CCUS applications in the power sector, including post-combustion carbon capture for CCGTs. Singapore is also a key player in the development and deployment of CCS technology for ships. **Hydrogen, ammonia, and biomass combustion** The National Hydrogen Strategy, launched in 2022, promotes investment, research and development, and international cooperation in low-carbon hydrogen to support decarbonisation by 2050, including its use in hydrogen-powered CCGTs for power generation. Singapore is advancing multiple initiatives to study the feasibility of ammonia combustion in power generation. These include the ammonia-fired gas turbine pilot project on Jurong Island, led by Keppel Infrastructure and Sembcorp-SLNG in 2024, and the planned retrofit of Sembcorp's Sakra Power Plant to operate on ammonia.

<table>
<tr><th rowspan="2">Country</th><th colspan="2">Thermal Power Installed Capacity</th><th rowspan="2">Decarbonisation Policy</th></tr>
<tr><th>Current (2022)</th><th>Plan</th></tr>
<tr><td>Thailand</td><td>Coal
22.7%
3.7 GW
(2024)

Gas
51.7%
8.4 GW
(2024)</td><td>(2037)
Fossil
31.2%
35.0 GW
No coal/gas detail specified</td><td>Installed capacity plan under the Alternative Energy Development Plan 2024–2037

Hydrogen, ammonia, and biomass combustion
Thailand is actively pursuing hydrogen adoption to decarbonise its power sector. The PDP outlines a goal to blend hydrogen with natural gas for power generation, with the government planning to provide financial incentives to support the production, distribution, and consumption of hydrogen. The country is proceeding with pilot projects to study the feasibility of hydrogen and ammonia combustion. These include cooperation between MHI and BLCP Power Ltd. to test ammonia combustion at BLCP's Map Ta Phut coal-fired power plant.

EGAT and MHI have agreed to test 20% hydrogen combustion in gas turbine power generation facilities.

C2G and repurposing
Although Thailand does not yet have a clear national policy on C2G conversion, individual projects are underway. Notably, in 2021, EGAT decided not to proceed with two proposed coal-fired power plants, opting instead to construct a gas-fired complex comprising two 700 MW plants, scheduled to begin operations in 2027 and 2029, respectively.

Natural gas
Thailand has sought to liberalise its natural gas market by introducing regulatory guidelines allowing third-party access. However, market liberalisation remains constrained by regulatory ambiguity, PTT Public Co., Ltd.'s monopoly over key infrastructure, and limited incentives to attract new participants.

CCUS
Whilst there is currently no specific policy for CCUS in thermal power generation, Thailand is promoting feasibility study projects. For example, Global Power Synergy Public Company Limited and Doosan have agreed to conduct joint research and introduce ammonia co-combustion and CCUS technologies. The government is updating the Petroleum Act B.E. 2514 (1971) to include provisions for exploration activities related to CCS site development.</td></tr>
</table>

Country	Thermal Power Installed Capacity		Decarbonisation Policy
	Current (2022)	Plan	
Viet Nam	Coal 32.5% 26.7 GW	(2050) 0%	Installed capacity plan under the PDP8, revised April 2025 **No new coal and Early retirement of Coal-fired Power Plants** Viet Nam will not develop any new coal-fired power plants from 2030 onwards. **C2G and repurposing** PDP8 sets directions for coal plants that have been in operation for more than 20 years to be converted to alternative fuels such as biomass or ammonia. Plants that have operated for more than 40 years must be decommissioned if fuel conversion is not feasible. Whilst Viet Nam has limited policies on C2G conversion, one notable project is the 600 MW Cong Thanh coal-fired power plant in the central province of Thanh Hoa, which has been proposed for conversion into an LNG-fired facility, with a capacity of 1,500 MW by 2024. **Hydrogen, ammonia, and biomass combustion** Viet Nam plans to pilot the combustion of natural gas with hydrogen and coal with ammonia as part of its fuel-switching plans outlined in PDP 8 for 2021–2030, with a vision to 2050. The government aims to increase hydrogen's contribution to power generation, targeting a share of 4.1%–5.4% of total electricity generation by 2050. **CCUS** PDP8 recognises the importance of CCUS in facilitating the transition to cleaner energy sources. The Viet Nam Petroleum Institute has commissioned Black & Veatch to conduct a feasibility study assessing the feasibility and effectiveness of current carbon capture technologies for treating flue gas emissions from coal-fired power plants.
	Gas 8.9% 7.3 GW	(2050) 6.7% 54.6 GW	

ADB = Asian Development Bank; ASEAN = Association of Southeast Asian Nations; C2G = carbon to gas; CCS = carbon capture and storage; CCGT = combined-cycle gas turbines; CCUS = carbon capture, utilisation, and storage; COP = Conference of the Parties; DOE = Department of Energy; EGAT = Electricity Generating Authority of Thailand; FEF = Future Energy Fund; G= gigawatt; Lao PDR = Lao People's Democratic Republic; LNG = liquefied natural gas; MEMR = Ministry of Energy and Mineral Resources; MHI = Mitsubishi Heavy Industries; MW = megawatt; NETR = National Energy Transition Roadmap; PDP = Power Development Plan; TNB = Tenaga Nasional Berhad.

Note: Percentage of installed capacity refers to the share of each country's total installed capacity.

Sources: National Climate Change Secretariat (Singapore), Tenaga Nasional Berhad (Malaysia), Viet Nam Thermal Power Association, International Centre for Sustainable Carbon, PT PLN Indonesia Power, Energy Market Authority, United Nations Framework Convention on Climate Change, Ammonia Energy Association.

Box 3-2

Policy Implications Drawn from Zero-emission Thermal Research by ERIA

In AZEC partner countries, thermal power, including coal- and gas-fired generation, will continue to play a critical role in ensuring energy security. Targeted policies are therefore needed to support decarbonisation efforts in these hard-to-abate segments of the power sector.

ERIA has conducted extensive research on this topic. This box highlights several key perspectives as an introduction.

Hydrogen, Ammonia, and Biomass Combustion

For coal- and gas-fired power plants, the combustion of hydrogen, ammonia, and biomass offers potential pathways to reducing emissions. However, these projects face challenges in achieving commercial viability.

- Support measures that facilitate the successful implementation of proof-of-concept projects for hydrogen, ammonia, and biomass combustion, along with proactive knowledge sharing and the dissemination of best practices, are needed. Operational know-how for technologies that enable high blend ratios would help advance the broader adoption of low-carbon combustion solutions.
- Explore mechanisms to ensure the economic viability of combustion-based projects, including cost-based approaches such as contracts for difference to offset the high costs of hydrogen, ammonia, and biomass, as well as revenue-based measures such as premium green power schemes for low-carbon thermal generation. Stable government funding will be essential.
- Establish cross-regional supply chains for hydrogen and ammonia to guarantee a stable and sufficient supply of low-carbon fuels.

Natural Gas

During the transition to renewable energy, gas-fired power generation will remain critical for ensuring grid stability whilst reducing carbon emissions in the power sector.

- Gas-fired power is a cost-effective and reliable energy source during the transition. Policies should ensure that its costs are shared equitably, rather than falling disproportionately on gas companies. To achieve this, governments could implement targeted financial support programmes and cost-sharing arrangements to distribute the financial burden more evenly.

Carbon Capture, Utilisation, and Storage

In oil field development and carbon capture and storage projects, high project risks continue to deter private sector participation. As resources are state-owned, companies are required to share profits with the government, which extends the timeline for cost recovery.

- Establish bilateral or multilateral agreements between AZEC partner countries to enable cross-border CO_2 transport projects, covering safety standards for CO_2 transport and storage, the allocation of GHG reduction benefits, and responsibilities in the event of CO_2 leakage.
- Clarify legal interpretations and establish exception provisions to ensure that CO_2 storage is not classified as 'marine disposal of waste' under the London Convention, whilst maintaining full compliance with relevant international treaties.

Sources: Author (2025).

3.4 Nuclear Power

3.4.1 Market trends

Nuclear power, regarded as a clean energy source, is a viable option for achieving zero emissions in the power sector, depending on national circumstances. However, approaches to nuclear power utilisation vary across countries. In ASEAN, several countries are exploring the construction of nuclear power plants as a means of decarbonising their economies whilst ensuring a stable electricity supply.

AZEC trends

No ASEAN country operates nuclear power generation facilities (Figure 3-6). Rising global fuel prices have placed significant financial pressure on countries reliant on imported fossil fuels. Although retail electricity prices have largely been kept stable through government subsidies, the burden on public finances continues to grow. As a result, whilst each country maintains its stance on nuclear development, some increasingly see nuclear energy as a cost-effective and stable source of decarbonised power.

Japan remains the only AZEC partner country where nuclear power has been developed and is operational. Before the 2011 Fukushima tsunami, nuclear energy accounted for approximately 30% of Japan's electricity generation. Following the disaster, all nuclear operations were suspended. Over the past decade, to ensure a stable energy supply, Japan has gradually resumed nuclear power operations, particularly in the western regions. Since 2024, reactivation has extended to eastern Japan. As of April 2025, 14 nuclear power plants in Japan have resumed operations.

Table 3-6: AZEC Partner Countries' Nuclear Power Plant Plans

Country	Direction		Status and Details
	Implemented/ Considering	Reflected to PDP	
Australia	No	No	-
Brunei Darussalam	No	No	-
Cambodia	No	No	-
Indonesia	Considering	Yes	The government targets reaching 8 GW of installed nuclear capacity by 2035, and 35 GW by 2050. The first nuclear power plant, to be operated by PT ThorCon Power Indonesia, is targeted for operation by 2030; however, the plan is under review and construction has yet to start.
Japan	Implemented	Yes	Japan has utilised nuclear energy since 1966. In 2023, the country enacted the GX Decarbonisation Power Supply Act, amending the Atomic Energy Basic Law and related legislation to promote nuclear power in achieving a decarbonised society.

Country	Direction		Status and Details
	Implemented/ Considering	Reflected to PDP	
Lao PDR	Considering	No	Discussions on nuclear power's role in the energy mix have been limited. In 2015–2016, Lao PDR engaged with Russia's State Atomic Energy Corporation, Rosatom, resulting in the signing of an MoU.
Malaysia	Considering	Yes	In December 2024, the Cabinet, after reviewing a nuclear road map proposed by the National Energy Council, decided that nuclear is 'one of the options for electrical power generation' post-2035. Nuclear power will be officially included as an energy option in the 13th Malaysian Plan (2026–2030).
Philippines	Considering	Yes	The Department of Energy published *Nuclear Energy Roadmap* in December 2024, aligned with the clean energy scenario in the Philippine Energy Plan 2023–2050, targeting 4,800 MW of nuclear capacity by 2050. The government has also been considering the revival of the Bataan Nuclear Power Plant, built in 1984 but never commissioned, to diversify the energy mix and reduce rising energy costs.
Singapore	Considering	No	The government is studying the potential deployment of nuclear power and has signed the 123 Agreement on Nuclear Cooperation with the United States, focusing on SMR technology.
Thailand	Considering	Yes	The government has included a 600 MW SMR nuclear capacity by 2037 in its latest PDP 2024–2037. The Energy Regulatory Commission has signed an MoU with the Office of Atoms for Peace to establish a study committee, conduct public hearings, and promote clean, low-cost energy.
Viet Nam	Considering	No	The government has revived its nuclear programme, aiming to begin operations by 2030 after shelving the plan in 2016. Under the latest PDP8, 2025, the target is 6,400 MW by 2030, expanding to 14,000 MW by 2050. The Ninh Thuân Nuclear Power Plant will be developed initially with 4,000–6,400 MW capacity, with further expansion depending on demand. The government has also signed a cooperation agreement with the Russian Federation on nuclear power development.

GW = gigawatt, Lao PDR = Lao People's Democratic Republic, MoU = memorandum of understanding, PDP = Power Development Plan, SMR = small modular reactor.

Sources: Tenaga Nasional Berhad (Malaysia), Department of Energy (Philippines), United States Embassy in Singapore, Japan Atomic Industrial Forum.

3.4.2 Key policies and regulations

The safe and stable use of nuclear power generation requires the establishment of comprehensive regulatory frameworks. In countries considering the development of nuclear power plants, discussions are taking place on various policy measures, including, but not limited to, the following:

- Japan, the only AZEC partner country with operational experience in nuclear power, significantly strengthened its regulatory regime following the 2011 Fukushima accident. This included the establishment of the Nuclear Regulation Authority (NRA) in 2012. In 2013, the NRA issued the upgraded Nuclear Regulatory Standards, which introduced the following:
  1) Strengthened measures against natural disasters.
  2) Mandatory countermeasures against severe accidents.
  3) A backfit system, requiring all existing facilities to meet the new standards before being allowed to resume operations.

- For ASEAN countries considering the adoption of nuclear power, safety remains the top priority. The formulation of common regulations and standards is therefore being emphasised, alongside cross-regional collaboration, human resource development, the creation of disaster-response plans, and regional and international cooperation.
- Beyond regional cooperation amongst ASEAN Member States, significant support is also being provided by the International Atomic Energy Agency, particularly in the development of safety standards and the training of human resources.

Table 3-7: AZEC Partner Countries' Nuclear Power Plant Safety and Operational Policies

Country	Safety Operation Policy		Notes
Indonesia	Standards and specifications	Yes	Overseen by BAPETEN, which is responsible for regulation, licensing, and inspection in line with national laws. The IAEA's IRRS has reviewed and confirmed that the regulatory framework aligns with international best practices.
	Professional talent	Yes	Interdepartmental bodies, including the Ministry of Energy and Mineral Resources, BATAN, the Department of Labor and Transmigration, BAPETEN, and the Ministry of Research and Technology, are reviewing competencies and human resources. They are developing a human resource development programme blueprint and planning Nuclear Training Center facilities.
	Business continuity plan	No	-

Country	Safety Operation Policy		Notes
	International collaboration	Yes	Joint research between the Japan Atomic Energy Agency and BATAN on nuclear reactor technologies and safety, with a special emphasis on high-temperature gas-cooled reactors. Active discussions and research are ongoing on SMRs, considered a safer and more adaptable solution for Indonesia.
Japan	Standards and specifications	Yes	Nuclear safety regulations are aligned with international standards through participation in key international conventions, such as the Convention on Nuclear Safety and the Convention on the Physical Protection of Nuclear Material. The Nuclear Regulation Authority further strengthens safety through operational programmes and updated regulatory requirements for commercial reactors.
	Professional talent	Yes	Collaboration with the NEA to strengthen workforce capacity via annual international mentoring workshops, the Global Forum Nuclear Education National Workshop, and mentoring programmes at power facilities like Mihama Nuclear Power Plant.
	Business continuity plan	Yes	Each nuclear facility must prepare a Nuclear Operator Emergency Action Plan as mandated by the Act on Special Measures Concerning Nuclear Emergency Preparedness.
	International collaboration	Yes	Joint research and development projects with the US on nuclear safety and technology, including sharing best practices in reactor safety and emergency preparedness. Long-standing partnership with France on advanced nuclear technologies, such as fast breeder reactors and nuclear fuel recycling. Member of the Generation IV International Forum, collaborating globally to develop next-generation nuclear reactor technologies.
Lao PDR	-	N/A	-
Malaysia	Standards and specifications	Yes	Established under the Atomic Energy Licensing Act 1984, the AELB oversees nuclear safety, radiation protection, and licensing, adhering to IAEA guidelines.
	Professional talent	WIP	A memorandum of understanding was signed between Korea Electric Power Corporation and Tenaga Nasional Berhad to undertake a preliminary feasibility study for a nuclear power programme in Peninsular Malaysia.
	Business continuity plan	Yes	The AELB has developed an emergency preparedness and response framework for nuclear and radiological emergencies. A radiological emergency response centre and a nuclear emergency team operate on a 24-hour standby basis, with trained personnel and equipment ready to respond.
	International collaboration	Yes	Collaboration with the US to explore SMR technology through the FIRST programme. Partnerships with Japan and France on technology transfer and human capital development. Participation in the IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles.
Philippines	Standards and specifications	WIP	The Philippine Nuclear Research Institute serves as the primary regulatory body responsible for nuclear safety, radiation protection, and the peaceful use of nuclear technology. Nuclear safety policy standards, adhering to IAEA guidelines, are under development.
	Professional talent	Yes	The NRD conducts training and professional development programmes to ensure technical competence in the nuclear sector.
	Business continuity plan	Yes	The NRD coordinates regular drills and develops response strategies to enhance nuclear and radiological emergency preparedness.

Country	Safety Operation Policy		Notes
	International collaboration	Yes	The US–Philippines 123 Agreement provides a legal framework for the transfer of nuclear material, equipment, and technology from the US, including advanced SMR technologies.
Singapore	Standards and specifications	No	-
	Professional talent	Yes	The Singapore Nuclear Research and Safety Initiative was established to consolidate expertise in nuclear technology and safety, aiming to sustain a critical mass of skilled manpower engaged in nuclear-related activities.
	Business continuity plan	Yes	The Radiation Protection and Nuclear Science Group, under the NEA, coordinates nuclear and radiological emergency preparedness and response, ensuring robust operational continuity plans.
	International collaboration	Yes	The US–Singapore Civil Nuclear Cooperation Agreement facilitates peaceful nuclear cooperation, including the FIRST programme for SMR technology.
Thailand	Standards and specifications	WIP	The OAP develops and enforces standards and regulations for nuclear and radiation technologies. Whilst standards are under development, the IAEA's IRRS has recognised Thailand's commitment to strengthening its national safety framework.
	Professional talent	Yes	The TRR-1/M1 research reactor serves as a key training centre for nuclear medicine and neutron imaging. Two additional research reactors are planned. The OAP has launched the Human Resource Development Plan to strengthen talent development.
	Business continuity plan	No	-
	International collaboration	Yes	The US–Thailand 123 Agreement establishes a framework for peaceful nuclear cooperation, enabling the transfer of nuclear materials, equipment, and technology to support Thailand's civil nuclear energy programme.
Viet Nam	Standards and specifications	Yes	Radiation and nuclear safety are overseen by the Viet Nam Agency for Radiation and Nuclear Safety, under the Ministry of Science and Technology. Safety and security provisions in the 2008 Atomic Energy Law are aligned with IAEA guidelines.
	Professional talent	WIP	Project No.7 focuses on establishing and implementing a human resource development plan to develop a skilled workforce for safe and efficient nuclear facility operations.
	Business continuity plan	WIP	A comprehensive plan is being prepared to identify potential threats, outline recovery strategies, detail response protocols, and regularly test and update preparedness measures.
	International collaboration	Yes	In January 2025, Viet Nam and the Russian Federation signed an agreement between Rosatom and Electricity of Viet Nam to explore nuclear power plant development. Discussions cover the construction of a centre for nuclear science and technology and options for large-scale reactor and SMR deployment.

123 Agreement = Civil Nuclear Cooperation Agreement, AELB = Department of Atomic Energy Malaysia, BAPETEN = Nuclear Energy Regulatory Agency, BATAB = National Nuclear Energy Agency, FIRST = Foundational Infrastructure for the Responsible Use of Small Modular Reactor, IAEA = International Atomic Energy Agency, IRRS = Integrated Regulatory Review Service, NEA = Nuclear Energy Agency, NRD = Nuclear Regulatory Division, OAP = Office of Atoms for Peace, SMR = small modular reactor, US = United States.

Note: Australia, Brunei Darussalam, and Cambodia are not included, as there is no information indicating they are considering the implementation of nuclear power.

Sources: International Atomic Energy Agency, Nuclear Regulation Authority (Japan), Cabinet Secretariat of Japan, Japan Atomic Energy Agency, U.S. Department of Energy, Economic Research Institute for ASEAN and East Asia, Philippine Nuclear Research Institute, National Environment Agency of Singapore, Office of Atoms for Peace of Thailand, World Nuclear Association.

Box 3-3

Policy Implications Drawn from Research on Nuclear Power by ERIA

Nuclear power can provide a reliable, clean energy solution that ensures a stable electricity supply at reasonable cost, depending on national circumstances. However, strict adherence to safety standards and gaining public understanding remain essential prerequisites.

ERIA has conducted extensive research on this topic. This box highlights several key perspectives as an introduction.

Infrastructure development for the introduction of nuclear power should be advanced in line with the 19 issues outlined in the International Atomic Energy Agency (IAEA) Milestones Approach (e.g. funding and financing, legal framework).

- To achieve this, governments should consider undergoing the Integrated Nuclear Infrastructure Review offered by the IAEA. In parallel, capacity-building activities should be promoted by using resources such as the Japan Atomic Industrial Forum's International Cooperation Center and the United States' Foundational Infrastructure for Responsible Use of Small Modular Reactor Technology programme.

Public understanding and the safe operation of nuclear power are essential.

- Maintain a consistent nuclear power policy and articulate a clear, forward-looking vision to foster local acceptance. To build trust and understanding, government, industry, and independent communicators should provide accurate and tailored information from their perspectives.
- Promote local business participation in the nuclear power supply chain, stimulate job creation, and support industrial diversification through the development of complementary sectors.
- Implement additional measures to enhance operational safety, including talent-development initiatives and the incorporation of knowledge and expertise from countries with extensive experience in long-term nuclear power plant operations.

Source: Economic Research Institute for ASEAN and East Asia (2024).

3.5 Power Grid

3.5.1 Grid reinforcement and stabilisation

Like other major regions, AZEC partner countries face numerous challenges in the development and operation of their power grids. Key issues include managing growing electricity demand, integrating increasing shares of renewable energy, enhancing resilience through microgrids, and promoting interconnection across the ASEAN region.

AZEC trends

In ASEAN, electricity supply is unstable in some areas, with certain regions still entirely off-grid. Strengthening grid infrastructure is urgently needed to accommodate renewable energy integration and to ensure stable power delivery. Whilst microgrid solutions are being explored for off-grid areas, the primary focus remains on reinforcing and modernising existing grid systems.

ASEAN continues to face persistent challenges in power supply, particularly in off-grid areas where grid infrastructure is underdeveloped. Economic growth is fuelling rising electricity demand, underscoring the need to upgrade and expand transmission and distribution systems. Simultaneously, the growing penetration of renewable energy creates an urgent need for grid modernisation and digitalisation, particularly to improve demand-side management.

- **Microgrids for islands and rural areas.** Due to the geographical characteristics of several ASEAN countries, the installation of large-scale interconnected grids – common in continental regions – is not always feasible. As a result, many communities remain off-grid. In such areas, initiatives are increasingly focused on deploying renewable energy systems integrated with microgrids to provide reliable electricity access.

Table 3-8: AZEC Partner Countries' Microgrid Implementation Plans for Islands and Rural Areas

Country	Microgrid for Rural Islands and Rural Areas	Status and Details
Australia	Yes	The government has implemented policies to improve rural electrification through microgrids, including the Regional Australia Microgrid Pilots Program in 2021 and the Regional Microgrids Program in 2023. Notable ongoing projects include Corryong Islandable Microgrid, which supplies power to 900 local households and businesses, and the Marlinja Microgrid Project, providing electricity to 60 indigenous residents 700 km south of Darwin.
Brunei Darussalam	-	-
Cambodia	Yes	Cambodia has implemented several policies to expand rural electrification through microgrids, including the Rural Electrification Fund established in 2004 to support off-grid solutions, the Rural Electrification Master Plan in 2005 to guide nationwide electrification with a focus on renewable energy and microgrid technologies, and Prakas No. 1053 in 2011 to define strategies for rural electrification from 2011 to 2030. A notable project is Okra Solar's DC Mesh Grid Microgrid Network, which provides clean energy to nearly 150,000 households in Steung Chrov.

Country	Microgrid for Rural Islands and Rural Areas	Status and Details
Indonesia	Yes	The Bright Indonesia Initiative, launched in 2016, has significantly improved energy access in rural and remote areas. Notable projects include the Papua Pilot Project, which provides modular generation and storage with smart metering, and microgrids in Maluku and North Maluku to sustain long-term energy access. Hybrid diesel–solar microgrids aim to provide 1 gigawatt of power to 12,000 villages. As of November 2022, the initiative has electrified 83,280 villages, providing sustainable energy to millions.
Japan	Yes	Policies under the 6th Strategic Energy Plan (2021) aim to improve regional grid resilience through microgrids, with a focus on increasing renewable energy use and enhancing resilience in disaster-prone areas. An example is the Mutsuzawa Smart Wellness Town in Chiba Prefecture, which integrates locally produced natural gas and solar energy in a self-reliant microgrid.
Lao PDR	Yes	The country has advanced rural electrification through microgrids, supported by the Power Grid Improvement Project (2015, with World Bank support) to improve distribution efficiency, and the Scaling Up Rural Electrification initiative (2014), which promotes renewable energy-based microgrids. Notable projects include solar microgrids in Xayaboury and Luang Prabang (2022), with a combined planned capacity of 400 megawatts, and hydropower microgrids such as the Nam Phay plant, operational since 2013.
Malaysia	Yes	Rural electrification programmes in Malaysia use microgrids to provide sustainable energy to remote communities. Examples include the Sarawak Alternative Rural Electrification Scheme (SARES, 2016), using solar and micro-hydro solutions, and the Ulu Baram Microgrid Project, which employs solar power with battery storage to reduce reliance on diesel. The Smart Microgrid for Sustainable Rural Development Project, led by Swinburne University, aims to optimise microgrid operations using renewable sources.
Philippines	Yes	The Philippines is rapidly advancing microgrid development through the Renewable Energy Act of 2008, the Philippines Energy Plan, the National Total Electrification Roadmap 2023–2032, and the Microgrid Systems Act of 2022. Pilot projects such as the Palawan and Romblon microgrids have provided electricity to 1,096 small communities as of December 2021.
Singapore	-	-
Thailand	Yes	Rural electrification policies in the 2015 Energy Development Plan prioritise renewable energy sources for microgrids. Notable projects include the Khlong Ruea Microgrid, integrating photovoltaic panels, pico-hydro, and battery storage for 306 residents, and the Ban Khun Pae Village Microgrid, Thailand's first smart hybrid microgrid, combining photovoltaic generation, battery storage, and small hydro to support power stability and irrigation.
Viet Nam	Yes	The Power Development Plan (2021–2030, with vision to 2050) prioritises renewable energy and microgrids for rural and remote areas. A solar-powered microgrid in An Giang has provided reliable electricity to homes, schools, and healthcare facilities in isolated villages.

Sources: International Renewable Energy Agency, Department of Energy (Philippines), Australian Renewable Energy Agency, World Bank Group, Ministry of Economy, Trade and Industry (Japan), Asian Development Bank, Organisation for Economic Co-operation and Development.

- **Grid reinforcement and strengthening.** As electricity demand and generation capacity increase, reinforcing the grid becomes essential. However, the rising share of renewable energy introduces supply variability, making grid modernisation and digitalisation critical to ensuring stability. As a result, countries are formulating strategic plans to address these challenges.

Table 3-9: AZEC Partner Countries' Grid Modernisation Plans

Country	Status		Status and Details
	Plan Status	Readiness	
Australia	Yes	Early stage	RtN is a government-funded programme providing more than US$20 billion for investments to upgrade, expand, and modernise electricity grids, unlocking renewables and storage capacity whilst driving down power prices. It also advances regulatory and policy reforms to remove barriers to transmission project delivery. RtN puts downward pressure on wholesale power prices by enabling greater interstate electricity flows and increasing the availability of lower-cost renewable generation and storage. As part of the government's energy and climate change agenda, the RtN will help achieve Australia's emissions reduction targets of 43% by 2030 and net zero by 2050. The Australian Renewable Energy Agency's battery storage initiative includes the Gannawarra Energy Storage System (25 megawatts/50 MWh lithium-ion battery, co-located with the Gannawarra Solar Farm, completed 30 January 2022) and the Ballarat Energy Storage System (operational since late 2018), both of which enhance grid reliability.
Brunei Darussalam	-	-	-
Cambodia	Yes	Early stage	Cambodia's grid modernisation, outlined in the PDP 2022–2040, focuses on enhancing transmission and distribution network to ensure reliable, sustainable supply. Key initiatives include upgrading and expanding 115 kV and 230 kV infrastructure, integrating solar and wind energy, improving efficiency, and supporting rural electrification. The Grid Reinforcement Project, supported by the Asian Development Bank, builds transmission lines and substations, whilst the grid modernisation project, funded by the Agence Française de Développement, aims to digitally transform the Electricité du Cambodge to improve efficiency, integrate renewables, modernise IT systems, reduce outages, and cut CO_2 emissions.

Country	Status		Status and Details
	Plan Status	Readiness	
Indonesia	Yes	Early stage	Indonesia is upgrading its grid under the Smart Grid Development Policy, the JETP, the National Energy Policy, and RUPTL. These programmes aim to enhance reliability, integrate renewables, and improve efficiency. The Smart Grid Development Policy focuses on digitalisation and automation; the JETP, backed by US$20 billion, targets 14,000 km of new transmission; RUPTL plans over 47,000 km of transmission and distribution lines by 2030.
Japan	Yes	Mature	Japan has deployed 80 million smart meters (2014–2024), upgraded advanced metering infrastructure, and expanded DERs and VPPs, and standardised load dispatch systems with Hitachi's support. Key initiatives include the Digital Grid Scheme, which segments the grid into digitally controlled cells, and high-voltage direct current transmission expansion between Hokkaido, Tohoku, and Tokyo, and between Kyushu and Chugoku. Japan is also adopting decentralised systems such as microgrids to enhance resilience, and has developed the Cyber-Physical Security Framework to address cyber risks in distributed energy systems.
Lao PDR	Yes	Early stage	The National PDP 2021–2030 includes substation upgrades, new transmission lines, and advanced monitoring systems. Priorities include renewable integration, smart grid development, and cross-border interconnection. The Lao PDR–China 500 kV Power Link (completion target: 2026) will enable two-way electricity exchange, delivering 3 billion kilowatt-hours of clean electricity annually.
Malaysia	Yes	Early stage	Tenaga Nasional Berhad is investing US$10.3 billion (2025–2027) to modernise the national grid, integrating renewables, meeting growth demand, and enhancing resilience. The smart grid strategy includes real-time data systems, advanced analytics, decentralised energy integration, renewable adoption, cybersecurity, and customer engagement.
Philippines	Yes	Early stage	Department Circular No. DC2020-02-0003 established the National Smart Grid Policy Framework and Roadmap to 2040, integrating on-grid, microgrid, and off-grid systems. The National Grid Corporation of the Philippines is pursuing the 2024–2050 Transmission Development Plan and the Grid Modernization for a Just Energy Transition, aiming for 35% renewables by 2030 and 50% by 2040, supported by a US$800 million World Bank loan. The Smart and Green Grid Plan will expand capacity for renewables, and a US$15 billion collaboration with Masdar will add 1 gigawatt of renewables by 2030.

Country	Status		Status and Details
	Plan Status	Readiness	
Singapore	Yes	Early stage	The Future Grid Capabilities Roadmap aims to integrate DERs with digital solutions such as a grid digital twin and a DER management system. The 200 MWh energy storage systems target for 2025 was achieved in 2022. The Energy Market Authority is piloting VPPs to aggregate and optimise DERs, with a strong focus on advanced analytics for planning and operations.
Thailand	Yes	Early stage	The 20-year Smart Grid Master Plan (2015–2036) focuses on security, efficiency, and sustainability. EGAT, Metropolitan Electricity Authority and Provincial Electricity Authority are implementing projects in renewable forecasting, smart metering, and demand response. Recent initiatives include a US$1.8 billion agreement with Gorilla Technology for energy digitisation and EGAT–INNOPOWER collaboration on renewable energy integration. The Smart Grid Policy Plan promotes both smart grids and microgrids for greater resilience.
Viet Nam	Yes	Early stage	Viet Nam's 20-year Smart Grid Roadmap prioritises advanced distribution management systems, smart metering, and demand response. The PDP8 includes major investment in grid capacity and storage to support renewable growth, improve reliability, and reduce congestion, helping the country achieve net zero by 2050.

DER = distributed energy resource, EGAT = Electricity Generating Authority of Thailand, JETP = Just Energy Transition Partnership, kV = kilovolt, Lao PDR = Lao People's Democratic Republic, MWh = megawatt-hour, PDP = Power Development Plan, RtN = Rewiring the Nation, RUPTL = Ten-Year Business Plan for Power Projects, VPP = virtual power plant,

Sources: Government of Australia, Department of Climate Change, Energy, the Environment and Water; Australian Renewable Energy Agency; French Development Agency; Asia Pacific Energy Portal; Just Energy Transition Partnership (Indonesia); Tenaga Nasional Berhad (Malaysia); National Grid Corporation of the Philippines; Energy Market Authority of Singapore; Electricity Generating Authority of Thailand; World Bank Group.

3.5.2 Regional interconnection

In ASEAN, the development of cross-border grid connections is essential to strengthening regional energy security and enabling the optimal and efficient use of renewable energy resources, given the differing renewable energy potentials of individual countries.

- The Lao PDR–Thailand–Malaysia–Singapore Power Integration Project (LTMS-PIP) is the first multilateral power trade pilot under the APG framework and has been designated a 'pathfinder' project. It demonstrates the technical and institutional feasibility of cross-border electricity trading amongst multiple ASEAN countries.
- The success of LTMS-PIP supports the APG's long-term goal of developing a regional power market and encourages regulatory alignment and market readiness across the region. LTMS-PIP's contributions to the APG include the following:
  1) Validating technological feasibility.
  2) Establishing cross-border transmission policy standards (e.g. pricing schemes).
  3) Serving as the foundation of the 'Southern sub-system' in the APG.

Table 3-10: Lao PDR–Thailand–Malaysia–Singapore Power Integration Project

Connection	Country	Project Overview	Status	Capacity
Nong Khai (TH)–Dongphosy (LA)	Lao PDR–Thailand	As of 2024, there are about 5,934.9 MW of existing generation-to-grid interconnections and 700 MW of grid-to-grid interconnections (maximum transfer capacity under N-1 conditions) between Thailand and Lao PDR. Several of these interconnections form part of the LTMS-PIP.	In operation	100 MW
Nong Khai (TH)–Thanaleng (LA)				100 MW
Bueng Kan (TH)–Pakxan (LA)				100 MW
Nakhon Phanom (TH)–Thakhek (LA)				180 MW
Mudhakan 2 (TH)–Pakbo (LA)				100 MW
Sirindhom 2 (TH)–Bangyo (LA)				275 MW
Tha Li (TH)–Ken Thao (LA)				100 MW
Sadao (TH)–Chuping (MY)	Malaysia–Thailand	The Thailand–Peninsular Malaysia interconnection has been operational since June 2002. This 300 MW high-voltage direct current connection spans about 110 kilometres, from Khlong Ngae, Thailand, to Gurun East, Malaysia. It supports energy exchange under LTM-PIP Phases 1 and 2, as well as LTMS-PIP, with total transfers of around 266 GWh as of June 2024.	In operation	82 MW
Khlong Ngae (TH)–Gurun (MY)				300 MW

Connection	Country	Project Overview	Status	Capacity
Plentong (MY)–Woodlands (SG)	Malaysia–Singapore	The Peninsular Malaysia–Singapore interconnection, operational since 1985, is a crucial grid-to-grid connection that has enabled over 266 GWh of electricity trade under LTMS-PIP. Phase II discussions are ongoing amongst member countries, with potential plans to increase trading capacity.	In operation	525 MW

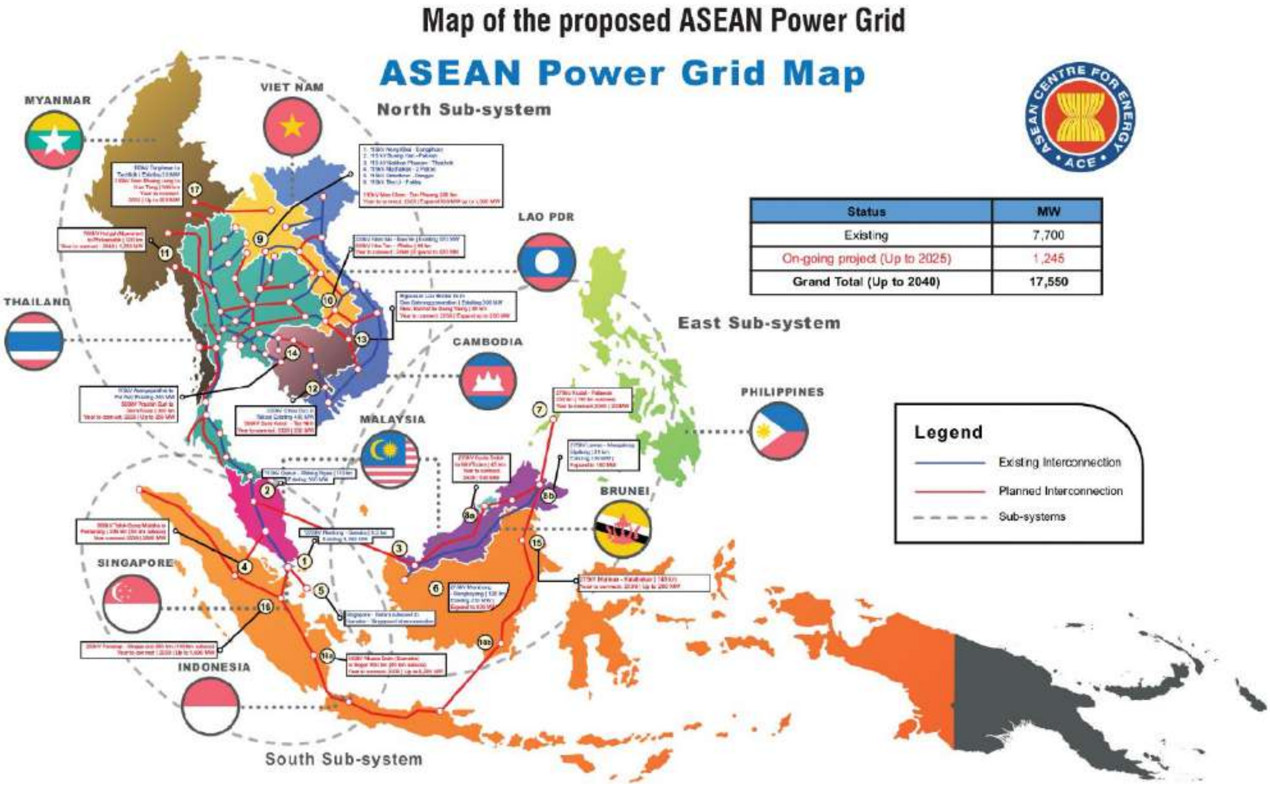
GWh = gigawatt-hour, LA = Lao People's Democratic Republic, LTMS-PIP = Lao PDR–Thailand–Malaysia–Singapore Power Integration Project, MY = Malaysia, SG = Singapore, TH = Thailand,

Source: ASEAN Centre for Energy.

- The APG is a flagship initiative under the ASEAN Plan of Action for Energy Cooperation. It aims to enhance energy security, sustainability, and connectivity in Southeast Asia through the integration of national power systems into a regional grid.

- The objectives of the APG include the following:
  1) Promoting cross-border electricity trade to optimise the use of diverse energy resources across ASEAN.
  2) Enhancing grid resilience and regional energy security.
  3) Facilitating the integration of renewable energy through greater system flexibility.
  4) Supporting decarbonisation efforts in line with regional and global climate goals.

Figure 3-12: ASEAN Power Grid



Source: ASEAN Centre for Energy (2024).

Table 3-11: ASEAN Power Grid Vision Details

	Connection	Country	Project Overview	Status	Progress	Interconnection Capacity in 2040 [MW] (AIMS III Projection)
1	Peninsular Malaysia–Singapore	Malaysia, Singapore	Transmission project connecting Peninsular Malaysia and Singapore for cross-border electricity trade. As part of LTMS-PIP, it aims to expand the adoption of renewable energy.	Operating	Operational since 1985. Capacity expansion is under consideration, but no feasibility study has been conducted, and no specific plans have been finalised.	1,050

	Connection	Country	Project Overview	Status	Progress	Interconnection Capacity in 2040 [MW] (AIMS III Projection)
2	Thailand–Peninsular Malaysia	Thailand, Malaysia	Interconnection between Thailand and Peninsular Malaysia that facilitates electricity trade through LTMS-PIP, with a planned expansion to 1,043 MW.	Operating	Operational since 2002. Ageing converter stations and system expiry necessitate renewal; a feasibility study has been completed and awaits approval.	1,043
3	Sarawak–Peninsular Malaysia (Greenfield)	Malaysia	1,600 MW HVDC subsea cable connecting Sarawak to Peninsular Malaysia.	Planned	Initially planned before AIMS III, but construction has not yet begun.	695
4	Peninsular Malaysia–Sumatra (Greenfield)	Malaysia, Indonesia	A 500 kV transmission system connecting Peninsular Malaysia and Sumatra via overhead and subsea cables.	Feasibility study ongoing	Supported by USTDA grants; technical, economic, and environmental assessments are in progress.	2,130
5	Batam–Singapore (Greenfield)	Indonesia, Singapore	-	-	-	-
6	Sarawak–West Kalimantan	Malaysia, Indonesia	275 kV HVAC transmission line enabling electricity exports from Sarawak to West Kalimantan.	Operating	Operational since 2015. AIMS III proposes expansion to 830 MW, but no specific expansion plans yet exist.	777

	Connection	Country	Project Overview	Status	Progress	Interconnection Capacity in 2040 [MW] (AIMS III Projection)
7	Philippines–Sabah (Greenfield)	Philippines, Malaysia	HVDC subsea cable connecting the Philippines and Malaysia, integrated with the Kalimantan–Sabah interconnection.	Planned	Part of Brunei Darussalam–Indonesia–Malaysia–Philippines Power Integration Project, expected to be operational by 2040 under AIM III.	196
8	Sarawak–Brunei–Sabah	Malaysia, Brunei				
a)	Sarawak–Brunei		Planned 275 kV HVAC transmission line (45 km).	Feasibility Study Ongoing	Feasibility study currently in progress.	To be confirmed
b)	Sarawak–Sabah]		Project to export 30 MW from Sarawak to Sabah.	Construction ongoing	Originally planned for late 2023; operation postponed to late 2024.	177
9	Thailand–Lao PDR	Thailand, Lao PDR	Expansion of six existing interconnections (5,934.9 MW generation and 700 MW grid capacity) with a new transmission line between Mae Chan and Ton Pheung.	Operating	Existing interconnections operational; further expansion planned.	700
10	Lao PDR–Viet Nam (Greenfield)	Lao PDR, Viet Nam	Transmission project for electricity exports from Lao PDR to Viet Nam.	Planned	Planning stage; feasibility study not conducted.	625
11	Thailand–Myanmar (Greenfield)	Thailand, Myanmar	230 kV HVAC transmission line from Mae Sot (Thailand) to Myawaddy (Myanmar).	Planned	Preliminary technical assessment completed; full feasibility study required.	1,262

	Connection	Country	Project Overview	Status	Progress	Interconnection Capacity in 2040 [MW] (AIMS III Projection)
12	Viet Nam–Cambodia	Viet Nam, Cambodia	220 kV HVAC transmission line from Chau Doc (Viet Nam) to Takeo (Cambodia).	Operating	Operational since 2009, transmitting over 10,000 GWh in a decade. Additional interconnections under consideration.	1,353
13	Lao PDR–Cambodia	Lao PDR, Cambodia	HVAC transmission line from Ban Hat (Lao PDR) to Stung Treng (Cambodia).	Operating	Operational since 2019, with future expansions planned.	625
14	Thailand–Cambodia	Thailand, Cambodia	650 MW transmission line from Wattana Nakhon (Thailand) to Battambang (Cambodia).	Operating	Operational since 2007 with a 115 kV line. Expansion to 500 kV under review.	1,315
15	East Sabah–North Kalimantan (Greenfield)	Malaysia, Indonesia	Transmission project to strengthen East Borneo's electricity supply and facilitate Malaysia–Indonesia electricity trade.	Feasibility study ongoing	Supported by USTDA; feasibility study in progress.	174
16	Singapore–Sumatera (Greenfield)	Singapore, Indonesia	100 km HVDC subsea cable supplying up to 1,600 MW from Sumatra to Singapore.	Planned	Target operational date: 2030, with expected capacity of 1,600 MW.	1,133
17	Lao PDR–Myanmar	Lao PDR, Myanmar	Transmission project for electricity exports from Lao PDR to Myanmar, with eventual expansion to 600 MW.	Operating	Operational since 2022 (30 MW). A 230 kV expansion is planned for operation by 2027.	624

	Connection	Country	Project Overview	Status	Progress	Interconnection Capacity in 2040 [MW] (AIMS III Projection)
18	Internal Indonesia (Kalimantan–Java, Sumatera–Java)	Indonesia				10,435
a)	Kalimantan–Java		Transmission project to support Java's electricity demand by connecting it with Kalimantan.	Planned	Planning phase; feasibility study not yet conducted.	435
b)	Sumatra–Java		500 kV HVDC transmission line connecting Sumatra and Java, targeting 2,600 MW capacity.	Pending construction	Feasibility study completed; construction pending due to funding and technical challenges. Target operational date: 2031.	10,000

AIMS = ASEAN Interconnection Masterplan Study, ASEAN = Association of Southeast Asian Nations, HVDC = high-voltage direct current, kV = kilovolt, Lao PDR = Lao People's Democratic Republic, LTMS-PIP = Lao PDR–Thailand–Malaysia–Singapore Power Integration Project, MW = megawatt, USTDA = United States Trade and Development Agency

Source: ASEAN Centre for Energy.

Box 3-4

Policy Implications Drawn from Research on Power Grid by ERIA

With rising electricity demand and increasing generation capacity across the ASEAN region, comprehensive policies are needed to enhance grid capacity, flexibility, and resilience. Key measures include modernising and reinforcing power grids to facilitate the integration of renewable energy, as well as advancing cross-border interconnection initiatives to strengthen regional energy security.

ERIA has conducted extensive research on this topic. This section presents several key perspectives as an introduction.

Grid modernisation. As the share of variable energy sources (e.g. solar and wind) increases alongside stable demand, policies that support grid modernisation are essential.

- Provide clear government guidance and support measures to facilitate renewable energy integration into the grid whilst ensuring reliability.
- Improve grid flexibility by expanding the integration of distributed energy resources (DERs) and promoting new business models such as energy resource aggregation businesses (ERABs).
- Integrate cybersecurity standards and guidelines into national energy policies, with a specific focus on DERs and ERABs. Reference may be drawn from Japan's Ministry of Economy, Trade and Industry Cyber-Physical Security Framework.
- Safeguard the resilience and stability of the power grid by clarifying the regulatory status of grid-scale storage batteries within electricity sector legislation. Accelerate the effective deployment of energy storage technologies and support cost reductions through the promotion of technological innovation and efficiency improvements.

Grid reinforcement. With demand and generation capacity projected to increase, it is essential to expand and reinforce grid capacity.

- Prioritise investments in power grid infrastructure to ensure adequate capacity and robustness, addressing both rising demand and the electricity needs of rural and island areas.
- Establish effective mechanisms to ensure adequate capacity, system flexibility, and stability.

Regional interconnections. The development of international transmission networks remains in progress and requires further advancement.

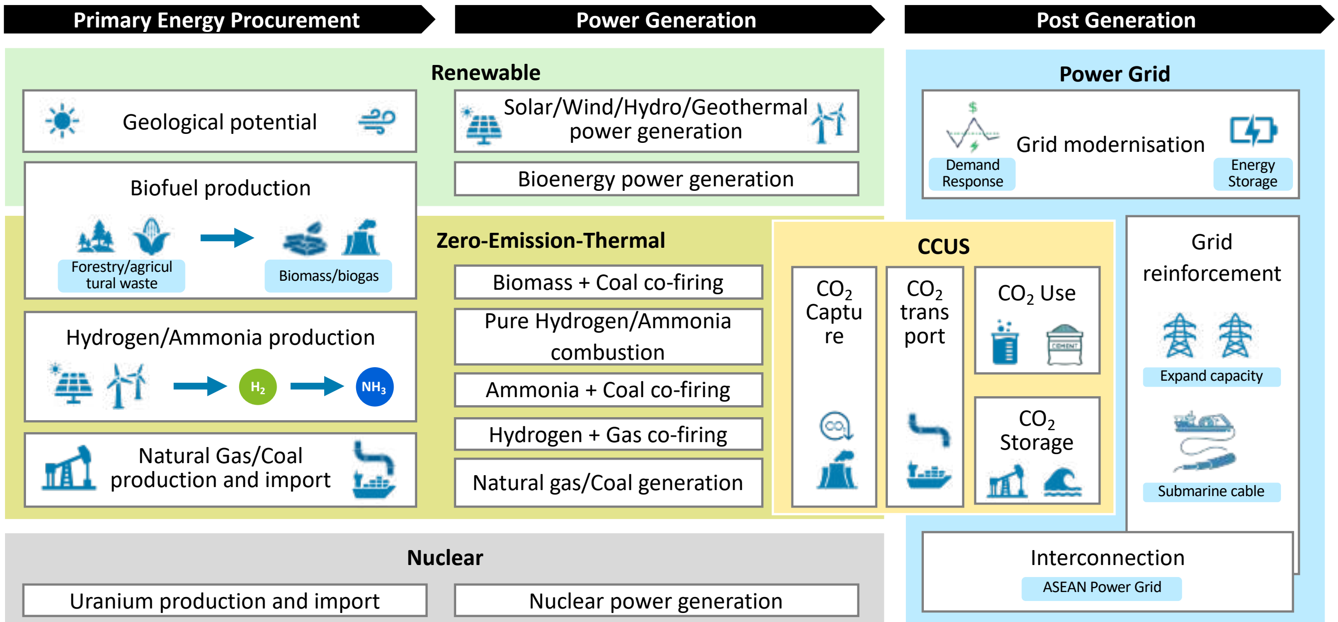
- Conclude multilateral agreements for the ASEAN Power Grid (APG) or subregional interconnection initiatives to ensure the smooth execution of APG projects and the formation of multilateral cross-border power markets.
- Harmonise the development of the regional power market by defining the operational and planning responsibilities of the ASEAN Transmission System Operator and the APG Generation and Transmission System. This will ensure seamless cross-border interoperability and operational efficiency. Strengthening APG institutional frameworks is a fundamental approach to accelerating investment in APG infrastructure and enabling multilateral power trading flows.

Source: Author.

3.6 Progress of Individual Projects

In the power sector, many projects are ongoing across the value chain in renewable energy, zero-emission thermal, CCUS, nuclear power, and power grid development.

Figure 3-13: Overview of Power Sector Project Coverage



ASEAN = Association of Southeast Asian Nations, CO2 = carbon dioxide, H2 = hydrogen, NH3 = ammonia.
Source: Author (2025).

Renewables

Amongst the various ongoing projects in AZEC partner countries, the following examples highlight key developments in renewable energy:

- A geothermal power plant expansion and study in Indonesia.
- Offshore wind power plant development in Viet Nam.
- Biomass production and waste power plant development in Cambodia, Indonesia, and Viet Nam.
- Hydropower plant development in Indonesia, and hybrid-purpose dam projects led by Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in Japan and the Philippines.

Feasibility study of biomass fuel and power generation

- **Country**. Cambodia
- **Business entities and partners.** erex Co., Ltd., SPHP (Cambodia) Co., Ltd., Ministry of Mines and Energy
- **Project overview.** MoU amongst erex Co., Ltd., SPHP (Cambodia) Co., Ltd. and the Ministry of Mines and Energy of the Kingdom of Cambodia on a biomass project
- **Project scale**. N/A
- Production scale. 50 MW
- **Progress overview.** The project, covering biomass fuel development and biomass-based power generation, forms part of the MoU between the above parties. In 2024, the Cambodian Ministerial Council approved the investment, and the feasibility study has since been completed.

Decarbonisation through biofuel production at West Kalimantan

- **Country**. Indonesia
- **Business entities and partners**. PT. Santomo Resources Indonesia, PT. Santomo Biomass Indonesia, PT. ATP Bio Indonesia
- **Project overview**. A bio-cokes production project in West Kalimantan, led by PT. ATP Bio with support from PT. Santomo Biomass and PT. Santomo Resources, targeting a maximum output of 90,000 million tonnes per year by October 2025
- **Project scale:** US$71 million
- **Production scale:** Maximum output of 90,000 million tonnes per year
- **Progress overview**: The MoU covers bio-coke production, with PT. Santomo Biomass and PT. Santomo Resources supplying palm kernel shells (PKS), gas, and other fuels to PT. ATP Bio for biofuel processing in West Kalimantan by October 2025. Planned capacity is 90,000 million tonnes per year, with further expansion targeted by 2030. Plans include LNG purchase and sale agreements and PKS supply agreements.

Expansion of Sarulla 2 (Sibual-buali) geothermal plant project

- **Country**. Indonesia
- **Business entities and partners.** ITOCHU Corporation, Kyushu Electric Power Co., Inc., INPEX Corp., PT. Medco Power Indonesia, PT. Ormat Geothermal Indonesia
- **Project overview**. Expansion of Sarulla 2 (Sibual-buali) geothermal plant to strengthen the financial and operational position of the existing facility.
- **Project scale.** N/A
- **Production scale.** 50 MW (Phase 1), 120 MW (Phase 2), 110 MW (Phase 3)
- **Progress overview.** ITOCHU, Kyushu, INPEX, Medco, and ORMAT are engaged in detailed discussions to advance the development and implementation of the Sarulla 2 (Sibual-buali) expansion. This follows an assessment of initiatives such as the output recovery plan and tariff optimisation, aimed at improving the financial viability of the existing Sarulla geothermal project.

Joint research on the full development potential of geothermal energy

- **Country.** Indonesia
- **Business entities and partners.** Toyo Engineering Corp. (TOYO), PT. Medco Power Indonesia
- **Project overview.** MoU between PT. Medco Power Indonesia and TOYO Engineering Corp. jointly explore the full development potential of geothermal energy
- **Project scale.** N/A
- **Production scale.** N/A
- **Progress overview.** Recognising geothermal energy's potential for green fuel production, PT. Medco Power Indonesia and TOYO Engineering Corp. have agreed to collaborate on research into its full exploitation. Current efforts are focused on preparing a study plan to explore and utilise this resource.

Large-scale geothermal utilisation study

- **Country.** Indonesia
- **Business entities and partners.** Toyo Engineering Corp. (TOYO), PT. Geo Dipa Energi (GDE)
- **Project overview.** PT. Geo Dipa Energi and Toyo Engineering Corp. have signed an MoU to collaborate on a comprehensive study for large-scale geothermal utilisation.
- **Project scale.** N/A
- **Production scale.** N/A
- **Progress overview.** TOYO and GDE are jointly researching the potential of geothermal energy, including closed-loop geothermal technology and mineral extraction from geothermal brine. The project aims to contribute to a sustainable society and support economic development through practical implementation.

Legok Nangka waste-to-energy power plant

- **Country.** Indonesia
- **Business entities and partners.** Sumitomo Corp., Kyuden International Corp., Kanadevia Corp., PT. Energia Prima Nusantara
- **Project overview.** Development of a waste-to-energy power plant to produce electricity from waste heat for PLN
- **Project scale**. US$400 million
- **Production scale.** Waste processing capacity of 1,853~2,131 tonnes per day; power plant capacity of 40 MW
- **Progress overview.** The project will process municipal waste through incineration whilst utilising waste heat energy for power generation, with electricity sold to PLN. It is being implemented as a build–own–operate–transfer scheme in two phases: (1) a waste management project contracted by the West Java provincial government, involving municipal solid waste processing; and (2) electricity sales to PLN. The project is at the stage of finalising agreements between the provincial government and Indonesia Infrastructure Guarantee Fund, expected by June 2025. These agreements include a cooperation agreement, a PPA, and a guarantee agreement.

Muara Laboh geothermal power expansion project

- **Country.** Indonesia
- **Business entities and partners.** PT. Supreme Energy Muara Laboh (SEML).
- **Shareholders.** Sumitomo Corp., INPEX Corp., PT. Supreme Energy, PT. Supreme Energy
- **Project overview.** Expansion of the geothermal power plant with the construction of Unit 2, aimed at generating electricity for almost 1 million households
- **Project scale.** US$494 million
- **Production scale.** 85 MW
- **Progress overview.** The expansion involves constructing Unit 2, matching the 85 MW capacity of Unit 1, which began commercial operations in 2019 in West Sumatra. Construction began in April 2025, with commercial operations scheduled for October 2027. Once operational, electricity will be supplied to PLN under a 25-year agreement, extending until 2052. Combined, Units 1 and 2 are expected to meet the electricity needs of approximately 900,000 households. Project financing will be provided by the Japan Bank for International Cooperation.

Tongar hydropower plant development

- **Country.** Indonesia
- **Business entities and partners.** NiX JAPAN Co., Ltd., PT. PLN (Persero)
- **Project overview.** Commercial operation contract signed with PT. PLN for the development of the Tongar hydropower plant
- **Project scale.** About US$14 million
- **Production scale.** Annual power generation of 38.7 GWh; estimated GHG emission reductions of 18,474 tCO2/year
- **Progress overview.** NiX JAPAN has signed an agreement with PLN to develop hydropower plants in multiple regions, including West Pasaman, West Sumatra. Electricity generated will be sold to PT. PLN under a 25-year contract. Commercial operations began in 2023, and the project has already exceeded its power generation target by 104% of planned output.

Promotion of hybrid dams combining flood risk reduction with hydropower generation

- **Country.** Japan
- **Business entities and partners.** MLIT, METI
- **Project overview.** Japan is promoting hybrid dams designed to combine flood risk reduction with hydropower generation, thereby enhancing overall dam functionality.
- **Project scale.** N/A
- **Production scale.** N/A
- **Progress overview.** At a disaster

management seminar held in the Philippines in February 2025, Japan presented its hybrid dam initiative, showcasing examples of smart reservoir water-level operation based on accurate weather forecasts during typhoons. This approach can increase both flood storage capacity and hydroelectric generation, offering the dual benefits of climate change adaptation and mitigation.

Development of a nearshore wind power project in Tra Vinh Province

- **Country.** Viet Nam
- **Business entities and partners.** Tokyo Gas Co., Ltd., Truong Thanh Viet Nam Group (TTVN), Truong Thanh Energy (TTP)
- **Project overview.** MoU between TTVN, TTP, and Tokyo Gas to develop a nearshore wind power project in Tra Vinh Province.
- **Project scale.** N/A
- **Production scale.** 48 MW
- **Progress overview.** The project involves the construction of a nearshore wind power facility in Tra Vinh Province with a total capacity of 48 MW. It is registered under Viet Nam's Power Development Plan 8 and is in the investor selection phase.

Development of offshore wind power projects in Tra Vinh Province

- **Country.** Viet Nam
- **Business entities and partners.** Kumagai Gumi Co., Ltd., The Kansai Electric Power Co., Inc., INPEX Corp., Truong Thanh Viet Nam Group JSC (TTVN), Refrigeration Electrical Engineering Corp. (REE)
- **Project overview.** Development of an offshore wind farm in Tra Vinh Province. Project scale. N/A
- **Production scale.** Planned capacity adjusted from 2 GW to 1,800 MW
- **Progress overview.** TTVN and a consortium of Japanese companies led by Kumagai Gumi, including INPEX and Kansai Electric Power, later joined by REE, signed an MoU to develop an offshore wind power project with an expected total capacity of 1,800 MW in the waters off Tra Vinh Province. The project has gained support from the provincial government and was proposed for inclusion in the PDP8 Implementation Plan in December 2024.

Production of biomass fuel from unused agricultural material

- **Country.** Viet Nam
- **Business entities and partners.** erex Co., Ltd., Tuyen Quang Province, and Yen Bai Province
- **Project overview.** MoU to develop biomass fuel from unused agricultural and forestry resources in Tuyen Quang and Yen Bai provinces
- **Project scale.** N/A
- **Production scale.** N/A
- **Progress overview.** To utilise unused resources from agriculture and forestry, Tuyen Quang and Yen Bai provinces, in partnership with erex, have signed an MoU on biomass fuel production. Construction of the wood pellet plant has been completed, and production of wood pellets, certified by the Forest Stewardship Council, has commenced. The provincial government is exploring sales opportunities for the pellets.

Zero-emission thermal

Key ongoing zero-emission thermal projects in AZEC partner countries are highlighted below:

- Production of renewable natural gas from palm oil mills in Indonesia.
- Installation of an ammonia-fired power plant in Malaysia and a study on the ammonia supply chain in Indonesia.

Green ammonia firing study at Labuan Power Station

- **Country.** Indonesia
- **Business entities and partners.** IHI Corp., PT.

PLN Indonesia Power, PT. Pupuk Kujang
- **Project overview.** A study on green ammonia firing at the Labuan Power Station
- **Project scale.** N/A
- **Production scale.** N/A
- **Progress overview.** This project examines the entire ammonia value chain, from supply and combustion of green ammonia to demonstration at the Labuan coal-fired power plant. PT. PLN Indonesia Power will provide site access, whilst IHI Corp. will lead the study. Following the completion of the MoU phase, the project carried out and completed its ammonia firing demonstration in February 2025.

Production of renewable natural gas (RNG) from palm oil mills for integration into the natural gas pipeline
- **Country.** Indonesia
- **Business entities and partners.** PT. Toyota Tsusho Indonesia, PT. Perusahaan Gas Negara Tbk
- **Project overview.** Development of RNG supply derived from palm oil mill effluent (POME) as a green alternative to conventional natural gas
- **Project scale.** US$6 million–US$8 million per RNG plant (with an estimated total of about 15 plants)
- **Production scale.** 1.6 million British thermal units per year
- **Progress overview.** The project involves producing RNG from POME and transporting it via the existing West Java natural gas pipeline to end users. The aim is to reduce GHG emissions and contribute to carbon neutrality targets. As of March 2025, the MoU has been signed, and the project is preparing to enter its next phase. Commercial operations are expected to start in 2027.

Installation of an ammonia-fired gas turbine to power an ammonia production plant
- **Country.** Malaysia
- **Business entities and partners.** IHI Corp., Gentari Hydrogen Sdn. Bhd.
- **Project overview.** Installation of a 100% ammonia-fired gas turbine to generate electricity for an ammonia production plant
- **Project scale.** N/A
- **Production scale.** N/A
- **Progress overview.** IHI Corp. and Gentari Hydrogen (a subsidiary of PETRONAS) will install a 100% ammonia-fired gas turbine (model IM270) at PETRONAS's ammonia production plant in Malaysia. This will be the world's first commercial project to generate electricity entirely from ammonia fuel and use it to power ammonia production.

Carbon capture, utilisation, and storage

The following are some key ongoing CCUS initiatives in AZEC partner countries:
- Feasibility study for CO_2 capture and transport between Japan and Australia.
- Pilot plant for Toshiba Energy Systems & Solutions Corp. (TESS) technology in Malaysia and feasibility study of CCS in Indonesia.

Setouchi and Shikoku CO_2 hub concept
- **Countries.** Japan, Australia
- **Business entities and partners.** Sumitomo Corp., JFE Steel Corp., Sumitomo Osaka Cement Co., Ltd., Kawasaki Kisen Kaisha, Ltd., Woodside Energy, Ltd.
- **Project overview**. Japanese companies are jointly conducting a feasibility study to capture CO_2 and transport it to Australia for permanent storage.
- **Project scale.** N/A
- **Production scale.** N/A

- **Progress overview.** Sumitomo Corp., JFE Steel Corp., Sumitomo Osaka Cement, Kawasaki Kisen Kaisha, Ltd., and Woodside Energy Ltd. are collaborating on a CCS feasibility study to capture CO_2 emissions from Setouchi and Shikoku and transport them to Australia for permanent storage. The plan involves temporarily capturing and storing CO_2 at a hub port in Japan before shipping it overseas. The initiative aims to scale up operations, reduce costs, and develop a CCS value chain that would be challenging for individual companies to establish alone. The project is assessing the cost of each stage in the CCS value chain.

Bioenergy with carbon capture and storage at Limau Niru oil field

- **Country.** Indonesia
- **Business entities and partners.** Marubeni Corp., Japan Petroleum Exploration Co., Ltd., PT. Pertamina (Persero), PT. Pertamina Hulu Energi
- **Project overview.** Feasibility study on capturing CO_2 from a bioenergy source and injecting it into an oil field storage site.
- **Project scale.** N/A
- **Production scale.** 300,000 tonnes per year of CO_2 in Phase1, expanding to 1,000,000 tonnes per year in the next phase
- **Progress overview.** The project aims to capture CO_2 generated from bioenergy at a Marubeni-operated pulp mill, transport it, and store it in deep saline aquifers near the Limau Niru oil field. The feasibility study is ongoing and is expected to be completed by mid-2026. Commercial operations, including the first CO_2 injection, are expected to commence in 2030.

TNB Genco's CCUS study with TESS technology for the pilot plant

- **Country.** Malaysia
- **Business entities and partners.** TESS, TNB Power Generation Sdn. Bhd., TNB Research
- **Project overview.** TNB Genco has signed an MoU with TESS to provide CCUS technology for a pilot plant facility.
- **Project scale.** N/A
- **Production scale.** 5 tonnes per year
- **Progress overview.** In line with Malaysia's target of achieving net zero by 2050, TNB Genco has conducted a research study on the CCUS value chain and selected TESS as its technology partner for the pilot plant facility. TESS has provided training to TNB Genco personnel. The project is scheduled to run from 2025 to 2027.

Power grids

Key ongoing power grid projects in AZEC partner countries are highlighted below:

Tasmania's transmission infrastructure development

- **Country.** Australia
- **Business entities and partners.** Hitachi Energy, Marinus Link Pty, Ltd.
- **Project overview.** Development of transmission infrastructure between Tasmania and mainland Australia to reduce CO_2 emissions
- **Project scale.** N/A
- **Production scale.** 750 MW
- **Progress overview.** The project aims to transmit clean renewable energy between mainland Australia and Tasmania, which has abundant hydro and wind resources. Hitachi Energy has been selected to supply

high-voltage direct current technology for Marinus Link Pty, Ltd., an electricity and telecommunications interconnector between Tasmania and Victoria. The transmission infrastructure will be commissioned in stages, with the first 750 MW phase targeted for early 2030. Once completed, it is expected to power 1.5 million homes and reduce up to 140 million tonnes of CO_2 emissions by 2050.

Feasibility study on the development of inter-island transmission lines

- **Country.** Indonesia
- **Business entities and partners.** Kansai Electric Power Co., Inc., Kansai Transmission and Distribution, Inc., PLN Survey and Testing Center of Electricity, New Energy, Renewable and Energy Conservation
- **Project overview.** Feasibility study for building inter-island transmission lines to facilitate the use of renewable energy
- **Project scale.** N/A
- **Production scale.** N/A
- **Progress overview:** To achieve carbon neutrality by 2060, Indonesia is conducting a feasibility study to develop inter-island transmission lines to address the uneven distribution of renewable power generation. The country is exploring various business schemes, including private sector investment, to promote infrastructure development. The study aims to assess the project's technical and commercial viability.

AZEC Sustainable Fuel Initiative

04

4 AZEC Sustainable Fuel Initiative

4.1 Overall

Decarbonising transport is essential, through not only electrification but also the pursuit of pathways that incorporate alternative fuels. The production of such fuels presents significant business opportunities for ASEAN countries.

AZEC Sectoral Initiatives towards carbon neutrality/net-zero emissions--AZEC Initiative to create Sustainable Fuel (AZEC Sustainable Fuel Initiative)

Purpose

With the expected increase in passenger vehicles, road fleets, aviation and shipping in AZEC partner countries, decarbonising the transport sector is essential to the global effort to transition away from fossil fuels. Given that large portion of vehicle stock, as well as almost all of aviation and shipping run by oil, supplying sustainable fuels, including biofuels, Sustainable Aviation Fuel (SAF) and e-fuels (synthetic fuels) is considered as one of the practical options to steadily reduce emissions. For example, in the international aviation sector, competition to secure SAF and its feedstock is intensifying to achieve the long term global aspirational goal (LTAG) adopted by the International Civil Aviation Organization (ICAO) Assembly to achieve net zero carbon emissions by 2050. This initiative aims to support AZEC partner countries to secure sustainable fuels using biomass and other resources in Asia, with a view to developing a sustainable fuel s supply chain centred on Asia in the future.

Possible areas of cooperation

- To conduct feasibility studies on sustainable fuels for transportation, including aviation, road transport, heavy duty, shipping, and the maritime sectors, such as expanding the use of SAF in the aviation sector, biofuels including biodiesel and bioethanol, and hydrogen and ammonia in more modes of transportation, and to formulate a roadmap of sustainable fuel demand and supply in Asia, based on the sectoral feasibility studies.
- To promote projects, such as demonstration projects, to create sustainable fuels markets, including development of supply chains.
- To share best practices on the production, operation, distribution, and retail of sustainable fuels.
- To explore the potential of the combination of sustainable fuels and high-performance mobility equipment such as flexible/dual-fuel and hybrid engines.
- To identify gaps in fuel supply infrastructure such as bunkering facilities and explore solutions.
- To develop infrastructure for sustainable fuels including bunkering for vessels as measures to decarbonise ports under the Carbon Neutral Port framework.

Global trends

The pathway to carbon neutrality in transport requires multiple approaches, including the production and deployment of sustainable fuels.

- Transport is a significant source of GHG emissions, comparable to industry and second only to the power sector, necessitating accelerated decarbonisation efforts. (See 'Climate Trends').
- Electrification is gaining traction as a means of decarbonising road transport, significantly reducing operational GHG emissions.
- However, much of the existing vehicle stock, along with most aircraft and ships, still relies on liquid fuels. Considering national differences and the specific characteristics of each transport mode, alternative fuels that are compatible with current infrastructure present a pragmatic path to decarbonisation.

This chapter outlines pathways for decarbonising transport through sustainable fuels.

- The first section addresses the consumption of alternative fuels in road, aviation, and marine transport.
- The second section discusses the production of sustainable fuels, including biofuels, hydrogen, ammonia, and other options, whilst assessing commercialisation potentials in AZEC partner countries.

Global trends for each topic are summarised below, with market-specific developments in AZEC partner countries detailed in the following sections.

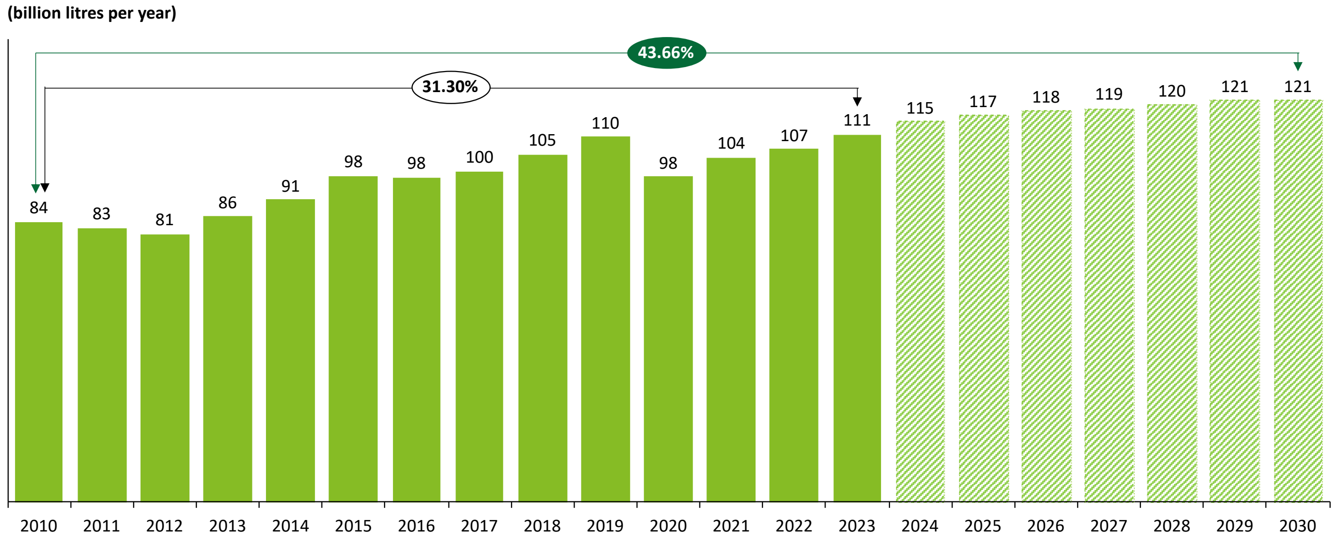
Fuel Consumption

Road transport

Fuel transition is one of the key strategies for decarbonising the road transport sector. Biofuels, in particular, have seen steady growth in global usage.

- Increasing attention is being paid to both powertrain transition and fuel transition.
- Powertrain transition involves shifting to battery-based technologies such as electric vehicles (EVs), hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs), which mainly contribute to decarbonising new vehicle fleets. In contrast, fuel transition, especially through the adoption of low-carbon fuels like biofuels, can be applied to existing internal combustion engine (ICE) vehicles, enabling emission reduction within the current vehicle fleet. Combining high-efficiency technologies (HEVs and PHEVs) with sustainable fuels offers an effective pathway to decarbonisation.
- Despite gains in EV adoption and fuel efficiency, a degree of fuel demand is expected to remain. Decarbonising fuel use, therefore, remains a priority. Biofuels are already commercialised and widely used, bioethanol mainly in passenger vehicles, and biodiesel, including renewable diesel (paraffinic diesel such as hydro-treated vegetable oil), in heavy-duty transport like buses and lorries.
- By 2023, bioethanol consumption had increased by 31.3% relative to 2010, whilst biodiesel consumption had grown by 224.6% (Figure 4-1 and Figure 4-2). According to International Energy Agency (IEA) projections, this trend is expected to continue, with bioethanol forecast to increase by 43.7% and biodiesel by 306.2% compared with 2010 levels by 2030.

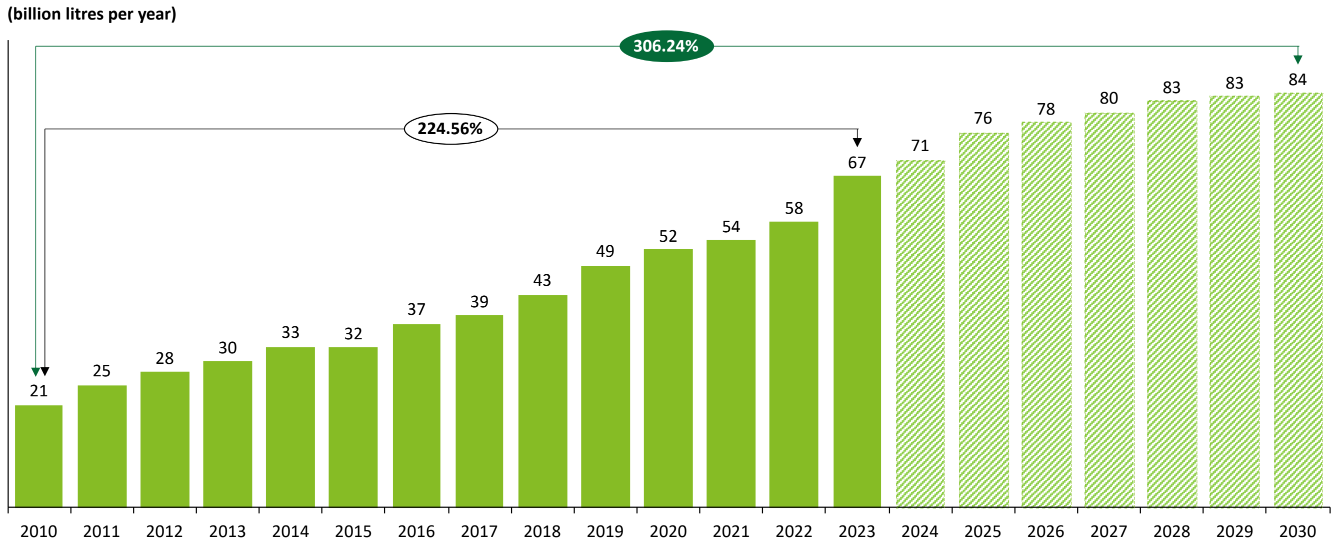
Figure 4-1: Global Bioethanol Consumption in Transport, 2010-2030



Note: The figures for 2024 to 2030 are projections.

Source: International Energy Agency (n.d.)

Figure 4-2: Global Biodiesel Consumption in Transport, 2010–2030



Note: Includes renewable diesel consumption. Figures for 2024 to 2030 are projections.

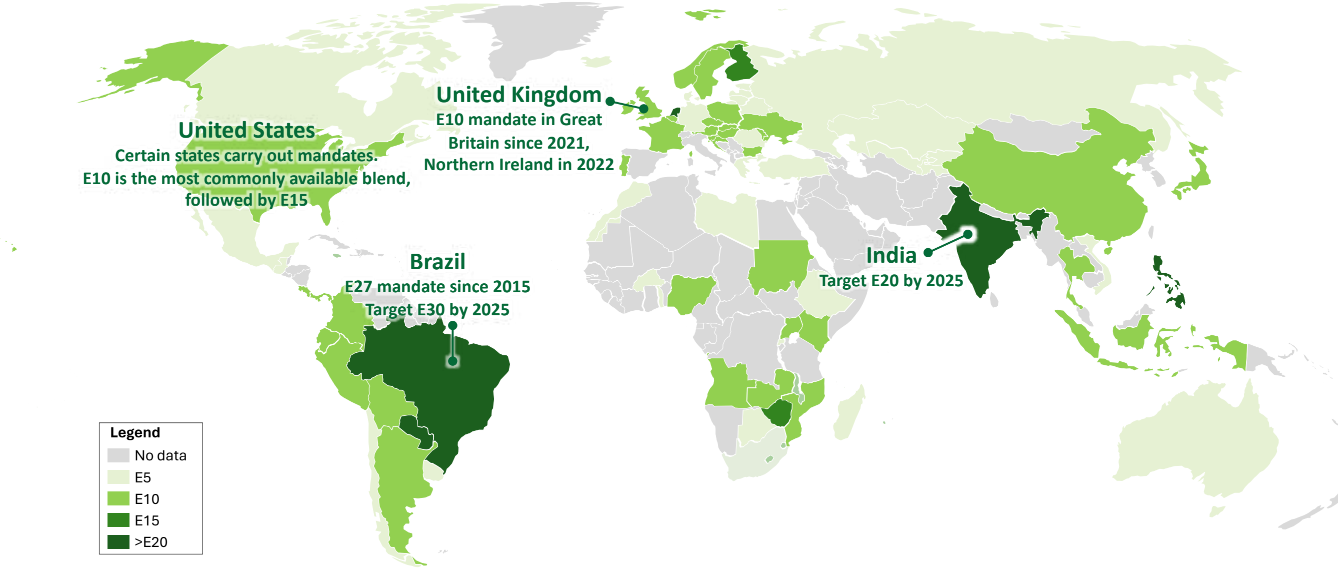
Source: International Energy Agency.

Several countries have introduced blending mandates or set national targets to promote biofuel use.

Bioethanol is widely used in many countries (Figure 4-3). For instance, mandatory bioethanol blending levels include E27 in Brazil, E10 in the United Kingdom, and, in the US,[1] E10 in Minnesota and E2 in Washington. Brazil has already commenced raising its blend to E30 as of August 2025, whilst India is working towards an E20 target.

[1] Volume-based mandate is applicable at the national level in the US.

Figure 4-3: Bioethanol Mandate and Average Content in Petrol



Note: EX is a fuel blend containing X% of ethanol and (100-X) % petrol (e.g. E5 contains 5% ethanol and 95% petrol).
Source: Based on data from the Ministry of Economy, Trade, and Industry, Japan.

- Biodiesel is also subject to blending mandates and national targets in several countries. In Brazil, B14 blending is currently mandated, with B15 scheduled for implementation in 2025. India has set an indicative target to mandate B5 blending by 2030. In the US, biodiesel is included under the volume-based mandate.

Aviation

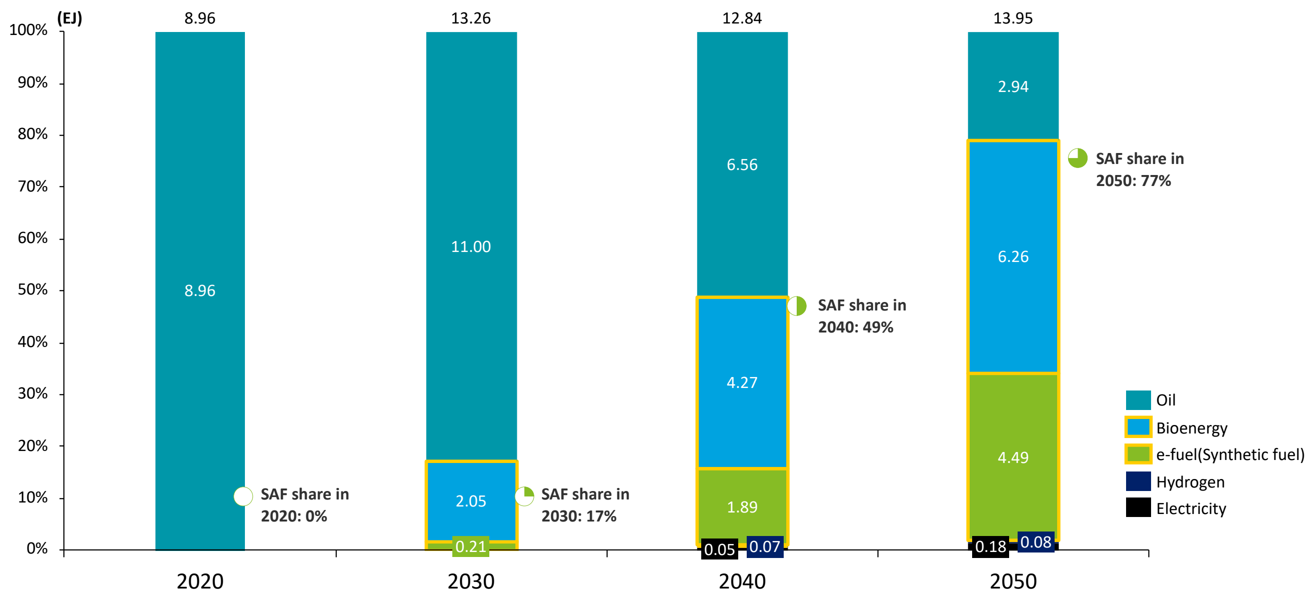
In line with ICAO 2050 net-zero target, airlines and airports worldwide are beginning to adopt SAF in earnest.

- ICAO, the only United Nations (UN) specialised agency responsible for setting international aviation standards and regulations, with over 190 member countries, has set a target for the aviation industry to achieve net-zero emissions by 2050. Starting in 2024, the goal is to limit CO2 emissions to 85% of 2019 levels. At the 2022 ICAO Assembly, specific measures were adopted, including the increased production and usage of SAF.
- In aviation, alternatives to SAF, such as the electrification of larger aircraft, remain in the research and development phase. Expanding SAF usage is therefore viewed as the most realistic and immediate pathway to decarbonisation.

The use of SAF is expected to grow significantly.

- As of 2022, SAF accounted for only about 0.1% of the global jet fuel supply. Key challenges remain, including limited feedstock availability and high production costs. (See 'Fuel Production – Biofuels').
- However, with demand rising rapidly, substantial growth is projected. According to IEA projection (Figure 4-4), SAF derived from biomass and e-fuels (synthetic fuels) is expected to represent 17% of total aviation fuel consumption by 2030. This share is projected to grow steeply, reaching as much as 77% by 2050.

Figure 4-4: Global Share of Fuels Used in Aviation, 2020–2050



EJ = exajoule, SAF = sustainable aviation fuel.

Source: Authors' calculations (2025) based on data from the International Energy Agency.

The projected growth in SAF usage is largely driven by commitments made by airlines.

- Whilst many carriers have set targets to achieve a 10% SAF usage rate by 2030, certain companies have adopted more ambitious or near-term goals (Table 4-1).
- For instance, the Air France–KLM Group aims to reach a 2% SAF usage rate by as early as 2025, in contrast to the mid- to long-term targets set by most other airlines. Similarly, DHL Aviation has announced a 2030 target that is three times higher than the industry average, reflecting the diversity of airline strategies.

Table 4-1: Examples of Airline Commitments to Using Sustainable Airline Fuel

Airline	Country/Area	Use of Sustainable Airline Fuel Target		
		2025	2030	2035
Air France–KLM Group	European Union	2%	10%	-
Alaska Airlines	United States	-	10%	-
American Airlines	United States			
Finnair	European Union			
British Airways	United Kingdom			
Qatar Airways	Qatar			
Cathay Pacific Airways	Hong Kong			
SriLankan Airlines	Sri Lanka			
Royal Air Maroc	Morocco			
Others				

Airline	Country/Area	Use of Sustainable Airline Fuel Target		
		2025	2030	2035
Delta Airlines	United States	-	10%	35%
DHL Aviation	Germany	-	30%	-

Sources: Air France–KLM (2023), Alaska Airlines (2022), American Airlines (2023), British Airways Media Centre (2022), Qatar Airways (n.d.), Cathay Pacific Airways, Ltd (n.d.), Oneworld (2021), Delta Airlines (n.d.), DHL Group (n.d.).

For airlines to use SAF, it must be readily available at airports. In recent years, various airports have made notable progress in establishing supply systems.

- A broad range of initiatives across the SAF value chain can be observed, covering demand stimulation, supply assurance, infrastructure development, and fuel production (Table 4-2).
- In Sweden, demand is promoted through an incentive scheme rewarding SAF usage beyond the national blending mandate.
- Supply security efforts include Heathrow Airport's SAF monitoring system and long-term procurement agreements signed by airports in Norway and Milan with SAF producers.
- In Belgium, Brussels Airport has developed infrastructure to enable SAF delivery via existing pipeline networks.
- In the US, Pittsburgh International Airport has formed a partnership with energy companies to support on-site SAF production, marking a significant step towards integrated fuel manufacturing at the airport level.

Table 4-2: Examples of Sustainable Aviation Fuel Supply Initiatives at Airports

Country	Airport	Overview
United States	Pittsburgh	**On-site Sustainable Aviation Fuel (SAF) production** In 2024, Pittsburgh International Airport initiated a partnership to develop an integrated on-site SAF production facility, with a capacity of up to 68,000 metric tonnes of hydrogen per year, or up to 70 million gallons per annum of SAF exclusively.
Belgium	Brussels	**Infrastructure development** In 2023, Brussels Airport achieved its inaugural SAF delivery via the Central Europe Pipeline System, the North Atlantic Treaty Organization's largest fuel pipeline network. This pilot involved 2,000 barrels of 1,000 litres each, comprising a 38% SAF blend. This marked both Europe's first SAF delivery through existing pipeline infrastructure and Brussels Airport's first SAF supply.
Italy	Milan	**Long-term procurement** Beyond existing SAF incentives, the airport operator signed a SAF supply agreement in 2022 with Eni to extend SAF usage to commercial flights, building on a 2021 arrangement covering only private aviation.

Country	Airport	Overview
Norway	Multiple airports	**Long-term procurement** Avinor, the national airport operator, entered a pre-purchase agreement with an SAF producer, committing to SAF procurement valued at NOK8 million to support domestic supply development.
Sweden	Multiple airports	**Incentive scheme** Swedavia, which owns and operates 10 of Sweden's busiest airports, launched an SAF incentive programme enabling participating airports to access greater SAF volumes by offering benefits for procurement exceeding the national mandate, which is already covered by the national emissions reduction scheme.
United Kingdom	Heathrow	**Incentive scheme and monitoring SAF usage** Heathrow's SAF incentive scheme requires airlines to nominate their SAF supplier and intended volume before each programme year, ensuring a consistent year-round SAF supply.

Sources: CNX Resources Corp., Pittsburgh International Airport, KeyState Energy (2024), PR Newswire, European Union Aviation Safety Agency (n.d.), SAF Market, Eni (2022), Biofuels International (2019), Swedavia Airports (2023), Heathrow Airport Limited (2024).

Marine transport

In line with the International Maritime Organization (IMO) net-zero goals and the decarbonisation targets set by major cargo-owner consortia, the development of zero-emission vessels (ZEVs) and the use of sustainable fuels, such as ammonia, methanol, and biofuels, are being actively pursued.

Efforts to decarbonise the maritime sector are advancing through both international regulatory frameworks and private sector initiatives.

- IMO, the only specialised UN agency responsible for setting international maritime regulations, with over 170 member countries, has set a target to achieve net-zero GHG emissions by 2050. It has also set an interim target to increase the use of zero-emission fuels to 5%–10% by 2030. The IMO Net-Zero Fund, slated for formal adoption in October 2025, will introduce a financial mechanism under which emission-based contributions will be collected and allocated to incentivise low-emission vessels. Implementation is anticipated to commence in 2027.
- Private sector initiatives are gaining momentum, with cargo owners working to reduce Scope 3 GHG emissions through the deployment of ZEVs. The Cargo Owners for Zero Emission Vessels (coZEV) coalition, comprising 27 members, including Amazon, IKEA, Nestlé, Unilever, and Inditex, aims to fully decarbonise maritime transport within its members' supply chains by 2040 (Table 4-3).

Table 4-3: Decarbonisation Efforts by Major Cargo-owner Alliances

Organisation	Target			Companies
	2030	2040	2050	
Cargo Owners for Zero Emission Vessels	-	Full decarbonisation of members' supply chains	Decarbonisation of the entire shipping industry	Amazon, IKEA, Nestlé Unilever, Inditex, and others
Getting to Zero Coalition	Deploy commercially viable zero-emission vessels operating along deep-sea routes; implement incentives for zero- and low-carbon fuels and technologies	-	Full decarbonisation of the shipping industry	BMW Group, Rio Tinto, Shell, Unilever, Volvo Cars, and others
Sustainable Shipping Initiatives	60% GHG reduction compared with 2008	90% GHG reduction compared with 2008	Zero GHG emissions	Rio Tinto, South32, and others

Sources: Cargo Owners for Zero Emission Vessel (n.d.), The Aspen Institute (2022), Zero Emission Maritime Buyers Alliance (n.d.), Zero Emission Maritime Buyers Alliance, Global Maritime Forum (2024), Getting to Zero Coalition Ambition, Blaxekjaer, L., S. Rud, T. Maver, F. Spiegelenberg, and T. Kirketerp-Moller (2021), Sustainable Shipping Initiative (2020).

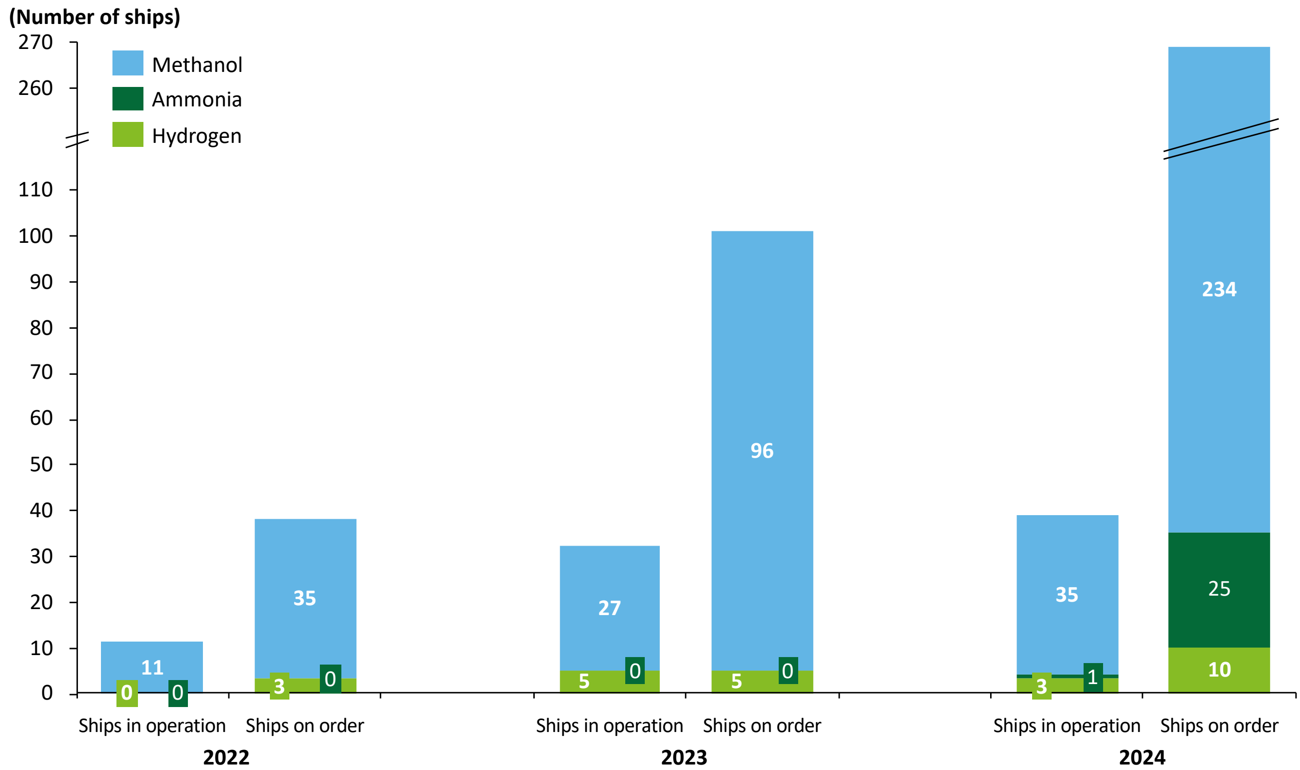
Zero- or low-emission vessels are ships that use fuels producing either no GHG emissions or significantly lower GHGs during operation, although, on a life-cycle basis, overall emissions depend on the production method of those fuels.

- Methanol is increasingly regarded as a promising alternative marine fuel. Although it emits less CO_2 than conventional fossil fuels when combusted, greater reductions can be achieved with biomethanol or e-methanol, offering significantly lower life-cycle GHG emissions.
- Ammonia is regarded as a potential primary fuel for long-distance shipping, whilst hydrogen is expected to be more suitable for short-sea or coastal vessels. Neither ammonia nor hydrogen emits CO_2 during combustion, resulting in zero operational CO_2 emissions.

In recent years, the development of such vessels has advanced as part of strategies to decarbonise new ships.

- Whilst conventional fuel vessels continue to dominate the global fleet, orders for ZEVs are increasing.
- In 2022, there were no ammonia-fuelled vessels on order, only three hydrogen-fuelled vessels, and 35 methanol-fuelled vessels (Figure 4-5). By 2024, these figures had risen substantially to 25 ammonia vessels, 10 hydrogen vessels, and 234 methanol-fuelled vessels, suggesting a major shift in marine fuel use may be on the horizon.

Figure 4-5: Global Number of Ships Using Sustainable Fuels, 2022–2024

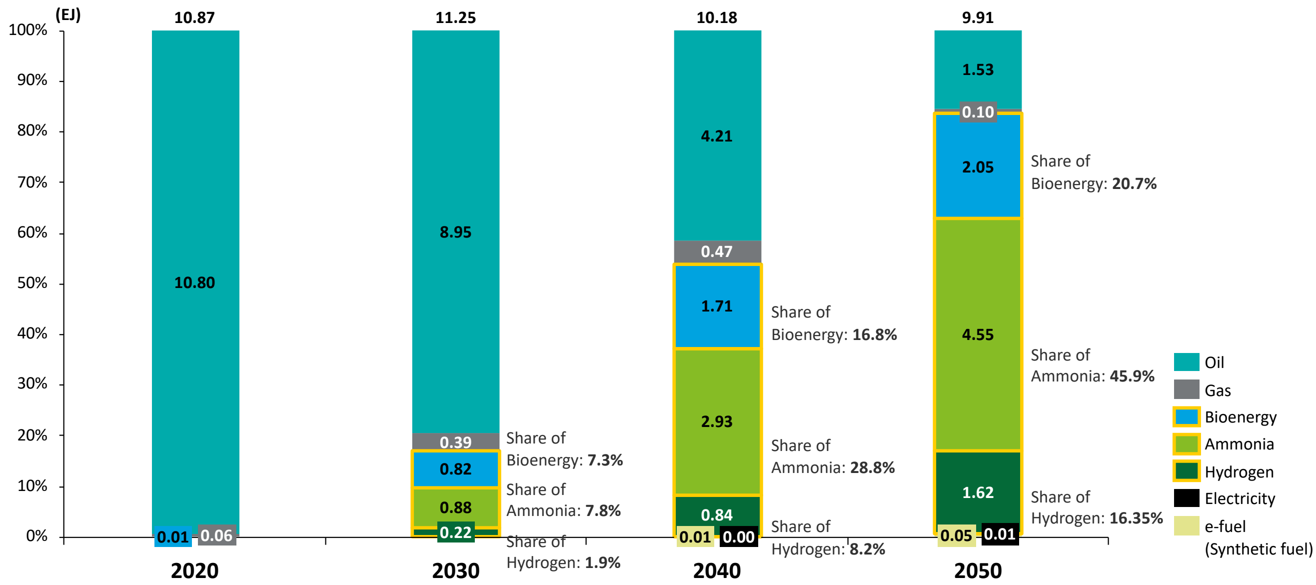


Source: Det Norske Veritas (2022, 2023, 2024).

By 2030, the gradual adoption of biofuels, ammonia, and hydrogen in marine transport is expected to begin (Figure 4-6). By 2050, these fuels are expected to constitute over 80% of the sector's energy mix.

- According to the IEA, bioenergy-derived fuels and ammonia are each projected to account for about 7% of marine fuel use by 2030, marking the beginning of their phased commercial deployment.
- By 2050, alternative fuels are expected to expand significantly, with bioenergy comprising about 20%, ammonia as much as 45%, and hydrogen about 16% of total marine fuel consumption.

Figure 4-6: Global Share of Fuels Used in Marine Transport, 2020–2050



EJ = exajoule.

Source: Authors' calculations (2025) based on data from the International Energy Agency.

The supply of sustainable fuel for ZEVs at ports is essential, and recent years have seen significant advances in this area.

Beyond the demonstration phase, several projects have progressed to commercial-scale infrastructure development for bunkering operations (Table 4-4). Many have secured formal approval, with operational starts planned from 2025 onwards.

Table 4-4: Examples of Initiatives to Establish Zero-emission Fuel Supply Hubs

Country	Fuel	Project overview
Germany	Ammonia	Plans are underway for Germany's first ammonia import terminal and bunkering facility at Hamburg. The terminal will supply ammonia for both industrial uses, specifically hydrogen and nitrogen production, and marine fuelling. Regulatory approval is in progress, with commissioning expected in 2027. Port. Hamburg Companies. HPA, Mabanaft, Port of Hamburg
Netherlands	Ammonia, hydrogen	Under the MAGPIE project, the Port of Rotterdam is spearheading a 5-year programme on ammonia bunkering research and concept design. Plans include a ship-to-ship ammonia bunkering demonstration once suitable vessels become available, as well as the development of infrastructure requirements for European Union ports. Pilot operations are expected in 2025, with commercial bunkering commencing in 2027. In parallel, a small-scale hydrogen bunkering facility is under construction. Port. Rotterdam Company. Port of Rotterdam

Country	Fuel	Project overview
Norway	Ammonia, hydrogen	As part of the Ammonia Fuel Bunkering Network Project, approval was granted in March 2024 for a 650-tonne capacity ammonia bunkering terminal at Floro. The associated bunkering barge is expected to be operational in 2025. If successful, this will be the world's first dedicated ammonia bunkering solution. Port. Floro Companies. Azane, Fjord Base, North Ammonia AS, Yara

Sources: Vessel Performance Info (2023), Port of Hamburg Magazine (2024), Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (2022), Port of Rotterdam (n.d.), Macqueen, J. (2024), Ship & Bunker, Yara (2024), Fjord Base Group (2024), Sintef (n.d.).

Fuel Production

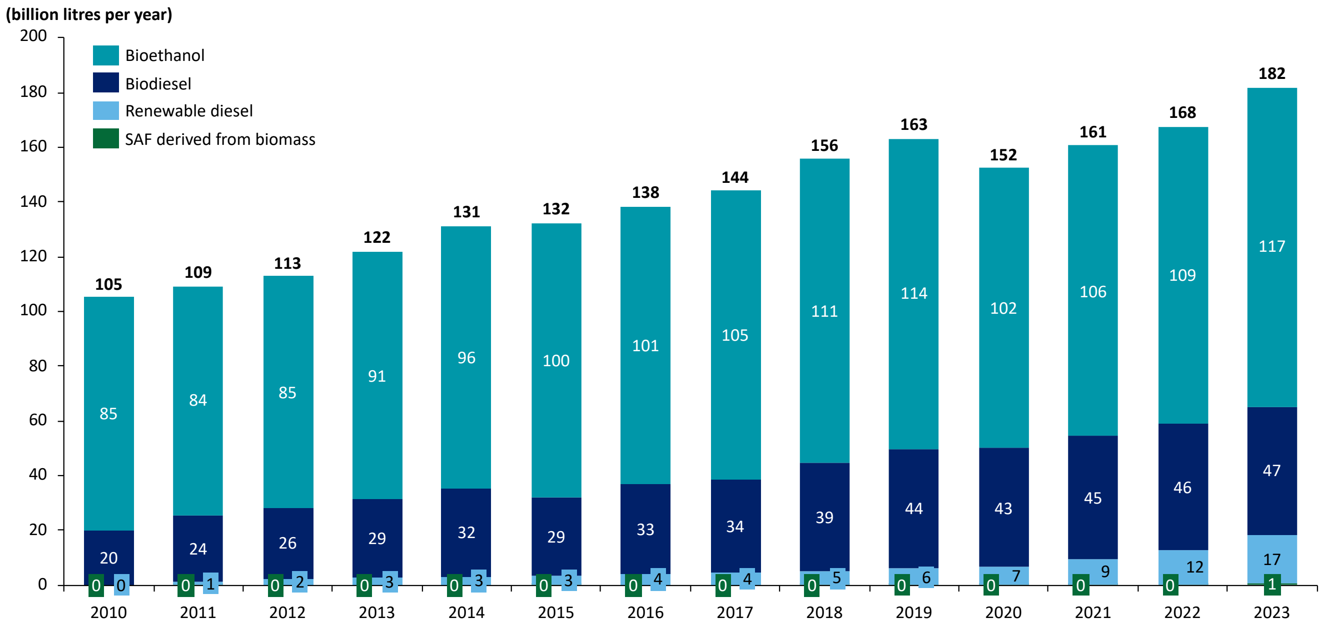
Biofuel

Fuels derived from biomass include solid, liquid, and gaseous forms. Solid fuels, such as woody biomass, and gaseous fuels, such as biogas and biomethane, are primarily used for power generation. Liquid fuels, including bioethanol, biodiesel (notably renewable diesel, such as paraffinic diesel like hydro-treated vegetable oil), and SAF derived from biomass, are used as alternative fuels in transport.

Biofuels for transport can be readily integrated into existing applications and have long been recognised globally as promising decarbonisation solutions.

- Several countries have already advanced in practical application, and production for transport is expected to continue expanding.
- Output has exhibited a consistent upward trend (Figure 4-7). In 2010, production stood at 105 billion litres, rising to 182 billion litres by 2023, an increase of 73%.

Figure 4-7: Global Biofuel Production in Transport, 2010–2023



SAF = sustainable aviation fuel.

Source: International Energy Agency.

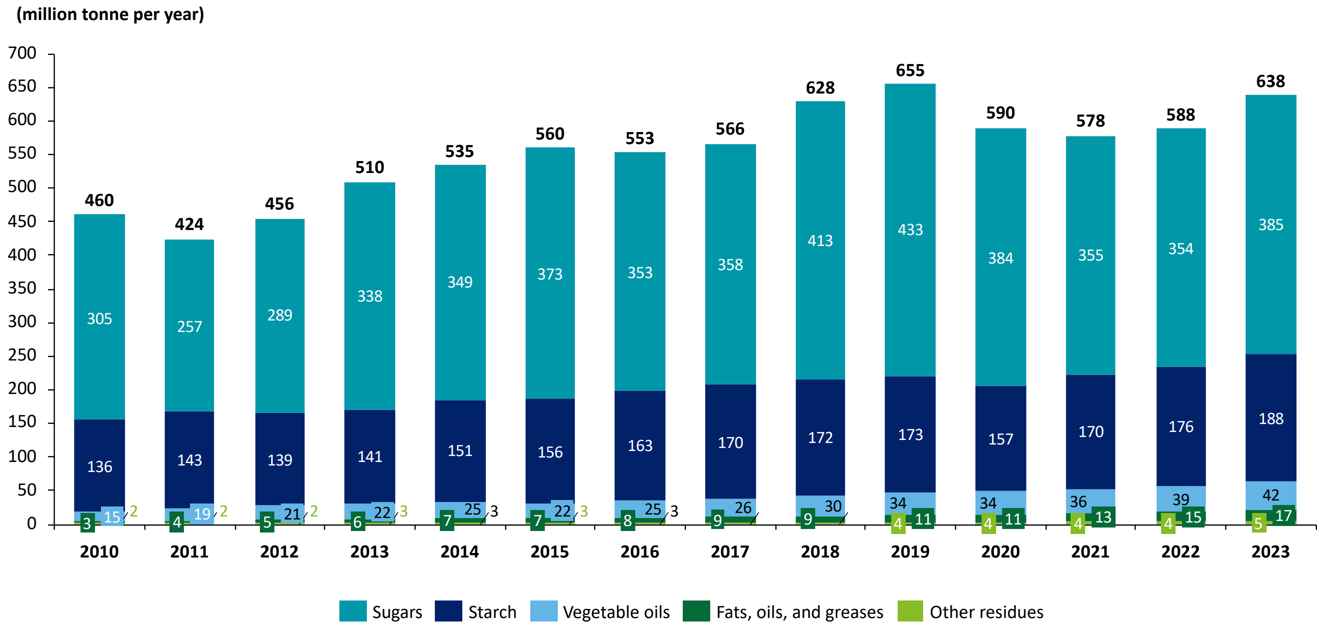
Biofuels are used across road, marine, and aviation transport.

- Biodiesel, including renewable diesel, is expected to serve heavy-duty vehicles such as large lorries, buses, and ships. Bioethanol will be used primarily in passenger cars, whilst biomass-derived SAF is regarded as a key solution for decarbonising aviation. Bio-methanol is also gaining recognition as a promising alternative marine fuel.

However, high production costs remain a barrier to widespread adoption.

- Feedstock prices are a major determinant of biofuel production costs, making a stable supply of raw materials crucial.
- Current supply stability is a concern, as conventional biofuels, primarily from edible feedstocks such as sugarcane and palm oil, compete with food resources (Figure 4-8).

Figure 4-8: Main Feedstock use of Biofuels, 2010–2023



Source: International Energy Agency.

To secure medium- to long-term supply, the sector is moving towards diverse biomass sources that do not compete with food. These include waste oils, cellulose, municipal waste, agricultural residues, and algae.

- The European Union, through the Renewable Energy Directive (RED), aims to avoid food competition and ensure sustainable feedstocks. From 2030, edible feedstocks will be banned or restricted where there is a risk of land-use change, such as deforestation.
- RED III, published in 2023, stipulates that consumption of fuels from edible sources must not exceed 2020 levels, with an upper limit of 7%. Fuels from high indirect land-use change risk feedstocks, such as starch-rich crops, cereals, sugar crops, and oil crops, will be restricted to 0% by 2030. Conversely, RED III sets specific targets for advanced biofuels from non-edible sources, such as biowaste, algae, cellulose, and agricultural or industrial residues.

Table 4-5: Targets for Biofuels Use Under the Renewable Energy Directive

Origin	Consideration and Grouping	Feedstock		RED III (2023) Consumption Level Requirement	
Edible	High ILUC risk (excluded if produced on abandoned, unused, or degraded land or exceeding productivity estimates)	Food and feed crops (excluding residues)	Starch-rich and cereal crops	Must not exceed 2020 level; capped at 7%	Must not exceed 2019 level; capped at 0% by 2030
			Sugar crops		
			Oil crops		
	Low ILUC risk		Other crops		Exempt from reduction and 0% cap by 2030
Non-edible	Advanced biofuels	Biowaste		Minimum 5.5% contribution	
		Algae (cultivated in ponds or photobioreactors)			
		Cellulosic	Non-food cellulosic crops (e.g. intermediate crops)		
			Ligno-cellulosic materials (excluding saw logs and veneer logs)		
		Waste and residues	Agricultural residues (e.g. straw, husks, bagasse, oil palm trunk, palm oil mill effluent, empty fruit bunches)		
			Forest and forest-based residues		
			Industrial waste not fit for food or feed use (excluding used cooking oil and animal fats categories 1 and 2)		
	Used cooking oil and animal fats categories 1 and 2**		Used cooking oil and animal fats categories 1 and 2	Must not exceed 1.7%	

EC = European Commission, EU = European Union, ILUC = indirect land-use change, RED = Renewable Energy Directive.

* High-ILUC-risk biofuels are those likely to impact food security due to a shift in land use from food and feed to fuel production, leading to repurposing of existing land (e.g. forests) for food needs.

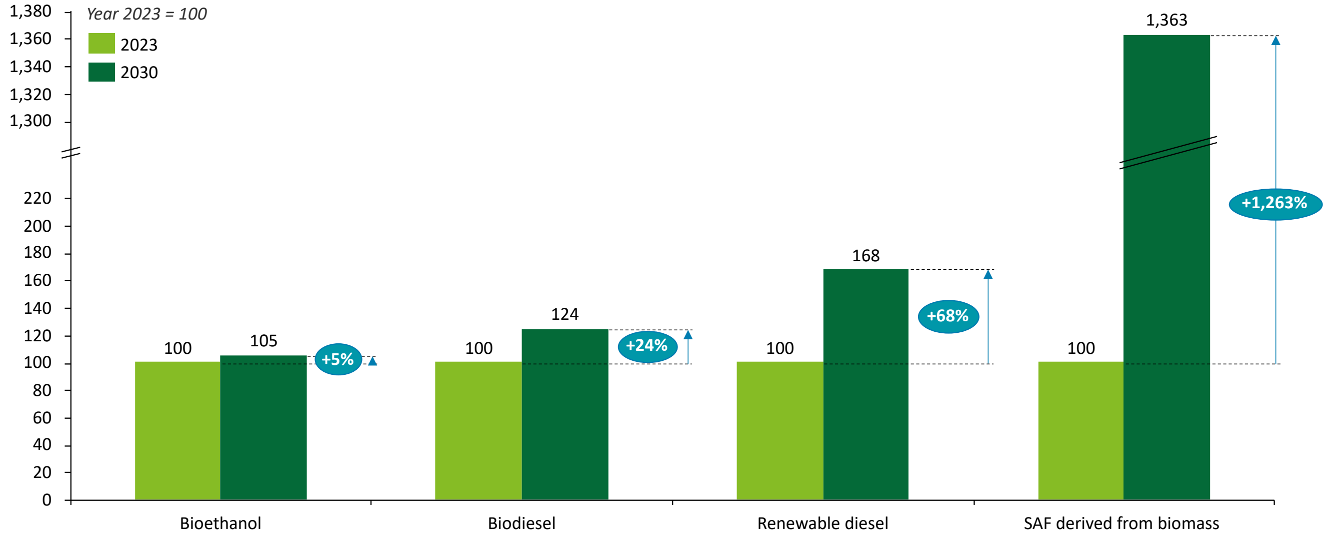
**Animal fat categories 1 and 2. Classified by their public and animal health risk (1 = highest, 3 = lowest). Categories 1 and 2 are unfit for human and animal consumption (e.g. products from virus-infected cattle).

Source: Authors' elaboration based on Directive (EU) 2023/2413, Directive (EU) 2018/2001, EC (2023), and Regulation (EC) 1069/2009 (2019).

Although cost remains a key barrier, SAF production is poised for substantial growth in demand.

- Based on IEA projections (Figure 4-9), with 2023 indexed to 100, production by 2030 is expected to reach 105 for bioethanol, 124 for biodiesel, and 168 for renewable diesel. SAF from biomass is projected to surge to 1,363, an unprecedented growth rate.

Figure 4-9: Biofuels Production Growth Index, 2023–2030



SAF = sustainable aviation fuel.

Source: Authors' calculations based on data from the International Energy Agency.

- This significant growth is likely due to aviation's relatively constrained decarbonisation pathways, coupled with its ability to pass higher fuel costs to consumers via surcharges. Airlines are, therefore, expected to continue purchasing SAF even at relatively high prices.

Hydrogen and ammonia

Hydrogen and ammonia are key commodities in decarbonising fuel use across a wide range of sectors, extending well beyond transport. However, the barriers to their commercialisation remain high.

Hydrogen and ammonia can make a significant contribution to carbon neutrality, as they emit no CO_2 during combustion. Their applications are outlined in Table 4-6.

- They are expected to be used in co-firing and dedicated firing in thermal power generation, in industrial heat applications, and as feedstocks in industrial processes such as hydrogen-based steelmaking and the synthesis of basic chemicals, including methanol.
- In transport, hydrogen is expected to be deployed in FCVs for road transport and as fuel for short-distance shipping. Ammonia is expected to be used as a fuel for long-distance maritime transport.

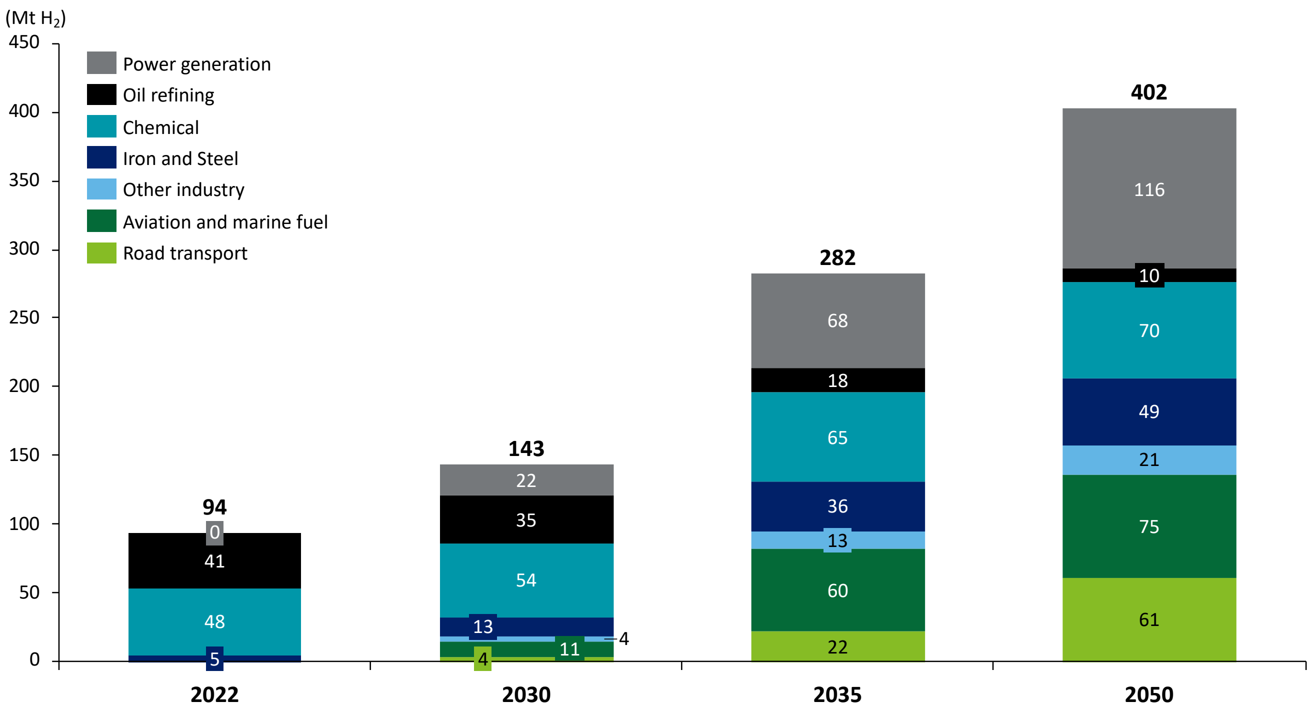
Table 4-6: Utilisation Methods for Hydrogen and Ammonia

Sector	Utilisation Methods	Hydrogen	Ammonia
Power	Co-firing and dedicated firing in coal-fired power plants	-	√
	Co-firing and dedicated firing in gas-fired power plants	√	-
Industry	Heat utilisation (e.g. industrial furnaces)	√	√
	Hydrogen-reduction steelmaking	√	-
	Synthesis of basic chemicals	√	√
Transport	Engines for ships and other vessels	√ (Short distance)	√ (Long distance)
	Fuel cells for mobility and stationary applications	√	-

Source: Author's collection based on The Ministry of Land, Infrastructure, Transport and Tourism, Japan.

Given this wide range of applications, demand is projected by the IEA to grow steadily. By around 2030, transport use is expected to expand gradually. The projections include hydrogen demand as a feedstock for producing low-emission fuels such as ammonia, categorised under 'aviation and marine fuel' and 'power generation'.

Figure 4-10: Global Hydrogen and Ammonia Demand by Sector, 2022–2050



MtH_2 = million tonnes of hydrogen.

Note: Demand for aviation and marine fuel and power generation includes hydrogen converted to produce low-emission hydrogen-based fuels.

Source: Based on data from the International Energy Agency (2023).

In line with anticipated growth in hydrogen and ammonia use, many countries are implementing long-term production strategies and setting manufacturing targets.

- In recent years, numerous national hydrogen strategies have been introduced to accelerate both production and utilisation, with strong emphasis on scaling up low-carbon hydrogen manufacturing (Table 4-7).
- Countries such as the US and the United Kingdom (UK) aim to position themselves as future exporters in the global hydrogen market.

Table 4-7: Key Hydrogen Strategies

Country or Area	Published Year	Project overview
United States	2023	**National Clean Hydrogen Strategy and Roadmap** Targets 10 million metric tonnes (Mt) of clean hydrogen annually by 2030, increasing to 50 Mt by 2050. Aims to become a global exporter, with potential domestic output of 12 Mt by 2030, subject to project implementation.
European Union	2020	**EU Hydrogen Strategy** Prioritises renewable hydrogen, targeting 40 GW of electrolysers by 2030 and an open, competitive EU hydrogen market. Up to one-quarter of renewable electricity may be allocated to hydrogen production, which could make up over 23% of the energy mix by 2050.
Germany	2023	**National Hydrogen Strategy** (Updated) Seeks at least 10 GW of domestic renewable hydrogen capacity by 2030. As demand will surpass supply, Germany anticipates importing 50%–70% of its hydrogen (45–90 TWh).
United Kingdom	2023	**Hydrogen Strategy Delivery** (Updated) Target 10 GW hydrogen production capacity and four CCUS clusters by 2030, alongside plans for a hydrogen-powered town. Positions itself as a potential exporter.
China	2022	**Medium- and Long-term Plan for the Development of the Hydrogen Energy Industry** Targets 100,000–200,000 tonnes of renewable hydrogen per year by 2025. Aims for 50,000 hydrogen fuel cell vehicles and the construction of numerous refuelling stations by 2025.

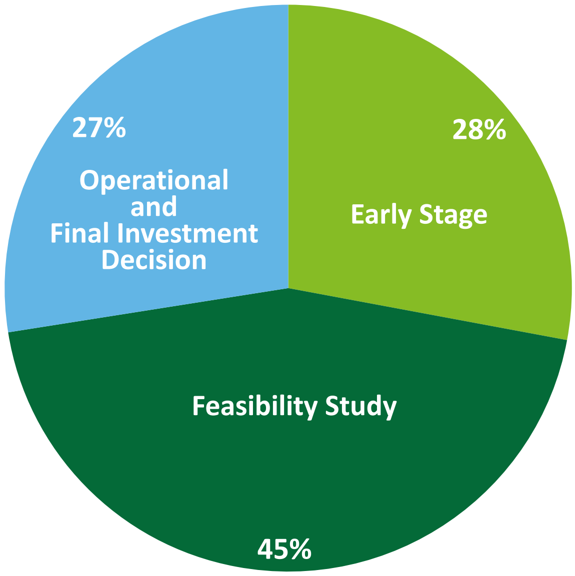
EU = European Union, GW = gigawatt, Mt = million metric tonnes, TWh = terrawatt-hour.

Sources: United States Department of Energy (2023), European Commission (n.d.), European Hydrogen Observatory (2023), Federal Ministry for Economic Affairs and Climate Action (Germany) (2023), Department for Energy Security and Net Zero (United Kingdom) (2023), National Development and Reform Commission (China) (2022), International Energy Agency (2023).

As reflected in these national strategies, low-carbon hydrogen production is widely recognised as a key enabler of CO_2 emissions reductions.

- Although hydrogen and ammonia emit no CO_2 during combustion, their production is energy intensive.
- When produced using renewable electricity or with CCUS to reduce GHG emissions during synthesis, they are classified as low-emission hydrogen and ammonia.

Figure 4-11: Status of Low-emission Hydrogen and Ammonia Projects



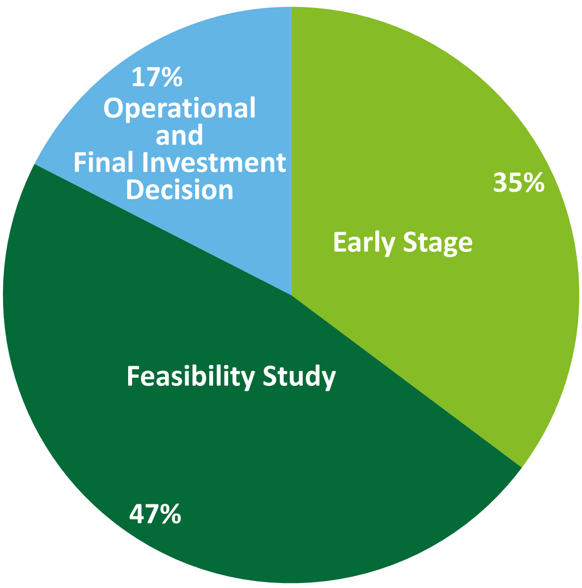
Note: As of October 2024.

Source: Authors' calculations (2025) based on data from the International Energy Agency (2024).

However, most of these projects are still at an early stage (Figure 4-11). According to the Hydrogen Production and Infrastructure Projects Database, more than 70% remain in the feasibility study or early development phase.

Ensuring a stable supply of hydrogen and ammonia necessitates infrastructure capable of transporting fuels from large-scale production sites. Ongoing initiatives include the construction of dedicated pipelines, blending hydrogen and ammonia into existing infrastructure, development of underground gas storage facilities, and enhancement of port facilities. Nevertheless, infrastructure development is still in its nascent stages (Figure 4-12).

Figure 4-12: Status of Low-emission Hydrogen and Ammonia Infrastructure Projects



Note: As of October 2024.

Source: Authors' calculations (2025) based on data from the International Energy Agency (2024).

Other fuel

In addition to biofuels, hydrogen, and ammonia, e-fuels (synthetic fuels) are also expected to be used as a sustainable fuel option.

- E-fuels are particularly anticipated as alternative transport fuels. They are also envisaged as substitutes for oil in heating systems and as feedstocks in the chemical industry.
- One major advantage of e-fuels is their compatibility with existing infrastructure, making them a promising option across all modes of transport: road, aviation, and marine. With their high energy density, e-fuels are particularly well-suited to applications in sectors where electrification poses greater challenges.
  (See 'Fuel Consumption – Aviation' and 'Fuel Consumption – Marine Transport' sections.)
- Discussions on the practical deployment of e-fuels are emerging in several countries. Since e-fuels emit CO_2 during combustion, they must be produced through carbon-neutral processes. However, efficient technologies for large-scale commercial production are still under development, particularly regarding hydrogen production and CO_2 capture.
- Under RED, the European Union (EU) recognises e-fuels only when the hydrogen used is derived from renewable energy and the CO_2 is captured via direct air capture (Table 4-8). The use of CCU from certain industrial sources, such as power generation and steel production, excluding biofuels, is permitted only until 2040, as CCU may perpetuate fossil fuel use.

Table 4-8: Raw Material Patterns and the European Union's Definition of E-fuels Under the Renewable Energy Directive

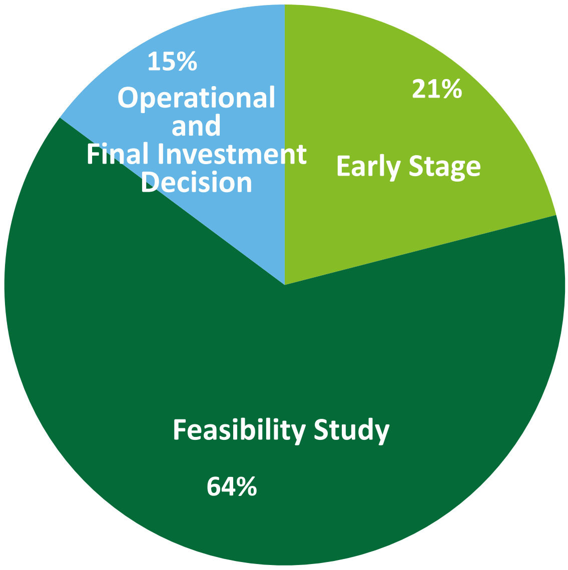
		Carbon Dioxide Capturing Method	
		CCU CO_2 from industrial source	Direct Air Capture CO_2 from the atmosphere
Hydrogen Type	Fossil-based hydrogen with CCUS	-	-
	Renewable-based hydrogen	Recognised as e-fuel - CCU permitted from power generation and steel production (excluding biofuels) only until 2040.	Recognised as e-fuel

CCU = carbon capture and utilization; CCUS = carbon capture, utilization, and storage.

Source: Authors' elaboration based on Arthur D. Little Japan (2023).

In most countries, discussions on e-fuels are still at a formative stage. Many fuel production projects are still in their initial stages, with commercialisation expected only in the medium to long term (Figure 4-13).

Figure 4-13: Status of Low-emission E-fuel Production Projects



Note: As of October 2024.

Source: Authors' calculations (2025) based on data from the International Energy Agency (2024).

4.2 Fuel Consumption – Road Transport

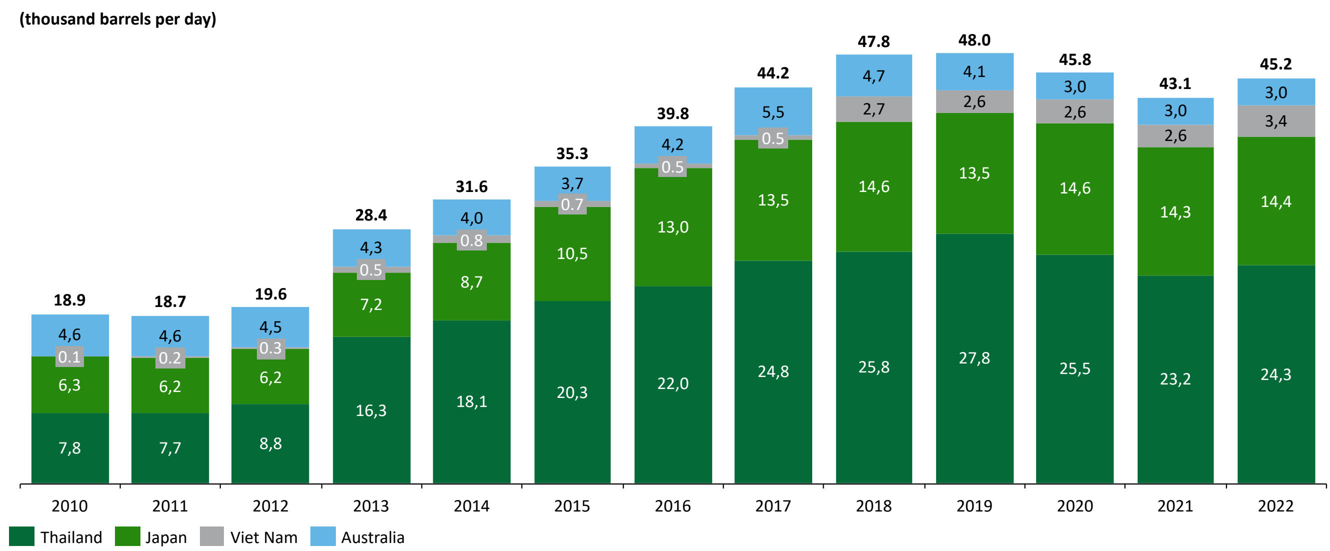
4.2.1 Market trends

AZEC trends

In AZEC partner countries, biofuels play a significant role as an alternative fuel in road transport, with consumption remaining notably active.

- Bioethanol consumption has been observed in Australia, Thailand, Japan, and Viet Nam (Figure 4-14). Thailand, in particular, has maintained a steady level of use over an extended period, although its recent upward trend appears to have levelled off.
- Figure 4-15 illustrates biodiesel consumption in countries such as Indonesia, Malaysia, and Thailand. Notably, Indonesia shows both a high volume of use and a continued upward trajectory in consumption.

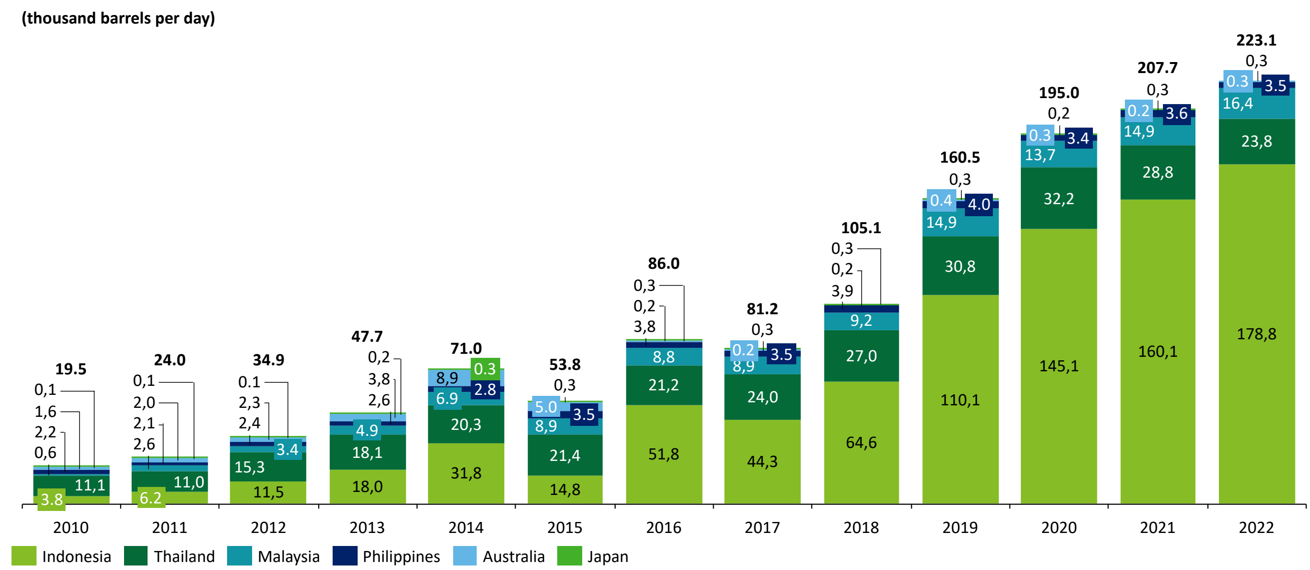
Figure 4-14: Bioethanol Consumption by Country, 2010–2022



Note: Malaysia, Singapore, and Indonesia recorded negligible or no bioethanol consumption, whilst no data were available for Brunei Darussalam, Cambodia, and Lao PDR. For the Philippines, consumption data can be confirmed through government announcements and other public sources; however, such data were not identified in the United States Energy Information Administration, which serves as the reference source for the other countries.

Source: Based on data from the United States Energy Information Administration.

Figure 4-15: Biodiesel Consumption by Country, 2010–2022



Note: Singapore and Viet Nam recorded negligible or no biodiesel consumption, whilst no data were available for Brunei Darussalam, Cambodia, and Lao PDR.

Source: Based on data from the United States Energy Information Administration.

4.2.2 Key policies and regulations

Across AZEC partner countries, biofuels are widely utilised, with governments actively stimulating demand through measures such as mandatory blending requirements and usage obligations.

- Bioethanol blending is mandated in certain regions of Australia, Indonesia, and the Philippines (Table 4-9). In other countries, future blending mandates are under consideration, or national consumption targets have already been established.
- For biodiesel, blending is mandatory in Indonesia, Malaysia, the Philippines, and Thailand (Table 4-9). In Indonesia and Malaysia, subsidy schemes have been implemented to bridge the price gap between biodiesel and conventional diesel.

Table 4-9: Key Policy Measures to Promote the Use of Biofuel

Country	Overview	
	Bioethanol	Biodiesel
Australia	• E6 in New South Wales and E4 in Queensland mandates are in place, although uptakes remain low in both states. • The government targets bioenergy (including bioethanol and biodiesel) consumption of 76 PJ by 2030.	• B2 in New South Wales and B0.5 in Queensland mandates are in place, with similarly low uptake. • The government targets bioenergy consumption of 76 PJ by 2030.
Brunei Darussalam	N/A	N/A
Cambodia	• No mandate currently. • Assessment ongoing for E3 introduction in 2023–2026, followed by E5 and E10 from 2027 onwards.	N/A
Indonesia	• E5 market trial has been underway since 2023 in Jakarta, East Java, and Banten. • Nationwide E10 mandate planned by 2033.	• B40 mandated nationwide from 2025, with technical assessment ongoing for B50. • The Crude Palm Oil Fund Agency subsidises the price differential between biodiesel and fossil diesel using palm oil export levy revenues.
Japan	• No mandate currently. • Target consumption of 823.7 million litres of bioethanol annually until 2027. • E10 targeted by 2030 and E20 by 2040, with all new passenger cars sold from the early 2030s to be compatible with E20.	• No mandate, but the government promotes the introduction of biodiesel.
Lao PDR	• E10 mandate planned for 2016–2025 but not implemented. • Target of 10% biofuel mix in the transport sector by 2025.	• B10 mandate planned for 2016–2025 but not implemented. • Target of 10% biofuel mix in the transport sector by 2025.

Country	Overview	
	Bioethanol	Biodiesel
Malaysia	N/A	• B10 mandated nationwide. • B20 mandated in Labuan, Langkawi, and Sarawak (excluding Bintulu) pending nationwide expansion. • B30 to be mandated nationwide by 2030. • Government applies a B10 diesel price cap and subsidises fuel retailers for the difference.
Philippines	• E10 mandated since 2024. • Government promotes a voluntary increase to E20.	• B3 mandated since 2024. • Planned increases: B4 in 2025, B5 in 2026, and B20 by 2030.
Singapore	• Target for all vehicles to run on cleaner energy by 2040.	
Thailand	• E20 promoted through price incentive, but no mandate. • Target of 4.1 billion litres of bioethanol by 2037.	• B7 as the primary blend rate, with B20 as an alternative. • Target of 2.9 billion litres of biodiesel by 2037.
Viet Nam	• E5 mandated since 2018; E10 proposed under biofuel road map. • Target to increase E5 usage in road vehicles by 2030. • Pricing mechanism underway to enhance competitiveness.	N/A

Notes:

BX: Blend containing X% bio-diesel and (100-X%) diesel (e.g. B5 contains 5% biodiesel and 95% diesel).

EX: Blend containing X% of ethanol and (100-X%) petrol (e.g. E5 contains 5% ethanol and 95% petrol).

Sources: Ninomiya et. al. (2025), ENEA Consulting and Deloitte for Australian Renewable Energy Agency (2021), New South Wales Fair Trading (Australia) (2019), State of Queensland (2024), Brunei Climate Change Secretariat (2020), General Department of Energy (Cambodia) (2019), Indonesia Investment Coordinating Board (2024), Ministry of Energy and Mineral Resources of the Republic of Indonesia (2025), Plantation Fund Management Agency (2018), Ministry of Economy, Trade and Industry (Japan) (2023, 2025), Lao Institute for Renewable Energy (2011), Ministry of Plantation and Commodities (Malaysia) (n.d.), US Department of Agriculture, Foreign Agricultural Service (2020, 2024a), Department of Energy (Philippines) (2016, 2024, 2025), Department of Finance (Philippines) (2024), Ministry of Sustainability and the Environment (Singapore) (n.d.), Government of Viet Nam (2022).

4.3 Fuel Consumption – Aviation

4.3.1 Market trends

AZEC trends

As a key international aviation hub, ASEAN must expedite the establishment of SAF supply bases.

- Since 2021, many airlines have operated commercial flights using SAF (Table 4-10). Most carriers have set SAF usage targets of 5% or 10% by 2030.

Table 4-10: Examples of Airline Commitments to Using Sustainable Airline Fuel

Airline	Country	Use of SAF Target			Status of SAF Adoption
		2026	2030	2050	
Qantas Airlines	Australia	-	10%	~60%	• First Australian airline with a SAF offtake contract for continuous supply, with refuelling at London Heathrow Airport. • SAF accounted for 0.2% of total fuel use in 2023.
Royal Brunei Airlines	Brunei Darussalam	-	5%*	-	• In 2024, conducted a SAF capacity-building workshop with the International Air Transport Association, involving policymakers and key stakeholders to discuss SAF production and adoption for aviation decarbonisation.
Garuda Indonesia	Indonesia	-	5%*	-	• Operated its first SAF-powered commercial flight in 2023 on a domestic return route.
Lion Air	Indonesia	-	-	-	• Announced an ambition to use SAF on all flights by 2030.
JAL Group	Japan	-	10%	-	• Since May 2025, has used domestically produced SAF. • Signed agreements in 2022 for future SAF offtake at United States airports.
All Nippon Airways	Japan	-	10%	-	• Started SAF use for commercial flights from Haneda and Narita airports in 2021.
Malaysia Airlines	Malaysia	-	10%*	-	• Operated its first commercial SAF flights in 2021. • In 2023, Malaysia Aviation Group signed a SAF offtake agreement, with gradual introduction planned from 2027 on selected services.
AirAsia Group	Malaysia	-	-	-	• Aims to start SAF use by 2025. • SAF target aligned with European mandates and availability at regional airports.

Airline	Country	Use of SAF Target			Status of SAF Adoption
		2026	2030	2050	
Philippine Airlines	Philippines	1%	5%*	-	• In 2023, partnered with a low-carbon energy provider to explore decarbonisation strategies, including SAF.
Singapore Airlines Group (Singapore Airlines, Scoot)	Singapore	-	5%	-	• Completed a 20-month SAF trial in November 2023, with Changi Airport as refuelling base. • In 2024, signed an agreement to purchase 1,000 tonnes of domestic SAF.
Bangkok Airways	Thailand	1%	5%*	-	• In 2024, operated a pilot SAF flight on the Bangkok–Samui route. • Launched the 'Low Carbon Skies' campaign, including SAF blending and usage initiatives.
Thai Airways International	Thailand	>2%	5%	~60%	• Conducted a domestic SAF trial flight from Phuket to Bangkok in December 2023.
Vietnam Airlines	Viet Nam	-	-	-	• Plans to expand SAF use. • Operated its first SAF-powered commercial flight in May 2024.
Vietjet	Viet Nam	-	-	-	• Signed a memorandum of understanding with a Dubai-based start-up for SAF development and supply. • Operated its first SAF-powered commercial flight in October 2024.

SAF = sustainable aviation fuel.

Note: Royal Brunei Airlines, Garuda Indonesia, Philippine Airlines, and Bangkok Airways are members of the Association of Asia Pacific Airways, which has committed to 5% SAF use by 2030. Malaysia Airlines, a member of the Oneworld Alliance, has committed to 10% SAF use by 2030.

Sources: Qantas Group (2024), PwC Japan (2023), SAF Investor (2024), The Jakarta Post (2024), Japan Airlines (2022), ANA Holdings (2023), Ministry of Transport (Malaysia) (2022), Reuters (2024), Aviation Philippines Update, Singapore Airlines Group (2023), Bangkok Airways (2024), The Nation (2023, 2024), Bangkok Airways (2024), Bangkok Post (n.d.).

- In parallel with airline commitments, airport-based SAF supply initiatives are emerging. Table 4-11 shows examples of SAF provision, including pilot projects, at several airports.
- In Bangkok, a pilot SAF transport project marks an initial step towards infrastructure development.
- Long-term SAF supply initiatives are underway in Australia and Japan.

Table 4-11: Examples of Sustainable Aviation Fuel Supply Initiatives at Airports

Country	Airport	Overview
Australia	Whitsunday Coast Airport	**National Clean Hydrogen Strategy and Roadmap** Targets 10 million metric tonnes (Mt) of clean hydrogen annually by 2030, increasing to 50 Mt by 2050. Aims to become a global exporter, with potential domestic output of 12 Mt by 2030, subject to project implementation.
Indonesia	Soekarno-Hatta	**Confirmed supply record** In 2023, completed its first SAF refuelling operation for a short-haul flight using domestically produced SAF, marking a milestone in Indonesia's SAF deployment.
Japan	Haneda	**Long-term procurement** In 2024, Japan Airport Terminal and Euglena signed an MoU to establish a SAF supply chain at Haneda Airport, targeting up to 50,000 kilolitres annually.
Singapore	Changi	**Confirmed supply record (pilot trial)** In 2023, undertook a 1-year SAF delivery and refuelling trial in collaboration with industry partners, supplying 1,000 tonnes of neat SAF via the existing hydrant infrastructure.
Thailand	Suvarnabhumi and Don Mueang	**Infrastructure development** In late 2024, a collaborative pilot project by the Bangkok Aviation Fuel Services (BAFS), BAFS Pipeline Transportation (BPT), and Bangchak facilitated the initial SAF delivery via Bangkok Airport's hydrant pipeline, paving the way for future infrastructure readiness.
Viet Nam	Tan Son Nhat	**Confirmed supply record** In 2024, completed its first SAF-blend refuelling for international flights to Melbourne and Seoul, marking Viet Nam's entry into SAF adoption.

Sources: Viva Energy Group (2025), Airways Publishing, Euglena (2024), Singapore Airlines Group (2023), Bangkok Post (2024), Vietjet Air (2024).

4.3.2 Key policies and regulations

To become an airport 'chosen by the world's airlines', policies have been introduced to lead the adoption of SAF, set production targets, and attract investment to secure a stable supply.

Government-led efforts to decarbonise aviation are also emerging across the region (Table 4-12).

- In countries such as Indonesia, Malaysia, Singapore, and Thailand, short-term targets have been set or proposed, aiming for 1% SAF usage between 2026 and 2027.

Table 4-12: Government Efforts for Decarbonisation and Sustainable Aviation Fuel Targets

Country	Decarbonisation Target in Aviation	SAF Target
Australia	10 Mt by 2030, rising to 11 Mt by 2040, with slower growth expected as low-emission fuel uptake and efficiency improve.	Further assessment is underway before deciding on mandates.
Brunei Darussalam	Reduce CO_2 emissions by 11%–12% annually from 2024 to 2050 compared to BAU.	N/A
Cambodia	Reduce CO_2 emissions by 250,000 tonnes compared to BAU by 2030.	N/A
Indonesia	Reduce CO_2 emissions by 5.67% (3 Mt) on international flights and 16.28% (21.85 Mt) on domestic flights compared to BAU.	1% mandate for all international flights from Denpasar (Bali) and Cengkareng (Jakarta) airports by 2027, increasing to 7.5% by 2030.* Starting from 2040, a 15% mandate to be applied to five major airports, with a national SAF usage target of 12.5%.*
Japan	Achieve carbon neutrality in both domestic and international aviation by 2050.	Target 10% of SAF usage by Japanese carriers by 2030.
Lao PDR	N/A	N/A
Malaysia	Ministry of Transport is developing a blueprint for domestic aviation decarbonisation.	1% mandate expected in 2027*, increasing up to 47% by 2050.
Philippines	Reduce CO_2 emissions by 25,253 tonnes or 64,232 tonnes by 2050 compared to BAU.	SAF road map under development.
Singapore	Reduce CO_2 emissions by 119,000 tonnes by 2030 compared to BAU.	1% mandate in 2026 for all outbound flights from Changi and Seletar airports, increasing to 3%–5% by 2030.
Thailand	Reduce CO_2 emissions from international and domestic flights by 0.3% by 2050 compared to BAU.	1% mandate from 2027 for Thai carriers*
Viet Nam	N/A	At least 10% SAF for some short-haul flights from 2035*.

*Draft or plan.

BAU = business as usual, SAF = sustainable aviation fuel.

Sources: PwC Japan (2023), Government of Australia (2024), Ministry of Economy, Trade and Industry, Japan (2023), Ministry for Maritime and Investment Affairs (Indonesia) (2024), Air Transport Action Group (2024), Ministry of Economy (Malaysia) (2023), Hussain (2024), The Straits Times (2024), Ministry of Transport (Singapore) (2024), Reuters (2025), Bangkok Post, Government of Viet Nam (2022).

Several AZEC partner countries have introduced policies to attract investment in SAF production, intending to ensure a stable and scalable supply. Measures include support for technology development, infrastructure enhancement, feedstock security, and preferential tax treatment (Table 4-13).

Whilst some initiatives remain at the planning stage, policy activity is expected to increase as governments move towards ensuring a long-term supply of SAF.

Table 4-13: Government Measures to Attract Investment for Stable Supply of Sustainable Aviation Fuel

Country	Overview
Australia	The SAF Funding Initiative offers up to AUD30 million for renewable-based SAF development, supporting technology advancement, commercial readiness, and national industry capacity. The voluntary guarantee-of-origin scheme certifies emissions-renewable electricity use in low-carbon products, supporting the Future Made in Australia plan to attract investment in low-carbon fuels and biomethane.
Brunei Darussalam	N/A
Cambodia	N/A
Indonesia	As of early 2025, Pertamina's advanced SAF initiatives have been designated as national strategic projects, qualifying for non-financial incentives such as fast-tracked administrative and legal procedures. SAF is now included in biofuel regulations, with feedstock security reinforced through export restrictions and adjusted domestic market obligations for certain palm-based materials, including used cooking oil.
Japan	Planned capital expenditure support for feedstock development, infrastructure, and supply chain formation; operational expenditure support through planned tariff and fuel tax exemptions for SAF and feedstocks from 2025. Additional research and development, demonstration, and certification support are envisaged for second-generation SAF from non-edible sources such as waste, algae, and cellulosic ethanol.
Lao PDR	N/A
Malaysia	In November 2024, the government expanded crude palm oil export quotas and proposed raising the windfall profit levy threshold in the palm oil sector to stimulate downstream investment, particularly in biofuels.
Philippines	N/A
Singapore	In 2023, the Aviation Sustainability Programme was launched, offering co-funding of up to 70% at the sector level or 50% at the firm level for eligible projects that support aviation decarbonisation, including low-carbon fuel testing.
Thailand	In January 2025, approved corporate income tax exemptions for SAF-related businesses, 8 years for SAF production and 3 years for blending operations, to encourage domestic investment.
Viet Nam	N/A

Lao PDR = Lao People's Democratic Republic, SAF = sustainable aviation fuel.

Sources: Australian Renewable Energy Agency (n.d.), Ministry of Economy, Trade and Industry, Japan (2023), Coordinating Ministry For Economic Affairs (Indonesia) (2023), The Malaysian Reserve (2024), Royal Malaysian Customs Department (2025), Civil Aviation Authority of Singapore (n.d.), Money & Banking Magazine (2025).

4.4 Fuel Consumption – Marine Transport

4.4.1 Market trends

AZEC trends

In AZEC partner countries, several shipbuilding projects for ZEVs are underway (Table 4-14), as part of efforts to advance their practical application.

- Operational milestones for ammonia-capable vessels have already been achieved through projects involving Australia and Singapore, as well as within Indonesia. In Malaysia and Thailand, collaborative initiatives are expected to begin operations in the coming years.
- In Japan, the world's first hydrogen combustion test on a large marine engine has been conducted.

Table 4-14: Examples of Zero-emission Vessels Projects

Country	Fuel	Overview
Australia, Singapore	Dual-fuel ammonia	An Australia-initiated project converted a four-stroke engine and obtained the world's first ammonia fuel and bunkering notation. The engine was built and tested in Singapore and Australia in 2022, completing its first bunkering trial in Singapore in 2024. • Companies. Det Norske Veritas (Norway), Fortescue (Australia), Seatrium (Singapore)
Indonesia	Dual-fuel ammonia	Two ammonia-ready dual-fuel engine ships were purchased and entered operation by 2023. • Company. Pertamina International Shipping
Japan	Dual-fuel hydrogen	The world's first 100% hydrogen combustion test on a large marine two-stroke engine, with a 50-centimetre bore, converted from a gas injection engine, was completed in Japan in March 2024. • Companies. Maschinenfabrik Augsburg-Nürnberg (Germany), Mitsui E&S (Japan)
Malaysia, Thailand	Dual-fuel ammonia	PTT Public Co., Ltd. signed a memorandum of understanding with AET Tankers Holdings Sdn. Bhd. for the design and construction feasibility of two zero-emission tankers running on ammonia. The construction of the shipyard has yet to be disclosed. Delivery is scheduled for late 2025 and early 2026. • Companies. AET (Singapore), PTT (Thailand)

Sources: Det Norske Veritas (2024), Maritime and Port Authority of Singapore (2024), Pertamina International Shipping (2024), MAN Energy Solutions (2024), PTT (2022).

Initiatives to establish supply bases for zero- or low-emission fuels are also emerging.

- Ammonia bunkering has been successfully conducted in several ports, whilst Singapore carried out the world's first methanol bunkering operation in 2023 (Table 4-15). In Indonesia, a project aiming to commence commercial operations by 2027 is under development.

Table 4-15: Examples of Initiatives as Zero-emission Fuel Supply Hubs

Country	Fuel	Overview
Australia	Ammonia	In September 2024, a proxy ammonia bunkering pilot was conducted at the Pilbara Ports Authority. This ship-to-ship transfer operation simulated future ammonia bunkering scenarios in the absence of both ammonia-fuelled vessels and dedicated ammonia bunkering ships. • Port. Dampier • Company. Global Centre for Maritime Decarbonisation Consortium (Singapore)
Indonesia	Ammonia	The Green Ammonia Initiative from Aceh Project, a joint venture led by PT Pertamina International Shipping (PTPI) with Toyo Engineering and ITOCHU Corp., aims to establish a renewable-based ammonia value chain, from production to marine fuel supply, centred on existing facilities near the Strait of Malacca. Commercial operations are anticipated in 2027. • Port. Near Aceh • Companies. PTPI (Indonesia), Toyo Engineering (Japan), ITOCHU (Japan)
Japan	Ammonia	Ammonia bunkering operations via truck-to-ship transfer were successfully executed at the Port of Yokohama, with fuel supplied by Resonac Corp. Following additional trials, Japan's Energy for a New Era (JERA) is expected to begin supplying ammonia fuel to its designated vessel operator. • Port. Yokohama • Company. JERA
Malaysia	Methanol	Development of a green bunkering ecosystem for methanol fuelling is underway in the Sungai Pulai region. The Port of Tanjung Pelepas (PTP) has committed RM26 billion over 5 years (to 2030) for infrastructure projects, including a green fuel terminal. • Port. Tanjung Pelepas • Company. PTP
Singapore	Methanol	In 2023, Singapore conducted the world's first biomethanol bunkering operation at the Vopak Terminal. The Maritime and Port Authority is developing a technical reference for methanol bunkering in collaboration with the Standards Development Organisation at the Singapore Chemical Industry Council. • Port. Singapore • Company. Hong Lam Marine

Sources: Global Centre for Maritime Decarbonisation (2024), Pupuk Indonesia (2024), Japan's Energy for a New Era (2024), Malaysian Investment Development Authority (2024).

4.4.2 Key policies and regulations

To become ports 'chosen by the world's cargo owners and shipping companies', several countries are working not only to decarbonise port facilities but also to position themselves as hubs for the supply of zero-emission fuels.

Government-led initiatives have emerged to make ports preferred choices for cargo owners and shipping lines by promoting decarbonisation across the entire supply chain.

These initiatives aim to drive industrial transformation and improve competitiveness by developing infrastructure for the reception of hydrogen, ammonia, and other next-generation fuels in ports and coastal areas where industries are concentrated.

Whilst several countries are prioritising GHG emissions reduction through port efficiency improvements, digitalisation, and renewable energy integration, others are advancing infrastructure development to support the bunkering of zero-emission fuels (Table 4-16).

Table 4-16: Government Efforts for Marine Transport Decarbonisation

Country	Overview
Australia	• The Maritime Emission Reduction National Action Plan, led by the Department of Infrastructure, Transport, Regional Development, Communications, Sports and the Arts, seeks to advance Australia's decarbonisation objectives through initiatives such as the development of 'green export'–oriented ports, zero-emission fuel bunkering infrastructure, and emerging low-carbon industries. • Whilst various initiatives, such as establishing clean hydrogen industrial hubs, zero-emission fuel-ready infrastructure, renewable shore power, and international hydrogen value chains, are underway or planned, national coordination remains in progress.
Brunei Darussalam	N/A
Cambodia	N/A
Indonesia	• The Ministry of Energy and Mineral Resources supports this strategy via regulatory measures on fuel consumption under the Green Ship Strategy. • Key port-related decarbonisation efforts include operational efficiency improvements (e.g. LED lighting, solar cells), development of renewable-based green port standards, and digitalisation. • Indonesia has yet to formalise its position on green shipping corridors, pending the readiness of zero-emission fuel infrastructure and production processes.
Japan	• The Carbon Neutral Port (CNP) initiative of Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) promotes decarbonisation in ports. MLIT has supported the development of Port Decarbonisation Promotion Plans, prepared by port management bodies under the Port and Harbour Act, providing assistance and advice for plan formulation. • The initiative has promoted the development of LNG bunkering bases, introduced low-carbon cargo-handling equipment, and implemented demonstration projects, starting in 2025, for hydrogen-powered cargo-handling equipment. In 2025, it established CNP certification for container terminals to objectively evaluate decarbonisation efforts. • Japan and ASEAN are collaborating through the ASEAN–Japan Port Technology Joint Meeting, led by MLIT, to develop regionally applicable guidelines for carbon-neutral ports, to be finalised at the 2026 ministerial meeting following discussions in 2025.

Country	Overview
Lao PDR	• The government targets to replace 10% of transport fuel with biofuels by 2025.
Malaysia	• The government targets a 40% share of low-carbon fuels in maritime transport by 2050, whilst positioning Malaysia as a regional LNG refuelling hub through incentives, policies, and other forms of support. • Maritime decarbonisation is incorporated into the National Energy Transition Roadmap, with a focus on the feasibility of future fuel bunkering (e.g. e-ammonia and e-methanol). • Major port authorities and private operators have launched green port initiatives, including operational efficiency, technological enhancement, and renewable energy deployment. The Port of Tanjung Pelepas has undertaken a joint study to position itself as a regional green bunkering hub.
Philippines	• The government intends to set a baseline for GHG emissions in the shipping industry and reduce them in line with the Green Port programme. • At a seminar on realising carbon-neutral ports in the ASEAN region, the Philippine Ports Authority presented initiatives such as adopting renewable energy for terminals and administrative facilities, digitalisation, coastal revitalisation, and optimising port operations through measures such as cold ironing.
Singapore	• In line with achieving net-zero emissions by 2050, the government is establishing a bilateral green digital shipping corridor and will electrify all new port vessels from 2030, ensuring compatibility with B100 biofuels and net-zero fuels. • The *Maritime Singapore Decarbonisation Blueprint*, published by the Maritime and Port Authority of Singapore, emphasises operational efficiency, infrastructure for a range of future fuels, and readiness for e-methanol and ammonia. It also provides incentives for green vessel adoption. Efficiency measures include integrating renewable energy and digital technologies, centralising container terminal operations, and developing port-centric industrial clusters linked to sectors such as steel.
Thailand	• The Port Authority of Thailand Green Strategic and Policy aims for 10% decarbonisation by 2030 and carbon neutrality by 2050. • Green Port projects focus on smart port development and green ship deployment. • Decarbonisation efforts include automation, the adoption of alternative and renewable energy sources, deployment of energy-efficient equipment, and implementation of the slow streaming concept.
Viet Nam	• The Green Port Development Strategy, led by the Vietnam Maritime Administration, makes green port construction and operation compulsory by 2030. Core measures include deploying clean energy (e.g. renewables, LNG, ammonia, and hydrogen), applying energy-saving technologies in port activities, digitalisation, and implementing environmental measures such as pollution prevention, waste treatment, and sustainability certification.

Sources: Department of Infrastructure, Transport, Regional Development, Communications and the Arts (Australia) (2023), Ministry of Land, Infrastructure, Transport and Tourism (Japan) (n.d.), Ministry of Energy and Mineral Resources of the Republic of Indonesia (2023), Ministry of Transportation of the Republic of Indonesia (2022), Lao Institute for Renewable Energy (2011), Centre for Maritime Economics and Industries, Maritime Institute of Malaysia (2024), UN ESCAP Committee on Transport, Port of Tanjung Pelepas (n.d.); Ministry of Economy (2023), Philippine Ports Authority (2024), Maritime and Port Authority of Singapore (2022), Ministry of Transport (2021), Government of Vietnam (2022).

4.5 Fuel Production – Biofuel

4.5.1 Market trends

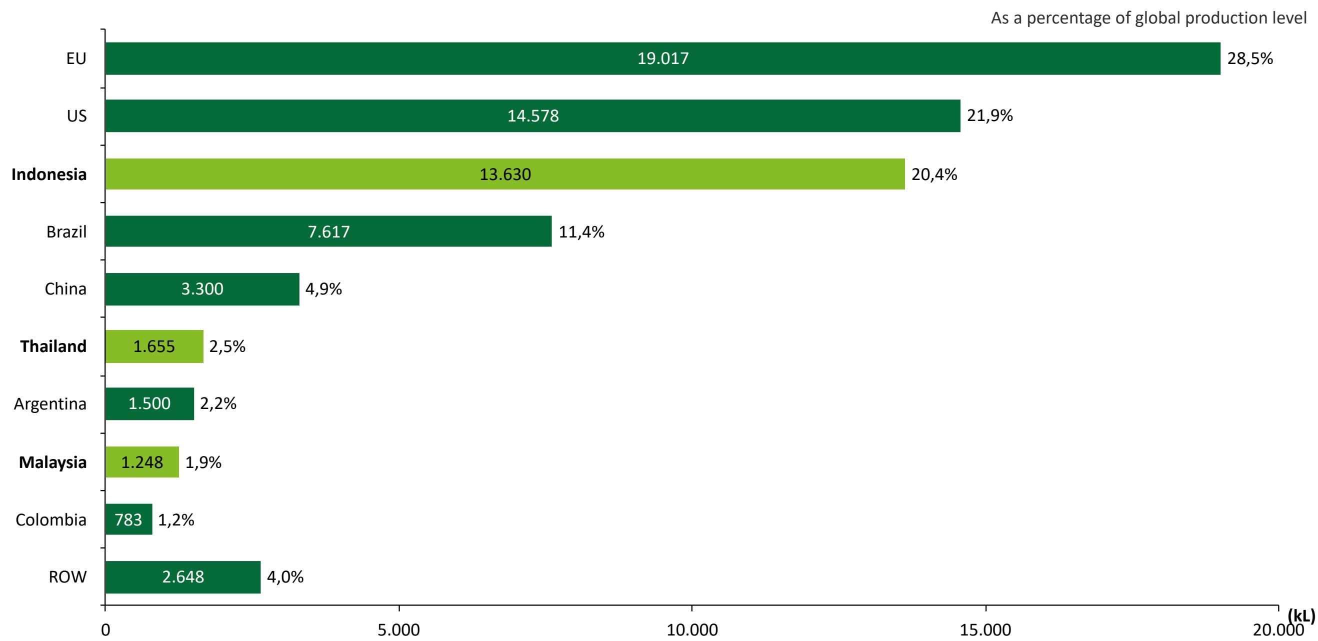
AZEC trends

Biofuels are readily utilised in existing applications, and many AZEC partner countries with abundant bioresources are investing in this promising technology.

In ASEAN, several countries with abundant bioresource endowments are actively producing biofuels.

- Indonesia ranks amongst the world's largest biodiesel producers, contributing about 20% of global production, largely due to its substantial palm oil output (Figure 4-16). Thailand and Malaysia also account for significant volumes.

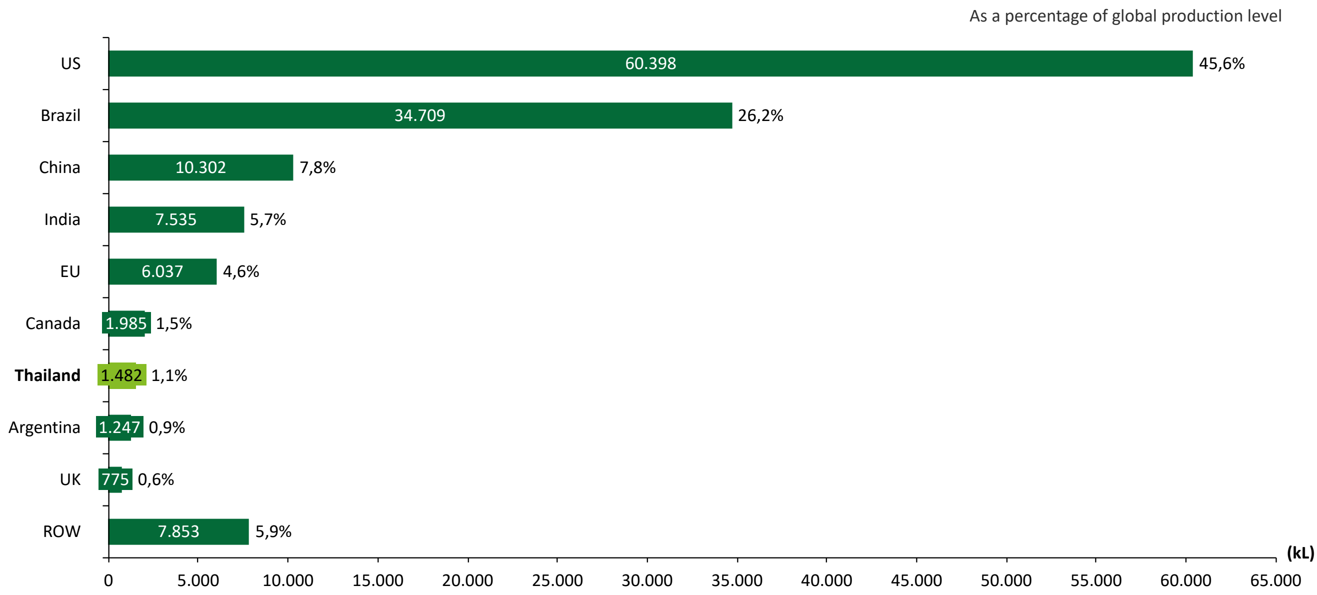
Figure 4-16: Major Biodiesel-producing Countries, 2023



EU = European Union, ROW = rest of the world, US = United States.
Source: Based on data from OECD Data Explorer.

- Although bioethanol represents a relatively small share of the global market, Thailand's use of sugarcane and cassava as feedstocks has supported domestic production, which accounts for about 1.1% of global output (Figure 4-17).

Figure 4-17: Major Bioethanol-producing Countries, 2023



EU = European Union, kL = kilolitre, ROW = rest of the world, UK = United Kingdom, US = United States.

Source: Based on data from OECD Data Explorer.

Despite the growth of biofuel production, output remains dominated by conventional biofuels derived from edible sources such as palm oil, sugarcane, or cassava.

Nevertheless, several projects are emerging that utilise non-edible feedstocks, such as agricultural residues, for the production of advanced biofuels and SAF (Table 4-17).

- A diverse range of initiatives based on non-edible feedstocks can be observed, including projects that utilise food waste residues, used cooking oil, and algae such as Euglena.
- Whilst many projects remain at their early stages – often limited to MoUs or feasibility studies – significant progress has been made in select cases.
- Notably, Finland-based Neste completed construction of the world's largest SAF production facility in Singapore in 2023, positioning the country as a strategic hub for SAF supply across the Asia-Pacific region.

Table 4-17: Examples of Biofuel Production from Non-edible Feedstocks

Country	Feed Stock	Fuel	Overview
Indonesia	Coconut waste (Non-food standard coconuts)	SAF	A SAF production facility utilising waste coconut feedstock is under construction in South Sumatra. • Companies. National Research and Innovation Agency, ABE Indonesia Berjaya, Green Power Development Corporation of Japan • Daily capacity. 100 tonnes of crude coconut oil
	Palm oil mill effluent	SAF	An advanced biofuel plant using palm oil mill effluent is under development in North Sumatra. • Companies. NEXTCHEM, Tripatra • Annual capacity. 60,000 tonnes • Completion. 2027
Malaysia	Euglena	Renewable diesel, SAF	Construction of an advanced biofuel facility, designed for potential expansion to third-generation technologies, was expected to begin in late 2024. • Companies. PETRONAS, Euglena, Eni • Annual capacity. 650,000 tonnes of feedstock • Daily capacity. 12,500 barrels • Operational. Second half of 2028
	Used cooking oil, wastewater from palm oil mills	SAF	An MoU has been signed for a major biofuel production hub in Johor. • Companies. EcoCeres, partners • Annual capacity. 350,000 tonnes • Operational. End of 2025
	Non-edible oil feedstock trees	SAF	An MoU was signed in 2023 for a joint feasibility study on SAF production and supply chain development, including assessment of non-edible oil feedstock trees. • Companies. PETRONAS, Idemitsu
Singapore	Used cooking oil	SAF	Neste completed construction of the world's largest SAF production facility in 2023. • Company. Neste • Annual capacity. Up to 2.6 million tonnes, of which 1 million tonnes may be allocated to SAF
Thailand	Bagasse	Bioethanol	An MoU was signed for the development of a bagasse-based bioethanol plant. Production capacity remains under review. • Companies. Global Green Chemicals (subsidiary of PTT), Sumitomo Corp. • Construction schedule. As early as 2025
	Cassava processing waste	Bioethanol	Ongoing research on advanced bioethanol derived from cassava industrial residues. • Company. Kao • Demonstration plant operation schedule. Around 2027

SAF = sustainable aviation fuel.

Sources: National Research and Innovation Agency (2024), Kontan, Maire SpA (2024), Petroliam Nasional Berhad (2022, 2023, 2024), EcoCeres (2023, 2024), Neste (2023), Singapore Economic Development Board (2022), The Business Times (2023), Nikkei Asia (2022), KrAsia.

4.5.2 Key policies and regulations

The relationship between supply and demand resembles the 'chicken-and-egg' dilemma, necessitating sustained medium- to long-term policy commitment. Consequently, governments are pursuing integrated strategies that combine infrastructure development to stimulate demand, mandatory blending ratios, and investment incentives to expand production capacity.

Stabilising the cost of biofuels and expanding their use as alternative fuels require simultaneous initiation of both supply and demand.

- From the demand perspective, governments are enforcing mandatory biofuel blending ratios whilst also offering subsidies and tax incentives to stimulate consumption (see 'Road Transport' section).
- From a supply perspective, efforts to promote production include value-added tax exemptions, corporate income tax relief, and other incentives (Table 4-18).
- In Indonesia and Malaysia, financial mechanisms are in place to bridge the price gap between biodiesel and conventional fuels, addressing cost barriers to adoption.

Table 4-18: Government Efforts to Promote Biofuel Production

Country	Overview
Australia	Low-carbon liquid fuels, including advanced biofuels, are identified as a priority sector under the Future Made in Australia plan, making them eligible for pre-commercial innovation, demonstration, and deployment funding. The guarantee-of-origin scheme, a voluntary certification programme, helps attract investment by verifying emissions and production attributes. Imported biofuels are subject to import customs duties, making domestic production more economically attractive.
Brunei Darussalam	N/A
Cambodia	Biofuel-related activities, classified under green energy, benefit from VAT exemptions on domestic inputs, income tax holidays, and progressive tax incentives to support industry growth.
Indonesia	(Focused on biodiesel) The Plantation Fund Management Agency subsidises the price differential between biodiesel and fossil diesel using palm oil export levy revenues. Biodiesel producers are subject to annual quota allocations, whilst palm oil commodities are levied to encourage domestic biodiesel production. Incentives include VAT and import duty exemptions, whilst non-financial support involves the provision of seeds and saplings.
Japan	The government provides capital investment tax relief and loss carry-forward benefits for biofuel businesses. In addition, the Green Innovation Fund offers grants to support the development and scaling of the domestic biofuel industry.

Country	Overview
Lao PDR	Biofuel production operates under a concession model, enhancing risk management and oversight. Inclusion in the investment promotion scheme enables VAT and import duty exemptions, income tax holidays in designated regions, 3-year loss carry-over, and streamlined permitting and visa procedures.
Malaysia	(Focused on biodiesel) Subsidies are applied through the automatic pricing mechanism, which sets the market price of biodiesel. Additional incentives include capital expenditure offsets, subsidies for blending facilities and distribution, and tax relief. In 2025, the staggered export levy on crude palm oil products was increased to encourage downstream activities.
Philippines	Sales VAT exemptions apply to raw materials used in biofuel production. Raw ethanol (>99%) for fuel use is subject to preferential import tax treatment, whilst import restrictions prioritise domestic production unless local supply is insufficient.
Singapore	N/A
Thailand	Imports of biofuels and their raw materials are restricted. The biofuel sector is classified as a priority industry by the Board of Investment, qualifying for import duty exemptions and corporate income tax holidays of up to 8 years.
Viet Nam	As part of its renewable energy investment incentives, biofuel projects benefit from corporate income tax deductions, land-use fee exemptions, and import duty relief. Additional support is provided by the Sustainable Energy Promotion Fund, which finances activities such as compensation for construction and research funding.

VAT = value-added tax.

Sources: Clean Energy Council (Australia) (2024), The Treasury of Australia (2024), Council for the Development of Cambodia (n.d.), Open Development Cambodia (2021), U.S. Department of Agriculture, Foreign Agricultural Service (2023, 2024, 2024b, 2024c), Ministry of Economy, Trade and Industry (Japan) (2021), National Assembly of Lao People's Democratic Republic (2016), Lao Institute for Renewable Energy (2011), ARC Group Securities (2024), The Malaysian Reserve (2024), Department of Energy (Philippines) (n.d.), Congress of the Philippines (2006), Civil Aviation Authority of Singapore (n.d.), Thailand Board of Investment (2025), Government of Viet Nam (2022), American Coalition for Ethanol (2023).

Although comprehensive frameworks to promote advanced biofuel production remain limited, certain government-supported initiatives are underway to develop the necessary technologies.

- Table 4-19 outlines examples of SAF projects using locally available resources such as palm oil residues and agricultural waste. These initiatives indicate early but important progress towards building the technological foundations necessary for stable medium- to long-term supply.

Table 4-19: Government-supported Development of Biofuels from Non-food Feedstocks

Country	Feed Stock	Fuel	Overview
Australia	Agricultural waste-fed yeast	SAF	Through its SAF Funding Initiatives, the Australian Renewable Energy Agency has allocated AUD9 million to support Jet Zero Australia's Project Ulysses, which aims to develop domestic SAF production capacity and value chains. The Government of Queensland, under the Queensland New-Industry Development Strategy, has committed an additional AUD5 million. • Government agency. National Research Council
Indonesia	Palm acid oil	Biodiesel	The Crude Palm Oil Fund Agency funded a study to optimise the conversion of palm oil mill effluent, particularly palm acid oil, into biodiesel. • Government agency. Plantation Fund Management Board
Japan	Used cooking oil	SAF	A subsidy was granted to Cosmo Oil and Mitsui through NEDO (under the Ministry of Economy, Trade and Industry) to support demonstration and supply chain development for SAF derived from used cooking oil. • Government agency. NEDO
Malaysia	Used cooking oil	SAF	An MoU was signed between MPOB and PETRONAS to explore palm-derived products and waste oils for SAF production. • Government agency. MPOB
Thailand	Agricultural waste-fed yeast	SAF	The National Research Council of Thailand awarded a grant for yeast-based SAF research, focusing on genetically modified strains to scale up production. • Government agency. National Research Council

VAT = value-added tax.

MPOB = Malaysia Palm Oil Board, NEDO = New Energy and Industrial Technology Development Organization, SAF = sustainable aviation fuel.

Sources: Jet Zero (2024), Plantation Fund Management Agency (2024), Cosmo Energy Holdings (n.d.), Cosmo Oil (2025), Reuters (2023), Momkaew, C. (2024).

4.6 Fuel Production – Hydrogen and Ammonia

4.6.1 Market trends

AZEC trends

Countries with limited access to renewable energy face substantial barriers to the commercialisation of low-carbon hydrogen and ammonia production. Nevertheless, progress is being made in developing production facilities and associated infrastructure.

- Despite the challenges of securing sufficient renewable energy, AZEC partner countries are pressing ahead with hydrogen production projects and related infrastructure. Activity across the region continues to expand.

- Whilst several initiatives remain at the pilot stage or are currently the subject of joint feasibility studies, several renewable-based hydrogen and ammonia projects are emerging (Table 4-20).
- Countries with abundant renewable resources and significant CO_2 storage capacity are considered to hold substantial potential for large-scale low-carbon hydrogen production.
  (See also 'Zero-emission Power Initiative').

Table 4-20: Examples of Hydrogen and Ammonia Production and Infrastructure Projects

Country	Company	Overview
Australia	Murchison Green Hydrogen	A project designed to produce renewable-based ammonia. Phase 1 is targeted for completion by the end of 2029. The development encompasses a hydrogen production and storage facility, an ammonia plant, and a marine export terminal. • Annual capacity: 2 million tonnes • Full operation: Early 2032
Brunei Darussalam	Chiyoda, Mitsubishi, NYK, ENEOS (Japan)	A demonstration of the world's first international hydrogen supply chain, spanning over 4,000 km between Brunei Darussalam and Japan. • Maximum annual capacity: 210 tonnes • Operational period: January–December 2020
Indonesia	PLN	Indonesia's first operational renewable-based hydrogen facility. The plant produces 51 tonnes of hydrogen annually, of which 43 tonnes are available for industrial, transport, and power generation use. • Annual capacity: 51 tonnes • Operational since 2023
Japan	Air Water, Kajima Corp.	Japan's first commercial-scale hydrogen production plant using livestock manure. The facility supplies renewable-based hydrogen for local industries, agriculture, and fuelling stations for heavy-duty vehicles and fuel cell electric vehicles. • Daily capacity: 70,028.09 litres • Operational since 2022
Lao PDR	AIF, RATCH (Thailand), Roni Tron (Thailand)	A joint study was launched in November 2024 to assess renewable-based hydrogen and ammonia production for industry, transport, and power generation. No production capacity figures have yet been released.
Malaysia	Hydrexia, WEDSB	A multi-phase initiative covering the full renewable-based hydrogen value chain, including production, transport, storage, and distribution via refuelling stations. Capacity figures have not yet been announced. • Scheduled completion: 2040
Viet Nam	PetroVietnam, PV GAS, JICA	A public–private partnership to produce and supply renewable-based hydrogen for industrial and transport applications. A pilot facility was registered in late 2024 or early 2025, but production capacity is yet to be disclosed.

AIF = Asia Investment, Finance, and Commerce Group; JICA = Japan International Cooperation Agency; NYK = Nippon Yūsen Kabushiki Kaisha; PLN = Perusahaan Listrik Negara.

Sources: Department of Climate Change, Energy, the Environment and Water (Australia) (2025), Murchison Green Hydrogen (n.d.), Crolius, S.H. (2017), Department of Energy, Prime Minister's Office (Brunei Darussalam) (2020), National Research and Development Agency, New Energy and Industrial Technology Development Organization (2017), Carter, P. and Kitty Knowles (2025), British Broadcasting Corporation, Team Sapporo-Hokkaido (2025), Perusahaan Listrik Negara (2023), Fuel Cells Works (2024), Hydrexia (2024), Viet Nam News (2025), Petrovietnam Gas (2025).

4.6.2 Key policies and regulations

The development of technologies for hydrogen and ammonia applications, production facilities, and equipment requires substantial funding. Governments are therefore signalling medium- to long-term policy commitments to encourage private sector participation.

AZEC partner countries have developed strategies and roadmaps to promote the medium- to long-term use of hydrogen produced with lower CO_2 emissions (Table 4-21).

- Hydrogen has significantly different properties compared with conventional fossil fuels, meaning that existing combustion equipment and distribution infrastructure often cannot be used without modification. Practical implementation necessitates substantial investment in end-use applications, production facilities, and supporting infrastructure.

Table 4-21: Key Hydrogen and Ammonia Strategies

Country	Published Year	Policy Overview
Australia	2024	**National Hydrogen Strategy** Sets a production target of 15 million tonnes of renewable-based hydrogen per year by 2050, with a stretch potential of 30 million tonnes. Export targets are 0.2 million tonnes per year by 2030, rising to a stretch potential of 1.2 million tonnes. Prioritises renewable-based hydrogen and associated industries, including ammonia, green metals, long-haul and heavy transport, and power generation. AU$500 million has been committed to develop regional hubs at Pilbara, Kwinana, the Hunter, and Port Bonython.
Brunei Darussalam	N/A	N/A
Cambodia	2021	**Long-term Strategy for Carbon Neutrality** Highlights the government's intention to study hydrogen and other zero-carbon fuels as long-term fuel alternatives for the road freight transport sector.
Indonesia	2023	**National Hydrogen Strategy** Commercial-scale production is expected after 2030, with domestic renewable-based hydrogen capacity reaching 87.2 GWh by 2060 under the net-zero emissions scenario.
	2025	**National Hydrogen and Ammonia Roadmap** Targets by 2030. Renewable-based hydrogen, 1 million tonnes per year; fossil-based hydrogen with CCUS, 0.02 million tonnes per year; renewable-based ammonia, 0.04 million tonnes per year; fossil-based ammonia with CCUS, 1.7 million tonnes per year. By 2060. Renewable-based hydrogen, 17 million tonnes per year; fossil-based hydrogen with CCUS, 0.15 million tonnes per year; renewable-based ammonia, 7.6 million tonnes per year; fossil-based ammonia with CCUS, 5.9 million tonnes per year. Positions Indonesia as a regional hub for low-carbon hydrogen and ammonia in ASEAN.

Country	Published Year	Policy Overview
Japan	2017 (updated 2023)	**Basic Hydrogen Strategy** Sets supply targets of up to 3 million tonnes per year by 2030, 12 million tonnes per year by 2040, and 20 million tonnes per year by 2050, covering both domestic production and imports. As renewable energy and CCUS remain relatively costly, policy incentives aim to strengthen domestic industry participation in both domestic and international low-carbon hydrogen markets.
Lao PDR	2024	**National Green Hydrogen and Ammonia Roadmap** Targets production across four phases. 700 kg per day by 2027; 20,000 tonnes per year by 2030; 280,000 tonnes per year by 2040; and 1.4 million tonnes per year by 2050. During Phase 3 (2030–2040), Lao PDR aims to export hydrogen (likely as ammonia), with a projected export value of US$2.35 billion or 3.35 million tonnes of ammonia by 2050.
Malaysia	2023	**Hydrogen Economy and Technology Roadmap** Aims to produce 1 million tonnes per year by 2030 (0.06% green, 99.94% low-carbon hydrogen) and 7 million tonnes per year by 2050 (49.53% green, 51.14% low-carbon hydrogen) under the business-as-usual scenario. Export volumes are projected to grow from 0.55 million tonnes per year in 2030 to 3.2 million tonnes per year by 2050.
	2023	**National Energy Transition Roadmap** Targets the complete phase-out of grey hydrogen and up to 2.5 million tonnes per year of renewable-based hydrogen production by 2050.
Philippines	2024	**National Policy and General Framework, Roadmap, and Guidelines for Hydrogen in the Energy Sector** Whilst no specific hydrogen targets are provided, hydrogen is recognised as an emerging technology under the renewable energy category. The Philippines aims for renewable energy to account for 35% of the energy mix by 2030, 50% by 2040, and over 50% by 2050. Incentives include income tax holidays, net operating loss carry-over, and accelerated depreciation.
Singapore	2022	**National Hydrogen Strategy** No production targets are disclosed. Singapore expects hydrogen-compatible combined cycle gas turbines to be commercially available by 2030 and expects low-carbon hydrogen to meet up to 50% of electricity demand by 2050. Hydrogen is identified as a key feedstock for low or zero-carbon fuels and industrial use. Owing to high domestic production costs, Singapore positions itself as a hydrogen importer.
Thailand	2024	**Thailand Hydrogen Strategy and Roadmap** Commercial-scale hydrogen production is expected to begin after 2030. Fossil-based hydrogen, fossil-based hydrogen with CCUS, renewable-based hydrogen, and naturally occurring hydrogen will be permitted until 2040, after which supply is to come entirely from renewable-based hydrogen.
	2024	**National Power Development Plan** Reaffirms Thailand's intention to prioritise renewable-based hydrogen.

Country	Published Year	Policy Overview
Viet Nam	2024	**Hydrogen Energy Strategy** Sets targets of 100,000–500,000 tonnes per year of hydrogen (renewable-based and fossil-based with CCUS) by 2030, increasing to 10–20 million tonnes per year by 2050. The country intends to become a renewable-based hydrogen exporter from 2030 onwards, once domestic demand is met. Whilst CCUS is considered, policy preference clearly favours renewable-based hydrogen and its derivatives, such as ammonia, by 2050.

CCUS = carbon capture, utilisation, and storage; GWh = gigawatt-hour; Lao PDR = Lao People's Democratic Republic.

Sources: Department of Climate Change, Energy, the Environment and Water (Australia) (2024), Australian Hydrogen Council (2024), PwC Japan (2023), Ministry of Environment and National Council for Sustainable Development (2021), Ministerial Council on Renewable Energy, Hydrogen, and Related Issues (2023), Ministry of Energy and Mineral Resources of the Republic of Indonesia (2023), Ministry of Energy and Mines (2024), National Economic and Development Authority (Philippines) (2023), Ministry of Science, Technology and Innovation (2023), Department of Energy (Philippines) (2024), Ministry of Trade and Industry (Singapore) (2022), Ministry of Energy (2024), Government of Viet Nam (2024).

4.7 Fuel Production – Other Fuels

4.7.1 Market trends

AZEC trends

E-fuels (synthetic fuels) that are compatible with existing infrastructure and applications are expected to play a vital role in decarbonising the transport sector. Their development is advancing with a medium- to long-term outlook.

In AZEC partner countries, e-fuel production is projected to expand progressively, with gradual steps towards commercialisation. Although many initiatives remain at an early stage, several are moving forward through large-scale demonstration and pre-commercial activities. These developments signal a transition towards broader production capacity and project scaling over the long term (Table 4-22).

Table 4-22: Examples of E-fuel Production Projects

Country	Company	Overview
Australia	Forico	In November 2023, an MoU was announced to support the development of Australia's first e-fuel production facility. Located in Tasmania, construction is scheduled to begin in 2025, with projected annual output reaching 100 million litres of e-petrol by 2028.
Indonesia	Teknologi Alam Semesta, Seagas Karya Indonesia	In March 2024, a successful demonstration of e-fuel production and associated power generation was completed, paving the way for a subsequent large-scale trial.
Japan	Sumitomo Corp.	In March 2024, the electrolyser unit for a domestic e-methane production facility in Japan was completed.
Singapore	IHI Corp., Agency for Science, Technology and Research (A*STAR)	In November 2024, an MoU was signed between a Japanese firm and a Singaporean research agency to accelerate the scaling up of an e-SAF production facility.

MoU = memorandum of understanding, SAF = sustainable aviation fuel.

Sources: Forico (2023), ITM Power (2024), Medcom (2024), IHI Corp. (2024).

4.7.2 Key policies and regulations

Although dedicated regulatory frameworks for e-fuels have yet to be widely established, Table 4-23 indicates that references to such fuels are increasingly being incorporated into broader national hydrogen strategies and energy policies. Specific regulatory structures are expected to emerge in the coming years.

Table 4-23: Key E-fuel Strategies

Country	Published year	Policy Overview
Australia	2023	**National Hydrogen Strategy** E-fuels are eligible for various financial incentives administered by federal and state governments, aimed at promoting the renewable hydrogen industry and low-carbon liquid fuels. Whilst no explicit production target has been set, e-fuels are expected to play a significant role in decarbonising long-haul transport, particularly heavy-duty vehicles, aviation, and the maritime sector post-2040.
Brunei Darussalam	N/A	N/A
Cambodia	N/A	N/A
Indonesia	N/A	N/A
Japan	2017 (updated 2023)	**Basic Hydrogen Strategy** E-fuels are included amongst nine strategic focus areas. Efforts to reach commercial feasibility focus on supporting large-scale and efficient production technologies through the Green Innovation Fund. Policies also support e-fuel distribution via existing gas and petrol infrastructure.
	2025	**Seventh Strategic Energy Plan** This envisions commercialisation of e-fuels by the first half of the 2030s. E-fuels are positioned as key tools for decarbonising transport: e-petrol and e-diesel for road transport, e-methanol for maritime applications, and e-SAF for aviation.
Lao PDR	N/A	N/A
Malaysia	-	**Hydrogen Economy and Technology Roadmap** Recognises the adoption of e-fuels, particularly e-kerosene, for aviation, whilst emphasising the need to modernise infrastructure to support their use.
	2023	**National Energy Transition Roadmap** Highlights a gradual medium- to long- term approach towards adopting e-methanol and e-ammonia, contingent upon commercial availability.
Philippines	N/A	N/A
Singapore	-	**National Hydrogen Strategy** Anticipates increased demand for e-fuels, driven by industrial decarbonisation needs, with synergies across multiple end-use sectors.
Thailand	N/A	N/A

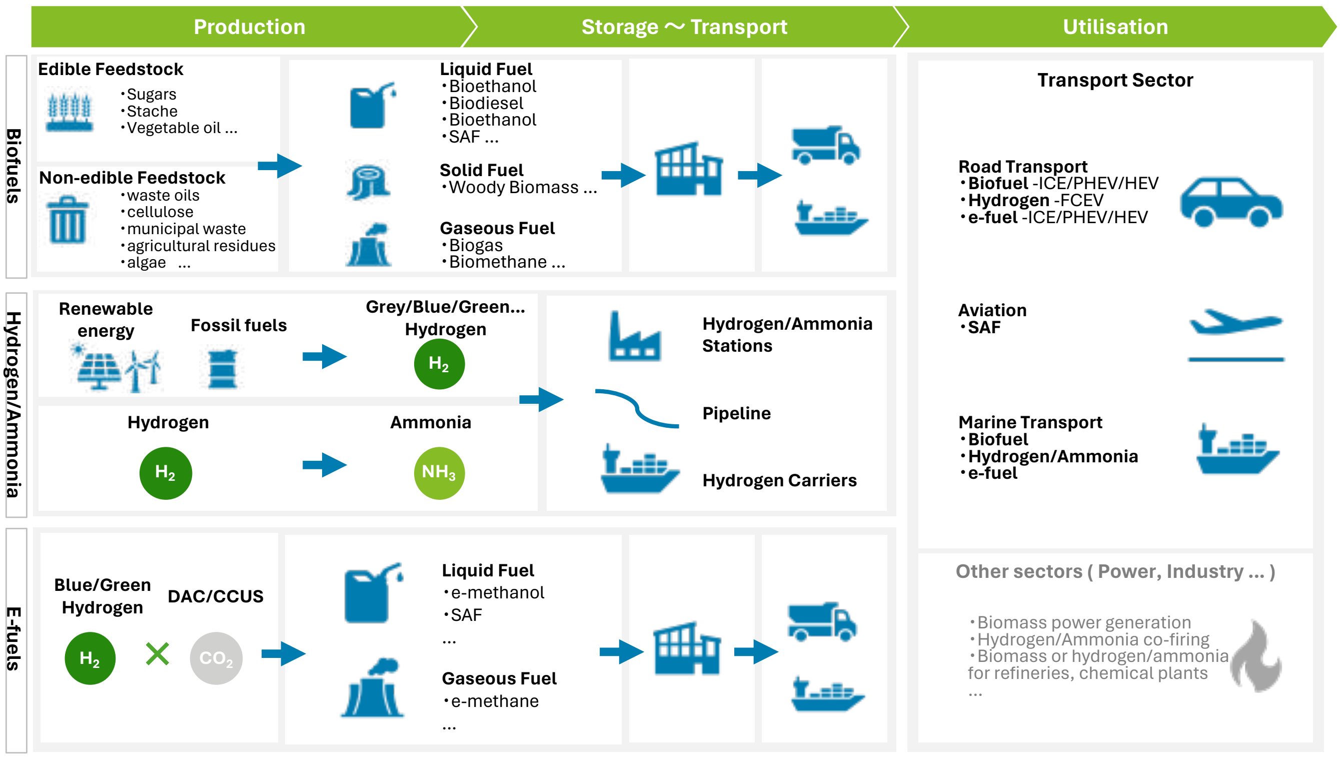
Country	Published year	Policy Overview
Viet Nam	2024	**Hydrogen Energy Strategy** Whilst e-fuels are not explicitly mentioned, the strategy includes pilot projects for hydrogen-derived fuels in transport and industry by 2030, and a full-scale transition by 2050.

Sources: Department of Climate Change, Energy, the Environment and Water (Australia) (2024), Ministerial Council on Renewable Energy, Hydrogen, and Related Issues (2023), Ministry of Economy, Trade and Industry, Japan (2025), Ministry of Science, Technology and Innovation (2023), Ministry of Economy (2023), Ministry of Trade and Industry (Singapore) (2022), Ministry of Industry and Trade (Viet Nam) (2024).

4.8 Progress of Individual Projects

The Sustainable Fuel Initiative has provided an overview of biofuels, hydrogen and ammonia, and other emerging fuels such as e-fuels, covering the entire value chain from production to storage and distribution, as well as their application across the transport sector.

Figure 4-18: Overview of Fuel Sector Project Coverage



For detailed information regarding utilization in other sectors, please refer to the Power Initiative and Next Generation Industry Initiative.

CCUS = carbon capture, utilisation, and storage; DAC = direct air capture; FCEV = fuel cell electric vehicle; HEV = hybrid electric vehicle; ICE = internal combustion engine; PHEV = plug-in hybrid electric vehicle; SAF = sustainable aviation fuel.

Source: Author (2025).

Amongst the various ongoing projects across AZEC partner countries, selected examples in the field of sustainable fuels are presented below:

Biofuels

Projects involving the production and utilisation of biofuels derived from non-food feedstocks are progressing in AZEC partner countries, including Indonesia, Malaysia, and Thailand.

Heads of Agreement on the Development of Biomethane from Palm Oil Waste

- **Country.** Indonesia
- **Business entities and partners.** JGC Holdings, Osaka Gas, INPEX Corp., Perusahaan Gas Negara Tbk. (a Pertamina subsidiary)
- **Project overview.** Joint commercialisation assessment and planning for palm-oil waste biomethane fuel, distributed via the national gas grid
- **Project goal.** Preparation for investment and establishment of a biomethane manufacturing company
- **Progress overview.** Detailed commercialisation studies are underway, whilst investment decisions and the establishment of a special purpose company remain under review. A final investment decision (FID) is targeted by the end of 2025, with construction scheduled to begin in 2026 and commercial operation in 2027.

Memorandum of Understanding for Supply of Palm Kernel Shells and Gas to PT ATP Bio Indonesia Plant

- **Country.** Indonesia
- **Business entities and partners.** PT Santomo Resources Indonesia, PT Santomo Biomass Indonesia, PT ATP Bio Indonesia
- **Project overview.** Establishment of a stable supply of materials for bio-coke production by PT ATP Bio Indonesia, through collaboration with PT Santomo Biomass Indonesia (supplier of palm kernel shell) and PT Santomo Resources (supplier of gas and other fuels)
- **Project scale.** About US$71 million
- **Production scale.** Maximum bio-coke production capacity of 90,000 metric tonnes per year
- **Project goal.** Expansion towards full production capacity by 2030
- **Progress overview.** The project timeline has been rescheduled, with construction to commence by April 2025 and commercial operations expected to start in October 2025.

Collaboration to Accelerate the Development of Sustainable Aviation Fuel for the Aviation Industry

- **Country.** Malaysia
- **Business entities and partners.** Idemitsu Kosan, PETRONAS
- **Project overview.** Enhancement of supply chain capabilities and optimisation of the route to market for SAF, aimed at producing lower-carbon energy solutions for customers worldwide.
- **Project goal.** Conduct a feasibility study on scaling-up bio-feedstock options (including non-edible plants), analysing production costs, and ensuring a steady and efficient SAF supply chain.
- **Progress overview.** A steering committee convened in 2024 agreed to explore SAF offtake from PETRONAS by 2030 and to establish a joint central platform for research, training, and feedstock cultivation. A demonstration project is planned for 2025, with further collaborative agreements on bio-feedstock cultivation expected in the near future.

Memorandum of Understanding on the Promotion of Carbon Neutrality through Effective Utilisation of Palm Oil–derived Waste

- **Country.** Malaysia
- **Business entities and partners.** JGC Holdings, Japan NUS Co. Ltd., Gas Malaysia Sdn. Bhd.
- **Project overview.** Joint feasibility study on the production and sales of biofuels and biochemicals derived from palm oil industry waste materials.
- **Production scale.** 5,000 tonnes of biomethane per year
- **Project goal.** Explore joint business opportunities, commercialisation, technology development, and solutions for the effective use of waste materials to produce biofuels and biochemicals (e.g. from palm oil mill effluent, empty fruit bunches, and waste wood).
- **Progress overview.** Following completion of the feasibility study, project members are currently discussing implementation.

Joint Study on the Development of Next-generation Automotive Fuels

- **Country.** Thailand
- **Business entities and partners.** Mitsubishi Corp., Tri Petch Isuzu Sales, PTT Public Co., Ltd.
- **Project overview.** Expansion of hydrotreated vegetable oil (HVO)–blended fuel use to decarbonise existing ICE vehicles, which remain essential to Thailand's economic growth. The HVO is derived from waste oil produced domestically.
- **Project goal.** Assess the impact of alternative fuels on ICE vehicle performance, functionality, decarbonisation potential, and adoption challenges.
- **Progress overview.** Road tests covering 20,000 km were conducted in 2024–2025, confirming that a 30% HVO blend in B7 delivers efficiency and technical performance comparable to conventional 100% B7.

Hydrogen and Ammonia

Significant progress is being observed in hydrogen and ammonia production and supply chain development projects across AZEC partner countries, including Australia, Indonesia, Malaysia, and Thailand.

Heads of Agreement for Investment and Offtake from the Murchison Green Hydrogen Project, Western Australia

- **Country.** Australia
- **Business entities and partners.** Sumitomo Corp., Copenhagen infrastructure partners
- **Project overview.** Development and offtake of a renewable-based ammonia production project in Western Australia
- **Project scale.** US$8 billion
- **Production scale.** 856,334 tonnes of ammonia per year
- **Progress overview.** The project was awarded Commonwealth major project status in 2024 and secured US$814 million in March 2025. With pre-front-end engineering design (pre-FEED) completed, the project is now undergoing an early contractor involvement process, which will lead to FEED in late 2025. An FID is scheduled for late 2026, with production expected to commence in 2029.

Green Ammonia Initiative from Aceh

- **Country**. Indonesia
- **Business entities and partners.** Toyo Engineering Corp., ITOCHU Corp. and PT Pupuk Indonesia (Persero)
- **Project overview.** Establishment of a comprehensive value chain by utilising an existing facility in the Aceh Special Economic Zone to produce renewable-based ammonia, to be procured as marine fuel. This initiative represents the first commercial-scale project for renewable-based ammonia production for maritime use in both Indonesia and globally.
- **Progress overview.** The project is progressing through the ongoing FEED process. FID is targeted for the second half of 2025, alongside the establishment of a joint venture company in the second quarter of 2025. Commercial operations are targeted to start in 2027.

Green Hydrogen and Methylcyclohexane Production Project in Sarawak (Project H2ornbill)

- **Country.** Malaysia
- **Business entities and partners.** ENEOS Corp., Sumitomo Corp., SEDC Energy
- **Project overview.** Development of the first large-scale hydrogen and methylcyclohexane (MCH) production plant in Southeast Asia, supported by a regional supply chain. The partnership also involves hydropower development in Sarawak, with products transported to Japan by sea.
- **Project goal.** Start commercial operations within fiscal year 2030, supplying renewable-based hydrogen and MCH to Japan via marine transport
- **Progress overview.** Engineering, procurement, and construction planning and FEED preparations are ongoing, with FEED scheduled for completion in 2025 to ensure timely production by fiscal year 2030

Development of Clean Hydrogen and Ammonia Value Chain

- **Country.** Thailand
- **Business entities and partners.** Chiyoda Corp., Mitsui O.S.K. Lines, Mitsubishi Co. (Thailand), Ltd., Electricity Generating Authority of Thailand
- **Project overview.** Production of clean hydrogen and ammonia from renewable energy in southern Thailand, with supply to domestic and international industries for value chain utilisation
- **Project goal.** Establish a renewable energy-based hydrogen and ammonia value chain to serve domestic and overseas markets, including the power sector.
- **Progress overview.** Stakeholders are engaged in further discussions, re-evaluations, and reviews to optimise MCH's competitiveness as a hydrogen carrier, following findings from the 2023 study. Demonstration activities are expected to start after 2030.

Other Fuels – E-fuels

Initiatives related to the production of e-methane are advancing in several AZEC partner countries, notably Australia and Malaysia.

Joint Study Agreement for Pre-FEED Study on E-methane Production in the Cooper Basin

- **Country.** Australia
- **Business entities and partners.** Tokyo Gas, Osaka Gas, Toho Gas, Santos
- **Project overview.** Pre-FEED activities are being conducted for an e-methane production facility at Moomba in the Cooper Basin. The project will synthesise methane through methanation, using renewable-based hydrogen and captured CO_2.
- **Production scale.** More than 130,000 tonnes of e-methane per year (equivalent to about 180 million cubic metres of city gas)

- **Progress overview.** The pre-FEED study is ongoing, to start commercial operations and export to Japan from 2030.

E-methane Production Project in Sarawak

- **Country.** Malaysia
- **Business entities and partners.** Tokyo Gas, Sumitomo Corp., PETRONAS
- **Project overview.** Production of e-methane through methanation in Sarawak, utilising CO_2 emissions from PETRONAS facilities to synthesise fuel for export to Japan.
- **Project goal.** Establish a supply chain to produce e-methane from renewable-based hydrogen in Malaysia and export it to Japan, supporting Japan's decarbonisation goals by utilising existing gas infrastructure.
- **Progress overview.** A feasibility study has been completed. An additional study is underway to reduce production costs in preparation for FEED. The plant is expected to start commercial operations by early 2030.

05

AZEC Next-Generation Industry Initiative

5 AZEC Next-Generation Industry Initiative

5.1 Overall

The industrial sector, as the world's second-largest source of GHG emissions, faces significant challenges in its decarbonisation efforts.

AZEC Sectoral Initiatives towards carbon-neutrality/net-zero emissions – AZEC Initiative to establish Next Generation Industry (AZEC Next Generation Industry Initiative)

Purpose

Manufacturing industry in Asia plays a significant role in its economy, with a relatively high share of manufacturing value-added in its Gross Domestic Product (GDP). Decarbonisation in the manufacturing industry sector is becoming increasingly important as a corporate strategy to respond to the demand from global companies to reduce GHG emissions per product in their whole supply chain. One of the approaches to address the need to establish green manufacturing supply chain and help countries attract foreign direct investment is to create 'carbon neutral industrial parks', where companies in the industrial zone can manufacture their products by using electricity generated from clean power sources and promoting energy efficiency. Furthermore, considering the significant role that automobile industry plays in Asian economy, addressing the decarbonisation in the automotive industry in Asia is also important. This initiative aims to establish next-generation industry in Asia by focusing on the decarbonisation efforts in industrial parks and automobile industry through a range of approaches as follows:

Possible areas of cooperation

- To conduct demonstration projects to support the introduction of energy management and CO_2 emissions visualisation system, energy saving and renewable energy.
- To provide capacity building program to develop human resources to promote energy efficiency.
- To formulate a report towards carbon-neutrality/net-zero emissions in industrial parks, sharing the efforts of exemplary industrial parks which use energy efficiency, renewable energy, or DER effectively.
- To support the development of necessary policies and measures to facilitate decarbonisation in industrial parks, such as through improvement of enabling environments for demand side sector to procure renewables.
- To promote the use of CCUS/Carbon recycling in industrial sector, and to support development of CCS legislation, including dissemination of the CCS guidelines published by Japan Organization for Metals and Energy Security (JOGMEC), and sharing knowledge of cross-border CO_2 transport.

- To develop master plan of energy provision for next-generation automotive industry strategy for ASEAN-Japan to pursue multi pathway transitions by taking advantage of strength of ASEAN and promoting Internal combustion engines (ICEs) and Hybrid Electric Vehicles (HEVs)combined with the use of sustainable fuels while investing in Battery Electric Vehicles (BEVs) for the future.
- To strengthen automotive manufacturing and exportation capabilities in multi-pathways from hybrids to EVs, such as human resource development, supplier support, decarbonisation of manufacturing processes, demonstration of EVs and e-fuels.
- To consider the possibility of using hydrogen and ammonia in industrial parks including FCVs.

Global trends

Companies are increasingly prioritising emissions reductions across their entire supply chains in response to stringent regulations and evolving environmental, social, and governance criteria. Globally, the public and private sectors are implementing initiatives and regulatory measures, such as the Task Force on Climate-related Financial Disclosures (TCFD) and the Corporate Sustainability Reporting Directive, to encourage comprehensive disclosure and reduction of GHG emissions.

CO_2 emissions from the industrial sector are substantial. Various industries are actively pursuing initiatives to reduce their emissions, including those in hard-to-abate sectors, where reductions are particularly challenging.

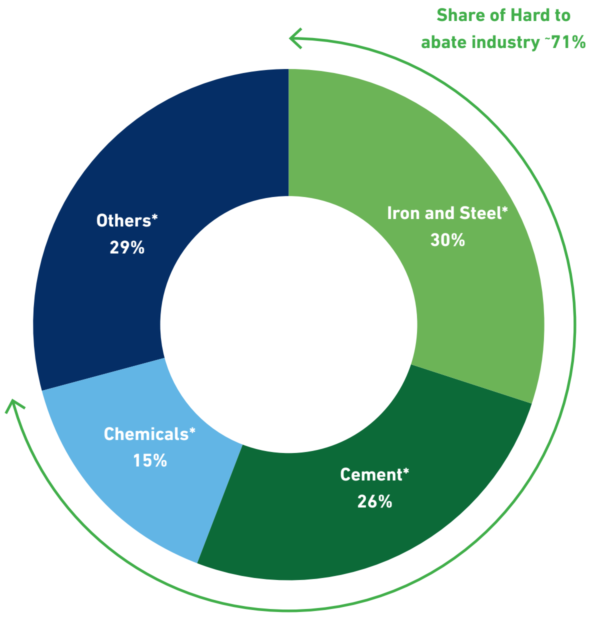
Industry remains a major contributor to global CO_2 emissions, with hard-to-abate industries such as iron and steel, cement, and chemicals presenting the most pressing challenges due to their reliance on fossil fuels. Despite these obstacles, industries are developing and deploying a variety of decarbonisation measures:

- As highlighted in Chapter 2, 'Energy and Climate Trends and Policy Developments', industry is the second-largest source of GHG emissions globally, after the power sector. Decarbonising industry is therefore essential for achieving overall emission reductions.
- Strategies for lowering emissions include enhancing energy efficiency through operational optimisation and equipment upgrades, integrating renewable energy sources such as solar and wind into manufacturing processes, and transitioning from fossil fuel–based systems to sustainable fuels and electric-powered infrastructure. These methods are broadly applicable and can be adopted across a wide range of industries.
- Certain industries, most notably iron and steel, cement, and chemicals, are designated as hard to abate. Their dependence on fossil fuels extends beyond generating high-temperature heat to using them as raw materials in chemical processes. For instance, most current steelmaking pathways rely on coal both as a source of heat and as a reducing agent to convert iron ore to iron, releasing significant volumes of CO_2. Steel and other metal production accounts for a substantial share of global CO_2 emissions, meaning greening these industries would greatly strengthen international climate

action. Similarly, much current ammonia production in the chemical industry uses natural gas, emitting CO_2 as a by-product. In such industries, low-carbon hydrogen pathways present significant opportunities for decarbonisation across a range of sectors.

- Despite the persistent challenges of cost and infrastructure development, efforts to decarbonise hard-to-abate industries are intensifying. These industries collectively account for about 70% of CO2 emissions from the industrial sector (Figure 5-1). To address their challenges, technologies such as hydrogen utilisation are being prioritised.

Figure 5-1: Carbon Dioxide Emissions Share of Hard-to-Abate Industries within the Industry Sector, 2023



*Includes industrial process emissions.

Source: World Energy Outlook 2024, International Energy Outlook.

Companies are placing growing emphasis on reducing GHG emissions across their entire supply chains, from upstream suppliers to downstream customers. This shift is driven by stricter regulations and the increasing focus on environmental, social, and governance criteria for investors.

Governments and businesses worldwide are implementing initiatives to reduce GHG emissions along supply chains.

The TCFD, established by the Financial Stability Board, encourages companies to disclose climate-related information:

- Scope 1: Direct GHG emissions from sources owned or controlled by the company.
- Scope 2: Indirect GHG emissions from purchased electricity, heat, or steam.
- Scope 3: All other indirect emissions across the value chain, including those from suppliers and product use by customers.

Such disclosures are now viewed as central to corporate value, with companies setting reduction targets and implementing measures such as procuring renewable energy.

- Table 5-1 illustrates the growing global trend towards mandatory disclosure of GHG emissions across entire supply chains.
  - o In the EU, the Corporate Sustainability Reporting Directive, which broadly aligns with the TCFD, mandates large companies and listed small and medium-sized enterprises to disclose Scopes 1, 2, and 3 GHG emissions under the European Sustainability Reporting Standards. It applies to companies meeting specific financial and employment thresholds, thereby expanding accountability.
  - o In the UK, TCFD-aligned reporting mandates that large businesses, financial institutions, and publicly listed companies disclose climate-related risks and opportunities. Scopes 1 and 2 emission reporting is compulsory, whilst Scope 3 reporting is recommended when material to an organisation's operations.
  - o Elsewhere, comprehensive supply chain disclosure requirements are expanding, with examples in California, the US and in China.

Table 5-1: Examples of Disclosure Policies of GHG Emissions Across Supply Chains

Country	Effective Year	Overview
European Union	2024	**Corporate Sustainability Reporting Directive** • Coverage. Large companies, listed small and medium-sized enterprises, and certain non–European Union companies generating over EUR150 million in revenues. • Requirement. Mandatory reporting of Scopes 1, 2, and 3 GHG emissions under the European Sustainability Reporting Standards. Broadly aligned with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations.
United Kingdom (UK)	2022	**TCFD-aligned Reporting** • Coverage. About 1,300 UK-registered companies, including listed companies, financial institutions, and large private firms • Requirement. Mandatory disclosure of Scopes 1 and 2 GHG emissions; Scope 3 disclosure recommended if material
US (California)	2026	**Senate Bill 253 (GHG Reporting)** • Coverage. Companies with annual revenues exceeding US$1 billion conducting business in California. • Requirement. Mandatory disclosure of Scopes 1, 2, and 3 GHG emissions.
China	2024	**Mandatory Stock Exchange Reporting** • Coverage. Main Board-listed companies (Shanghai, Shenzhen, Beijing) • Requirement. Mandatory disclosure of Scopes 1 and 2 emissions; Scope 3 and scenario analysis recommended.

Sources: European Commission (2023), HM Treasury (2025), The California Air Resources Board (2024), Klynveld Peat Marwick Goerdeler (KPMG) (2024).

- Private sector companies are placing greater emphasis on GHG reductions across their entire supply chains, with a focus on establishing company-specific green procurement standards (Table 5-2).
- These standards increasingly require suppliers to disclose their GHG emissions and product carbon footprints. Many leading firms also provide tools, resources, and training to help suppliers decarbonise, reflecting a commitment to go beyond compliance towards genuine supply chain transformation.

Table 5-2: Examples of Supply Chain Decarbonisation Initiatives

Company	Industry	Overview
Apple	Technology	• Suppliers must submit annual reports on Scopes 1 and 2 emissions. • Transition to 100% renewable energy across all production activities is strongly encouraged by 2030.
Amazon	Technology	• Provides tools and resources to help suppliers reduce carbon emissions. • Prefers suppliers with net-zero targets. • Facilitates engagement through the Amazon Sustainability Exchange, which supports collaboration and knowledge exchange on decarbonisation.
BASF	Chemicals	• Requires suppliers to calculate and disclose the product carbon footprint of their offerings in line with company guidelines. • Expects suppliers to actively collaborate on reducing emissions. • Encourages alignment with frameworks such as Together for Sustainability.
Siemens	Industrial	• Offers guidance, tools, and resources through the Carbon Reduction @ Suppliers initiative to support accurate measurement and systematic reduction of supply chain emissions.
Unilever	Fast-moving consumer goods	• Provides suppliers with co-financed advisory services to establish baselines and implement best practices. • Pursues innovation partnerships with suppliers to co-develop and implement emission reduction strategies.

Sources: Amazon (2024), Apple (2022), BASF (2025), Siemens (2025), Unilever (2024).

This initiative examines the automotive industry, a core sector in AZEC partner countries, alongside industrial parks where diverse manufacturing activities are concentrated. Both areas are central to the transition to a 'next generation of industry', with decarbonisation as a foundational principle achieved through enhanced energy efficiency and the adoption of clean energy solutions.

Automotive industry

One of the most significant trends reshaping the automotive industry is the transition of powertrains. Whilst governments worldwide are implementing policies to accelerate this shift, the pace of adoption remains uncertain due to evolving regulations, market dynamics, and geopolitical factors.

- The EU has begun its powertrain transition, with policies banning the sale of new ICE vehicles from 2035, although exceptions will apply to vehicles running on certain clean fuels (Table 5-3).
- In China, there is no outright ban on ICE sales, but incentives for electrified vehicles are driving a gradual transition.
- Policy momentum faces headwinds. In Europe, industry stakeholders and political groups are calling for a review of the 2035 ban. Similarly, in the US, there are signs of reversal, including the repeal of EV subsidies under the Inflation Reduction Act following passage of the One Big Beautiful Bill Act in Congress, and ongoing federal challenges to California's zero-emission vehicle (ZEV) regulations (Table 5-3).

Table 5-3: Policies to Promote Powertrain Transition

Country	Overview	
	Sales and Usage	Manufacture
United States	• No national legislation banning ICE cars. • EV subsidies under the Inflation Reduction Act repealed following passage of the One Big Beautiful Bill Act, eliminating key tax credits for new and used EV purchases from 30 September 2025, 7 years earlier than planned. • California mandates 100% zero emission vehicle sales by 2035 under the Advanced Clean Cars II rule; Senate vote signals repeal. • The National Electric Vehicle Infrastructure programme requires charging stations every 80 km on major highways.	• Corporate average fuel standards increase efficiency requirements • Environmental Protection Agency regulations tighten CO_2 emission limits.
European Union	• Ban on sales of new ICE cars and vans from 2035. Plug-in hybrid electric vehicles may remain until 2035 if they meet emission standards. • Interim target: 55% CO_2 reduction for new cars by 2030 (compared to 2021 levels). • Germany negotiated an exemption for e-fuel-powered vehicles beyond 2035, provided they meet strict CO_2-neutrality standards. • Subsidies: up to EUR5,000 for individuals and EUR4,000 for legal entities in Estonia. • Tax exemptions: e.g. road tax exemption for EVs in the Netherlands. • Expanded EV charging infrastructure with supporting educational initiatives.	• CO_2 emission standards for new passenger cars and light commercial vehicles under Regulation (European Union) 2019/631, targeting a 100% reduction by 2035.

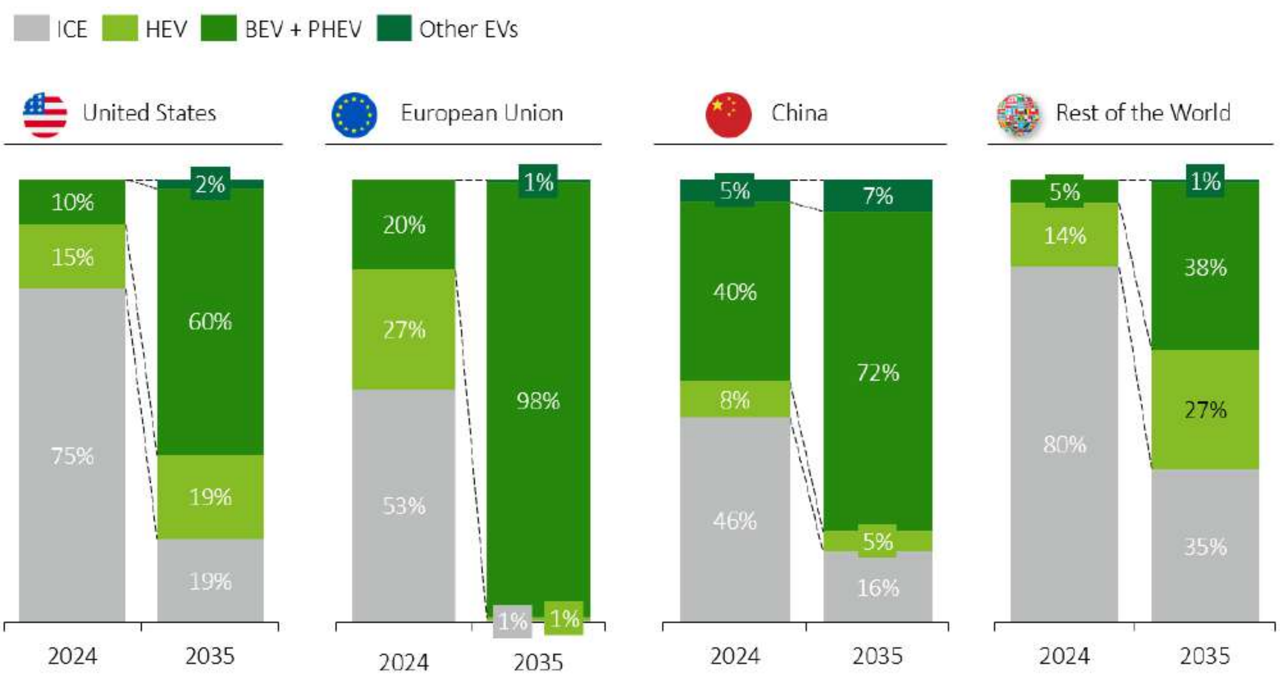
Country	Overview	
	Sales and Usage	Manufacture
China	• No formal ban on ICE sales, but strong EV and HEV quotas. • All new car sales must be EVs and HEVs by 2035; traditional ICEs phased out 2030–2035. • Trade-in subsidy worth US$2,728 and sales tax exemption of up to US$4,180 for EV purchases. • Preferential access to license plates in major cities such as Shanghai and Beijing.	• Production mandates require original equipment manufacturers to meet annual EV quotas. • Significant government investments in research and development for EVs, including batteries and autonomous technology.

EV = electric vehicle, HEV = hybrid electric vehicle, ICE = internal combustion engine.

Sources: CBS News (2025), The California Air Resources Board (2025), European Automobile Manufacturers' Association (2024), Reuters (2024), South China Morning Post (2025), Wall Street Journal (2025), Reuters (2025).

- Forecasts of future vehicle sales by powertrain indicate a sharp rise in the market share of BEVs, particularly in advanced economies (Figure 5-2).

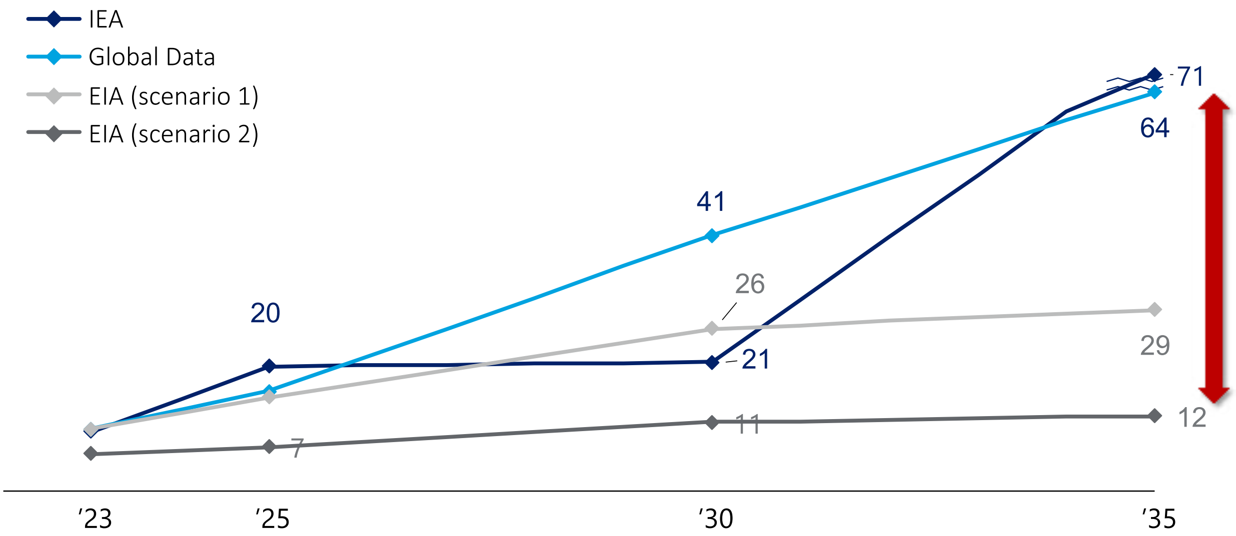
Figure 5-2: Powertrain Mix Forecast



BEV = battery electric vehicle, EVs = electric vehicles, HEV = hybrid electric vehicle, ICE = internal combustion engine, PHEV = plug-in hybrid electric vehicle.

Source: GlobalData (2024).

Figure 5-3: United States Market Forecast for Battery Electric Vehicle and Plug-in Hybrid Electric Vehicle Penetration (%)



Note: The International Energy Agency (IEA) projection reflects the Stated Policies Scenario. The United States Energy Information Administration (US EIA) 'high oil price' scenario assumes US$190 per barrel oil price by 2050, whilst the 'low oil price' scenario assumes US$51 per barrel (both in 2022 US dollars).

Sources: GlobalData (2024), IEA (2024, 2025), US EIA (2023).

- At the same time, such forecasts are uncertain (Figure 5-3). Future BEV and PHEV market penetration varies widely depending on the scenario or data source.

Another major global trend is the reduction of GHG emissions across entire automotive supply chains. Regulatory frameworks are beginning to adopt life-cycle assessment (LCA)–based approaches, whilst global open electricity markets are introducing green procurement criteria and supplier engagement mechanisms.

- In the automotive sector, regulations are advancing faster than in many other industries. Emission reduction is expanding beyond vehicle use–phase emissions to address manufacturing, recovery, and recycling.
- In Europe, momentum is building for comprehensive LCA-based policies:
  - o The EU is deliberating LCA regulations covering total CO_2 emissions across the production life cycle, from raw material extraction and energy use to disposal and reuse.
  - o A carbon footprint tracking system for automotive batteries is being developed. The EU Battery Passport, expected as early as 2027, will initially require disclosure of carbon footprints before moving to life-cycle emission caps.
  - o To enable secure supply chain data exchange, the German automotive sector is spearheading Catena-X, a traceability and data-sharing platform.
- Table 5-4 outlines how global automotive manufacturers are proactively pursuing emission reductions across their supply chains.

Table 5-4: Examples of Supply Chain Decarbonisation in the Automotive Industry

Company	Overview
Mercedes-Benz	• Target. Carbon neutrality across the entire value chain by 2039, including development, supply chain, manufacturing, and vehicle use. • Achieved CO2-neutral own production worldwide by 2022, powered by renewable energy. • Requires suppliers to commit contractually to carbon neutrality by 2039; non-compliant suppliers will be excluded. • Invested in Swedish start-up H2 Green Steel to secure fossil-free steel from 2025.
Toyota	• Target. 30% emission reduction across suppliers, logistics, and dealerships globally by 2030 (vs. 2019). Net zero across the vehicle life cycle by 2050. • Requires suppliers to reduce emissions through product development, operational improvements, material substitution, and renewable energy adoption. • Exploring low-carbon fuels to power existing vehicles whilst advancing fuel cell vehicle technology. • Building a closed-loop battery ecosystem through recycling and re-use of lithium, nickel, and cobalt, promoting circular economy practices.

Sources: Mercedes-Benz Group AG (2025), Toyota Motor Corp. (2021, 2025), Toyota Motor North America (2023).

Industrial parks

Mounting pressure is being placed on the manufacturing sector to reduce GHG emissions. In response, MNCs are enforcing more rigorous green procurement standards as part of broader supply chain decarbonisation strategies. Consequently, industrial zone decarbonisation is emerging as a critical approach.

- As expectations for supply chain emissions reductions continue to rise, many companies face barriers to advancing decarbonisation independently, particularly due to financial and resource constraints.
- Against this backdrop, collective decarbonisation initiatives in industrial estates, where infrastructure and human capital are concentrated, are gaining traction. These include clean energy procurement and improved energy efficiency through conservation and system optimisation.
- By advancing solutions that individual companies may find difficult to implement by themselves, industrial parks are enabling the broader deployment of high-efficiency and energy-saving technologies, as well as facilitating increased renewable energy adoption.

Table 5-5: Examples of Decarbonisation Initiatives in Industrial Parks

Country	Overview
China	**Suzhou Industrial Park** It has established an industrial symbiosis model by integrating a wastewater treatment plant, a sludge drying facility, and a combined heat and power plant. Waste heat is reused for heating, cooling, and further sludge drying, whilst steam condensate is recycled. This closed-loop system saves about 13,700 tonnes of standard coal annually and recycles ash residue into construction material.
Republic of Korea	**Ulsan Mipo and Onsan Industrial Parks** These parks are being transformed into sustainable, resource-efficient areas. Over 1,000 companies in sectors such as vehicle manufacturing and oil refining have collectively invested US$520 million in energy efficiency, waste management, and industrial symbiosis. This has resulted in US$554 million in savings, 665,712 tonnes of CO_2 emissions reduced, 79,357 tonnes of water reused, and 279,761 tonnes of oil equivalent in energy saved (2005–2016).
Bulgaria	**Trakia Economic Zone** Its goal is to eliminate GHG emissions by 2040. A quarter of companies already use rooftop solar energy. The Zero Carbon Industrial Parks Consortium – Strategic Intent foresees renewable energy generation (hydrogen production and storage, biogas, solar, wind), energy storage, and end-user distribution. Biogas production relies on wastewater and organic waste, targeting a 10% reduction in natural gas demand.
Denmark	**Kalundborg Symbiosis** Globally recognised as a pioneering model of industrial symbiosis, it circulates heat, water, steam, and waste materials amongst companies. Excess heat from a power plant warms 3,500 local homes. Sludge is repurposed as fertiliser, whilst gypsum, another by-product, is supplied to wallboard manufacturers.
Sweden	**Haraholmen Industrial Park** It hosts the SunPine bio-refinery, which produces tall diesel, rosin, bio-oil, and turpentine. Waste heat generated during cooling is used for district heating at the plant itself and in neighbouring businesses.
United Kingdom	**London Sustainable Industrial Park** This waste management company includes a Cyclamax power plant generating 16 megawatts of electricity from renewable sources. Organic waste specialist TEG Group supplies electricity to tenant companies from its waste-to-energy facility.

Sources: CNN (2011), United Nations Industrial Development Organization (2020), World Bank Group (2018), Balkan Green Energy News (2023), Swedish Environmental Research Institute (2025), IDEAS FOR GOOD (2021).

Concerning the decarbonisation of industrial parks, international organisations are now establishing structured frameworks and preparing certification schemes to guide estate operators seeking alignment with global sustainability standards.

- There is no international regulatory body with legal authority over the governance of industrial parks. Operations are therefore carried out under national and local policies. Similarly, decarbonisation efforts remain at the discretion of individual operators, leading to significant variability in pace and scope across sites.
- Amongst industrial parks engaged in reducing environmental impacts, diverse terminologies and classifications are applied by institutions, for example, 'eco-industrial parks' and 'carbon-neutral industrial parks.'
- The United Nations Industrial Development Organization (UNIDO), a specialised UN agency, has promoted the eco-industrial park concept. In collaboration with the World Bank, UNIDO published An International Framework for Eco-Industrial Parks in 2017, outlining requirements and evaluation criteria across environmental, social, and economic dimensions. This framework, updated to version 2.0 in 2021, is now widely recognised as a global reference.
- UNIDO is advancing the formulation of standards and certification systems for eco-industrial parks, with full certification expected to begin after 2025.

AZEC trends

This section provides a macro-level overview of next-generation industry trends across AZEC partner countries. The following sections elaborate on global trends within these countries in greater detail.

In AZEC partner countries, there is growing momentum towards the disclosure of GHG emissions across entire supply chains.

- Manufacturing constitutes a significant share of value-added GDP throughout Asia. Given their critical position in global supply chains, AZEC partner countries bear a key responsibility for contributing to global GHG emission reduction efforts. To remain competitive as manufacturing hubs, these countries must balance reducing environmental impact with delivering economic benefits, such as improved production efficiency and cost effectiveness, thus paving the way for the 'next generation of industry'.
- An increasing number of AZEC partner countries are aligning their disclosure requirements with international frameworks, such as the TCFD.
- Disclosure of Scopes 1 to 3 GHG emissions is broadly encouraged, although regulatory mandates typically prioritise Scopes 1 and 2 (Table 5-6). However, attention to Scope 3 disclosure is on the rise. For instance, in Singapore, disclosure is required if Scope 3 emissions are deemed material; in Australia, Scope 3 reporting becomes mandatory in the second year of implementation; and in Malaysia, the requirement takes effect from the third year onwards.

Table 5-6: Trends in the Disclosure of GHG Emissions Across the Entire Supply Chain

<table>
<tr><th>Country</th><th>Effective Year</th><th>Overview</th></tr>
<tr><td>Australia</td><td>2025–2027</td><td>ASRS
• Coverage:
<table>
<tr><th>Group</th><th>Effective Date</th><th>Reporting Thresholds</th><th>Other Inclusions</th></tr>
<tr><td>1</td><td>On or after 1 January 2025</td><td>Meet 2 of 3:
• ≥ US$500M revenue
• ≥ US$1B assets
• > 500 employees</td><td>•NGER reporters above NGER 1 threshold
•Asset owners (if not scoped out)</td></tr>
<tr><td>2</td><td>On or after 1 July 2026</td><td>Meet 2 of 3:
• ≥ US$200M revenue
• ≥ US$500M assets
• > 250 employees</td><td>•All other NGER reporters
•Asset owners with ≥ US$5B assets</td></tr>
<tr><td>3</td><td>On or after 1 July 2027</td><td>Meet 2 of 3:
• ≥ US$50M revenue
• ≥ US$25M assets
• > 100 employees</td><td></td></tr>
</table>
• Requirement. Mandatory disclosure of Scope 1 and 2 emissions in the first reporting year, with Scope 3 becoming mandatory in the second. The ASRS are largely aligned with global standards such as the IFRS Sustainability Disclosure Standards and TCFD recommendations.</td></tr>
<tr><td>Brunei Darussalam</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Cambodia</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Indonesia</td><td>2020</td><td>SEOJK16/SEOJK.04/2021
• Coverage. OJK, Indonesia's financial services authority, requires publicly listed companies to publish sustainability reports under POJK51/2017, covering economic, environmental, and social aspects
• Requirement. Disclosure of Scope 1 and 2 emissions is encouraged, in accordance with the GRI standards and the TCFD recommendations, whilst Scope 3 remains voluntary.</td></tr>
<tr><td>Japan</td><td>2022</td><td>TCFD-aligned Reporting
• Coverage. All Prime Market–listed firms
• Requirement. Mandatory disclosure of Scope 1 and 2 emissions; Scope 3 emissions encouraged but voluntary.</td></tr>
<tr><td>Lao PDR</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Malaysia</td><td>2025</td><td>NSRF
• Coverage. In 2025, Main Market–listed issuers with a market capitalisation of MYR2 billion or more; in 2026, remaining Main Market-listed issuers; in 2027, ACE (Access, Certainty, Efficiency) Market and large non-listed companies with revenue ≥ MYR2 billion.
• Requirement. Mandatory disclosure of Scope 1 and 2 emissions from the first reporting year; Scope 3 mandatory from the third year. The NSRF incorporates the IFRS Sustainability Disclosure Standards.</td></tr>
<tr><td>Philippines</td><td>2023</td><td>Sustainability Reporting Guidelines for Publicly Listed Companies
• Coverage. All publicly listed companies.
• Requirement. Disclosure of Scope 1 and 2 emissions encouraged under the Securities and Exchange Commission sustainability framework, based on global standards such as GRI or TCFD; Scope 3 remains voluntary.</td></tr>
</table>

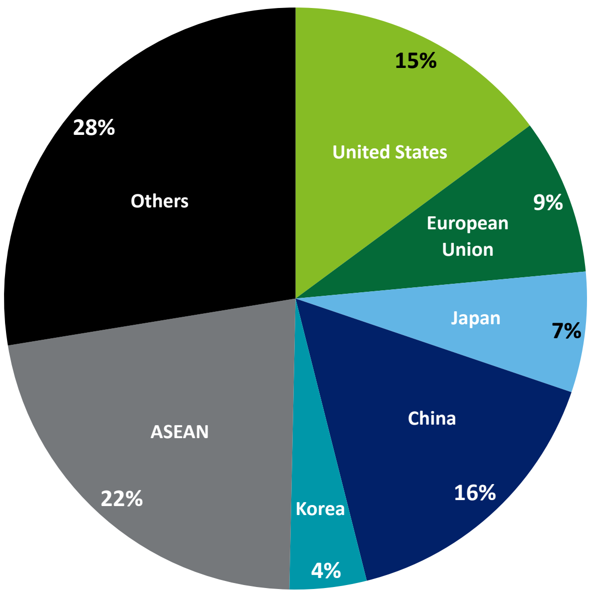
Country	Effective Year	Overview
Singapore	2025 (listed firms); 2027 (large non-listed firms)	**Mandatory Climate Reporting** • Coverage. From 2025, all publicly listed issuers; from 2027, large private companies (≥SGD1 billion+ revenue or ≥SGD500 million+ assets). • Requirement. Mandatory disclosure of Scope 1 and 2 emissions; Scope 3 mandatory if material, in line with TCFD recommendations.
Thailand	2022	**GRI Sustainability Reporting Standards** • Coverage. Publicly listed companies must prepare environmental, social, and governance reporting in Form 56-1 One Report (integrated annual report). • Requirement. Disclosure of Scope 1 and 2 emissions encouraged in line with TCFD recommendations; Scope 3 remains voluntary.
Viet Nam	N/A	**Circular No. 155/2015/TT-BTC by the Ministry of Finance** • Coverage. Publicly listed companies must consider environmental and social impact in annual reports. • Requirement. Voluntary sustainability disclosures encouraged; Scope 1, 2, and 3 are yet to be required.

ASRS = Australian Sustainability Reporting Standards, GRI = Global Reporting Initiative, IFRS = International Financial Reporting Standards, Lao PDR = Lao People's Democratic Republic, NGER = National Greenhouse and Energy Reporting, NSRF = National Sustainability Reporting Framework, OJK = Otoritas Jasa Keuangan, TCFD = Task Force on Climate-related Financial Disclosures.

Sources: Klynveld Peat Marwick Goerdeler (KPMG) (2025), Japan Exchange Group (2023), Securities Commission (Malaysia), Ministry of Finance (2024), National University of Singapore (2022), Singapore Exchange Regulation (2024).

ASEAN, whose economies are deeply embedded in global supply chains and export to a wide range of markets outside the region (Figure 5-4), is expected to play its part in reducing GHG emissions

Figure 5-4: Share of Export Destinations in ASEAN's Total Exports, 2023



Source: ASEAN Statistics Web Portal.

- To remain a preferred global manufacturing hub, ASEAN must give equal weight to reducing environmental impacts and achieving economic advantages such as improved manufacturing efficiency and cost effectiveness, thereby advancing towards the development of a 'next generation of industry'.

5.2 Automotive Industry

5.2.1 Market trends

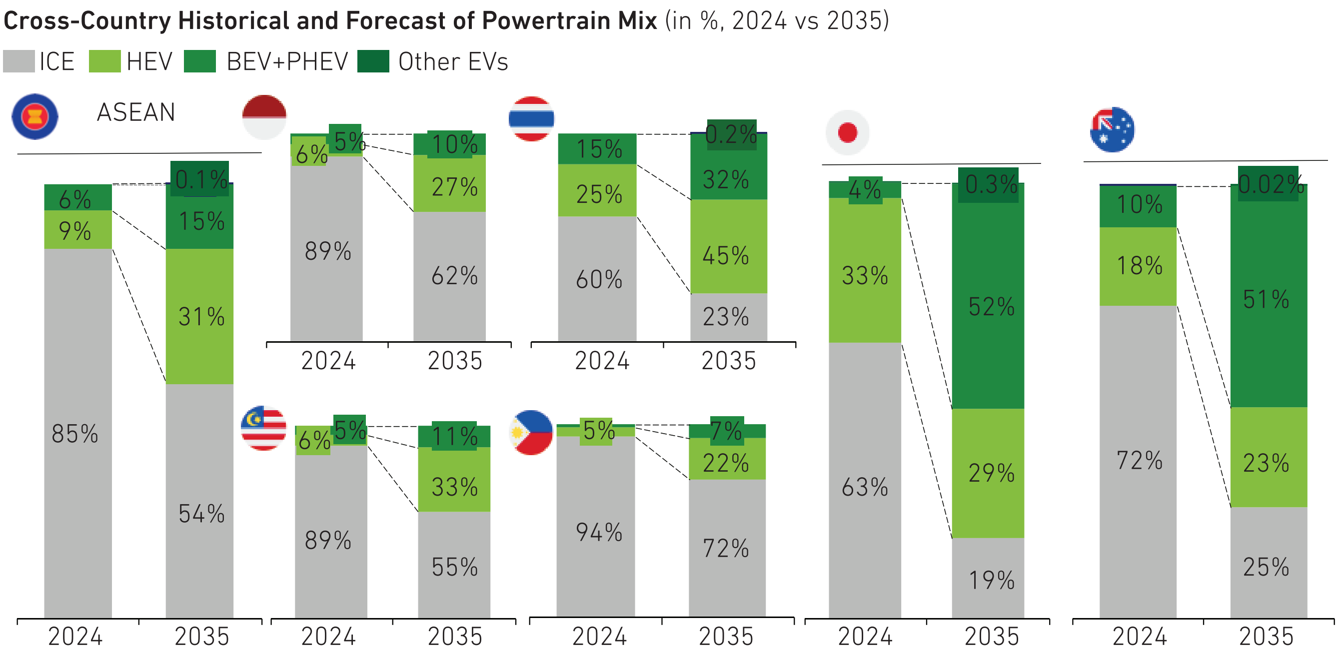
AZEC trends

Whilst regions such as Europe are advancing restrictions on the sales of new ICE vehicles, the transition of powertrains in the ASEAN region is progressing at a more measured pace. This is largely attributed to concerns surrounding vehicle affordability, the limited availability of charging infrastructure, and uncertainties related to resale value. At the same time, increasingly stringent global decarbonisation regulations and intensifying international competition are compelling the ASEAN automotive industry to modernise its supply chains, thereby enhancing both efficiency and value addition.

Powertrain transition in ASEAN is anticipated to proceed at a gradual pace, shaped primarily by structural factors such as income levels.

- As shown in Figure 5-5, ICE vehicles are expected to remain dominant within the ASEAN region, comprising about 54% of the total vehicle stock in 2035.
- This slow pace of transition is largely driven by income levels, as the purchase of a new vehicle continues to represent a significant financial hurdle. Using Indonesia and Thailand as examples, Figure 5-6 and Figure 5-7 show that even the best-selling ICE models have long maintained on-the-road prices far above average annual household income, with income growth failing to keep pace.

Figure 5-5: Powertrain Mix Forecast, 2024–2035

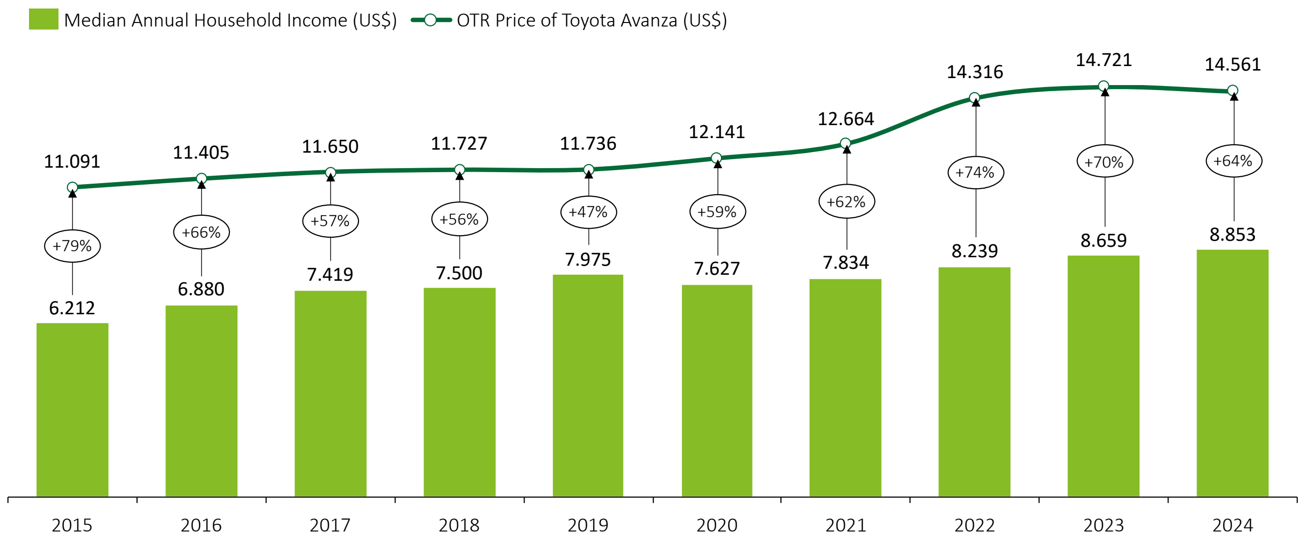


BEV = battery electric vehicle, EVs = electric vehicles, HEV = hybrid electric vehicle; ICE = internal combustion engine; PHEV = plug-in hybrid electric vehicle.

Source: GlobalData (2024).

Figure 5-6: Annual Household Income and Best-seller Model On-the-Road Price in Indonesia

Annual Household Income vs. Toyota Avanza Price in Indonesia (in US$, 2015–2024)

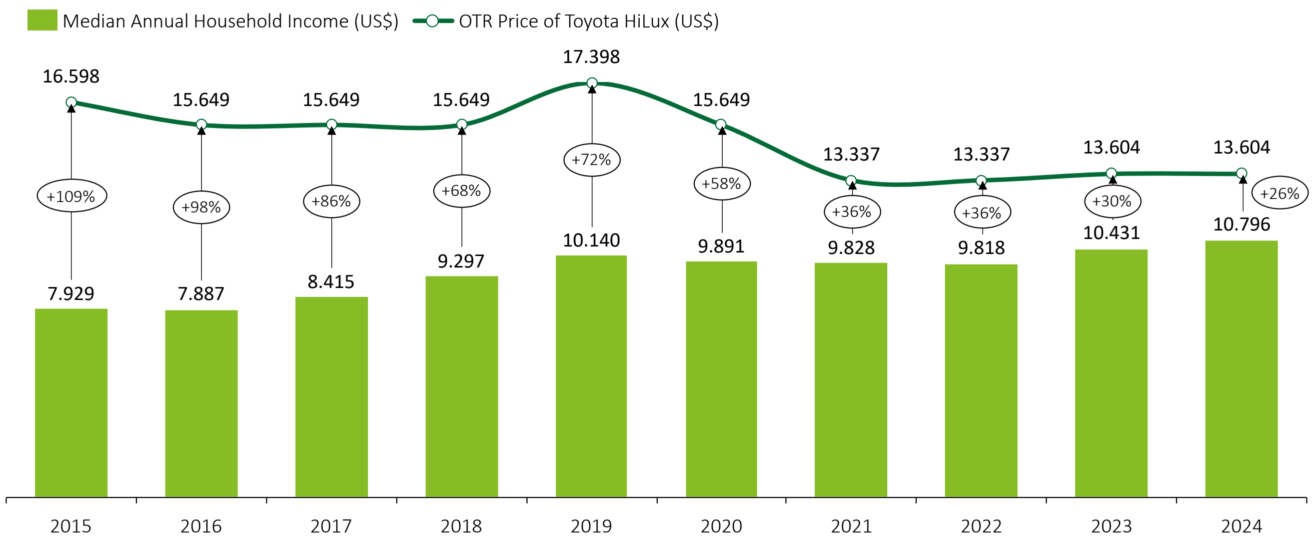


OTR = on the road.

Source: Euromonitor (2024).

Figure 5-7: Annual Household Income and Best-seller Model On-the-Road Price in Thailand, 2015–2024

Annual Household Income vs. Toyota HiLux Price in Thailand (in US$, 2015–2024)



OTR = on the road.

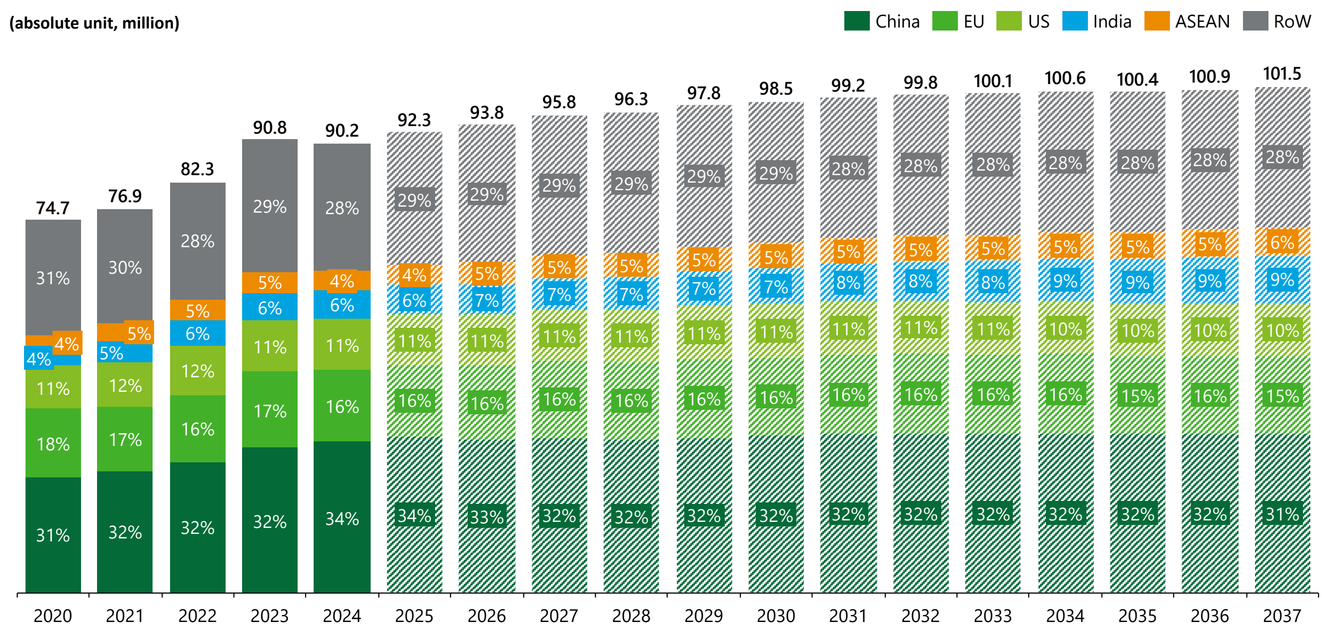
Source: Euromonitor (2024).

- Other contributing factors include the early-stage development of charging infrastructure and ongoing concerns over vehicle resale value.

A second notable trend is the reduction of GHG emissions across entire automotive supply chains, where ASEAN is expected to play a significant role.

- As a global hub for automobile manufacturing, the region sustains an extensive supply chain that spans multiple adjacent industries. In this context, decarbonisation of the manufacturing process is crucial.
- ASEAN produces about 3.8 million vehicles annually, accounting for about 4% of global output (Figure 5-8). Projections indicate that the region will continue to serve as one of the industry's principal production hubs over the medium to long term.

Figure 5-8: Global Vehicle Production by Region, 2020–2037



ASEAN = Association of Southeast Asian Nations, EU = European Union, RoW = rest of the world, US = United States.

Note: Figures for 2025–2037 are projections.

Source: GlobalData (2025).

5.2.2 Key policies and regulations

To remain competitive as a manufacturing base for global automotive producers, it is essential to foster an enabling environment that supports high-value-added and energy-efficient production. Collaborative efforts to achieve these conditions are underway.

AZEC partner countries are advancing transport sector decarbonisation through diversified strategies rather than relying solely on the transition to BEVs (Table 5-7).

- Policy frameworks extend beyond the exclusive promotion of BEVs, with several countries also implementing measures to support the production and sale of HEVs, PHEVs, and FCEVs.
- The establishment of mandatory or targeted biofuel blending requirements is accelerating the decarbonisation of ICEs, HEVs and PHEVs. (See 'Fuel Consumption – Road Transport' in 'Sustainable Fuel Initiative.')

- By continuing to manufacture a diverse portfolio of vehicle types that contribute to decarbonisation through various pathways, the automotive industry can reinforce its global competitiveness.

Table 5-7: Policies to Promote Powertrain Transition

Country	Overview	
	Sales and Usage	Manufacture
Australia	• [BEV/FCEV] FBT exemption on eligible zero-emission vehicles, i.e. BEVs and FCEVs Note: FBT exemption ceased for HEVs starting from 1 April 2025. • New Vehicle Efficiency Standard (2024) promotes the development and supply of more fuel-efficient and low- or zero-emission automobiles to the Australian market.	N/A
Brunei Darussalam	N/A	N/A
Cambodia	• Reduced tariffs on imported electric motorcycles (15%–25% lower) • Reduced import duties (about 50% lower) and taxes (from 30% to 10%) on EVs compared with conventional vehicles	N/A
Indonesia	• [BEV] BEVs (CKD). 1% VAT, with government covering 10%. 15% luxury goods sales tax exemption for BEVs (CKD and CBU). • Purchase subsidy up to IDR80 million • 0% import duty for CBU BEVs • [HEV] PPnBM reduction of 3% for HEV (CKD with at least 40% local content) plus purchase subsidy up to IDR40 million	• Import tax exemptions for machinery and equipment for foreign open electricity markets • 0% import taxes and 15% local luxury tax reduction for committed manufacturers • [BEV] BEVs (CKD) are only 1% VAT, with the government covering 10%. • [HEV] PPnBM reduction for HEV (CKD with at least 40% local content), plus purchase subsidy up to IDR40 million
Japan	• [BEV/FCEV] CEV subsidies. JPY850,000 for a BEV, with an additional JPY50,000 if manufactured using green steel; and JPY2,550,000 for an FCEV • [PHEV] CEV subsidies. JPY550,000, with an additional JPY50,000 if manufactured using green steel	• [BEV/FCEV] 10-year tax breaks worth JPY400,000 for each BEV and FCEV produced, plus a subsidy of US$2.4 billion • [PHEV] 10-year tax breaks worth JPY200,000 for each unit
Lao PDR	• 30% reduction in annual road tax • 0% import tariffs	N/A

Country	Overview	
	Sales and Usage	Manufacture
Malaysia	• 100% road tax and excise tax exemption until 2025 • Income tax relief of RM2,500 annually for the installation, rental, or subscription of home charging facilities • Excise and sales tax exemptions for CKDs until 2027 • Import duty exemptions on CBUs until 2025 Note: Tax incentives for locally assembled HEVs ended in 2017.	• 70% of statutory income exempted from corporate income tax for 3 years for EV and critical component manufacturers • Full tax exemption for charging equipment manufacturers until 2032 • Excise and sales tax exemptions for CKDs until 2027
Philippines	• [BEV] 100% excise tax exemption, 0% import tariffs until 2028, plus 30% discount on registration fees • [HEV] 50% excise tax exemption, 0% import tariffs until 2028, plus 15% discount on registration fees	• Income tax holiday up to 7 years under the Corporate Recovery and Tax Incentives for Enterprises (CREATE) Act
Singapore	• [BEV/FCEV] VES Band A1: rebate of SGD25,000, plus 45% rebate on additional registration fee capped at SGD15,000 until 2025 • [HEV] VES Band A2 rebate cut from SGD5,000 to SGD2,500 in 2025	N/A
Thailand	• [BEV] Subsidies up to US$2,900 per vehicle. • Excise tax reduced from 8% to 2% for BEVs (CBU) • [HEV/MHEV] From 2026 to 2032, excise taxes for HEVs and MHEVs reduced to 6%–12% depending on CO_2 emissions	• R&D tax incentives extended • Manufacturers and importers receive up to 40% reduction on import duties for CBUs priced at ≥THB2 million • [HEV] Firms investing ≥THB3 billion and using local parts qualify for excise tax reductions
Viet Nam	• [BEV] Registration fees waived for 3 years (from 2022), with 50% reduction for the subsequent 2 years • Special consumption tax reduced to 1%–3% until 2027	N/A

BEV = battery electric vehicle, CBU = complete built-up, CEV = clean energy vehicle, CKD = complete knocked-down, CO2 = carbon dioxide, EV = electric vehicle, FBT = fringe benefits tax, HEV = hybrid electric vehicle, MHEV = mild hybrid electric vehicle, PPnBM = *pajak penjualan atas barang mewah* (luxury goods sales tax), PPN DTP = pajak pertambahan nilai ditanggung pemerintah (value-added tax borne by the government), R&D = research and development, VAT = value-added tax, VES = vehicular emission scheme.

Sources: Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry (2024), ASEAN Briefing From Dezan Shira & Associates (2023), ASEAN Centre for Energy (2024, 2025), Australian Taxation Office (2025), Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts (Australia) (2025), B&Company, Inc. (2025), CNA (2024), Deloitte Philippines (2025), Clean Air Asia (2020), HLB Thailand (2024), International Council on Clean Transportation (2024), Invest in ASEAN (2025), Jakarta Globe (2024), Khmer Times (2024), Lao News Agency (2023), Malaysia Investment Development Authority (2024), Maybank Investment Banking Group Sustainability Research (2023), Ministry of Economy, Trade and Industry (Japan) (2025), Myanmar Energy Monitor (2023), paultan.org (2025), Department of Finance (Philippines) (2024), Reuters (2023, 2024), Land Transport Authority (Singapore) (2025), Sok Siphana & Associates (2025), The Laotian Times (2023), The Metalnomist (2025), The Phnom Penh Post (2025), theSun (2023), Toyota Bicutan, Paranaque (2021), Vietnam Investment Review (2023), VietnamNet Global (2024), Xinhua (2022).

To achieve deep reductions in GHG emissions across the automotive supply chain, robust systems for end-to-end data traceability and sharing are increasingly required. These must cover the entire product life cycle, from manufacturing to end use, and interface with emerging international data platforms.

In Japan, the development of the platform is underway to support cross-border data exchange, including with other Asian countries.

- Similar to Europe's Catena-X platform, Ouranos Ecosystem seeks to establish a national data collaboration infrastructure.
- It is designed to enable cross-industry system integration, with one of its core initiatives focused on creating a data-sharing infrastructure for the automotive and battery sectors.
- A mechanism for calculating CO_2 emissions associated with the automotive battery manufacturing across corporate boundaries has already been implemented. Building on this use case, the platform is expected to expand to other vehicle components and facilitate cross-sectoral collaboration beyond the battery industry
- UNIDO is advancing the formulation of standards and certification systems for eco-industrial parks, with full certification expected to begin after 2025.

Box 5-1

Policy Implications from ERIA's Research on the Automotive Industry

As a key sector across AZEC partner countries, the automotive industry has been the focus of targeted policy interventions addressing both strategic direction and implementation capacity. Based on Economic Research Institute for ASEAN and East Asia's research, several considerations and recommendations are outlined below.

Within policy direction, despite growing momentum for decarbonisation, including powertrain shifts, fuel transitions, and reductions in GHG emissions across the entire supply chain, the industry still lacks a clear regional vision, even though these changes are reshaping the sector as a whole.

- Establish a regionally coordinated yet nationally adaptable policy framework, building on initiatives such as the Masterplan for the ASEAN–Japan Next-generation Automotive Industry.
- Support green transformation (GX) through regionally coordinated action, such as the production and use of clean fuels, carbon footprint tracing, and resource circulation.
- Reform national vehicle inspection regimes to incentivise timely vehicle replacement, ensuring resource recovery from end-of-life vehicles at the point of replacement, thereby reducing the environmental impacts of outdated vehicle use.
- Develop unified regional regulations for scrappage, disposal, and traceability to support resource circulation.

The region's capacity to implement decarbonisation measures remains constrained by limited support for fuel and electrified vehicle material production, a lack of technical expertise, insufficient data systems, and underdeveloped infrastructure for carbon-neutral manufacturing.

- Expand regional production capacity for biofuels and e-fuels.
- Facilitate the introduction of GX expertise whilst fostering domestic human resources to enhance technical capabilities.
- Strengthen regional mechanisms for information sharing and digital connectivity, with priority given to platforms for tracing materials and carbon footprints.
- Promote the establishment of green energy industrial parks to support carbon-neutral manufacturing in the region.

Source: Author.

5.3 Industrial Parks

5.3.1 Market trends

AZEC trends

AZEC partner countries continue to play a pivotal role in global manufacturing. However, many face considerable constraints in accessing clean energy procurement options, creating considerable challenges for companies seeking to pursue decarbonisation independently. For countries with a high dependence on fossil fuels, achieving nationwide decarbonisation remains a formidable task. Under such circumstances, focusing on the decarbonisation of industrial parks represents a pragmatic and efficient means of advancing climate action. This approach can also help attract foreign direct investment and support sustainable economic growth.

- In AZEC partner countries, manufacturing remains central to economic growth, whilst expectations for stronger climate action continue to rise. Advancing decarbonisation across industry is essential to sustaining the region's competitiveness as a high-quality manufacturing base.
- As outlined in the Power Initiative, structural barriers to clean energy access persist in several partner countries, rendering company carbon neutrality efforts insufficient in many cases. Collective decarbonisation in industrial parks is gaining traction as a strategic means of supporting tenant companies in reducing GHG emissions.
- A growing number of AZEC partner countries are implementing industrial park initiatives to pursue decarbonisation, underscoring the effectiveness of this collective approach (Table 5-8). More advanced measures, such as the integration of hydrogen, ammonia, and CCUS, have also begun to be explored.

Table 5-8: Examples of Decarbonisation Initiatives in Industrial Parks

Country	Overview
Indonesia	**Kota Deltamas (Greenland International Industrial Centre)** PT Surya Nippon Nusantara (a joint venture between Sojitz Corp. and PT Energi Mitra Investama) plans to install solar facilities with a total capacity of 100 megawatt-peak (MWp) by 2030. Sojitz has obtained I-renewable energy certificate (REC) since 2021, achieving carbon neutrality for electricity used in public areas. Efforts also include large-scale urban reforestation and advanced data centre development. Investigations are underway into business models for supplying renewable energy to data centres and industrial or commercial entities within the estate, alongside energy efficiency services through third-party ownership schemes and the provision of decarbonised fuels such as biogas.

Country	Overview
	MM2100 With over 30 years of operation, MM2100 was selected for the United Nations Industrial Development Organization Global Eco-Industrial Parks Programme II Indonesia initiative, under which demonstration projects aim to reduce environmental impact, enhance efficiency, and improve operations. In 2024, Zeroboard, PT Megalopolis Manunggal Industrial Development, PT KDDI Indonesia, and Kamar Dagang dan Industri Indonesia jointly conducted a pilot project to model industrial park GHG emission visualisation. The initiative guided tenant companies on emission calculation methods and systems and hosted standardised workshops to raise awareness and build capacity.
Lao PDR	**Pakse–Japan Small and Medium-sized Enterprises Special Economic Zone** It is transitioning towards increased reliance on electricity and hydrogen, capitalising on its predominantly hydropower-based grid and exploring on-site solar generation, whilst addressing challenges related to power sales regulations and grid constraints. Locally produced renewable-based hydrogen is used in coffee roasting projects.
Malaysia	**Samalaju Industrial Park** The concept of a carbon-neutral industrial zone forms part of the Bintulu Development Authority's Post-COVID Development Plan 2030. Although specific planning details remain undisclosed, the concept prioritises clean and green industries. In alignment with the state-led Sarawak Corridor of Renewable Energy initiative, the park uses stable and competitively priced hydropower from hinterland dams to support energy-intensive sectors and promote a low-carbon development trajectory.
Philippines	**First Philippine Industrial Park** In collaboration with independent power producers, the estate promotes geothermal energy for large-scale off-takers through direct power purchase agreements and natural gas–fired power generation as a lower-carbon alternative. The estate has considerable potential for deploying negative emission technologies, leveraging its managed forest areas. Under the Green Energy Option Project, efforts include promoting solar and geothermal generation, encouraging the use of electric vehicles, and developing bicycle lanes to reduce employees' carbon footprints.
Thailand	**Eastern Economic Corridor (EEC)** EEC supports initiatives such as shared infrastructure (including carbon capture, utilization, and storage [CCUS]), pilot test sites, and circular industrial estates. It plays a pivotal role in promoting carbon neutrality through tax incentives and collaborative projects. In 2023, EEC launched its Net Zero Roadmap and Action Plan, aiming for net-zero emissions by 2050, with emphasis on CCUS and bioenergy with CCUS technologies.

Country	Overview
Viet Nam	**Thang Long Industrial Park II** Sumitomo Corp. has introduced rooftop solar power systems using tenant company facilities. By purchasing I-RECs, Sumitomo Corp. aims to achieve RE100 compliance for its electricity and encourage tenants to shift to renewable energy. A demonstration project with North Hanoi Smart City Development Investment JSC uses a dedicated private power line to expand on-site renewable supply and energy-efficient demand-side equipment.
	Long Duc Industrial Park Efforts include achieving total renewable energy use via I-REC, implementing smart energy management, and pioneering eco-industrial models. SOL Energy Co., Ltd. (a joint venture between Osaka Gas and Sojitz) plans to install rooftop solar systems with a capacity exceeding 10 megawatts. Tenant companies will be able to use the solar power at no initial cost, with electricity supplied under long-term agreements; surplus power will be provided to the park operator. In 2024, the operating company achieved virtually 100% renewable consumption by obtaining I-REC.

Sources: Bangkok Post (2024), Ministry of Economy, Trade and Industry (METI) (2022, 2024); Agency for Natural Resources and Energy, Economic and Industrial Cooperation Committee–METI, and Nippon Koei (2025); Japan External Trade Organization (2024); and Sumitomo Corp. (2022).

Decarbonisation pressures are mounting for manufacturers in ASEAN. Industrial park operators are expected to act as platform providers, offering decarbonisation solutions, and as aggregators collecting tenant needs and advocating for supportive policies. AZEC seeks to systematise and disseminate these practices as shared knowledge, thereby fostering common ground amongst key stakeholders: industrial park operators, tenants, technology providers, and governments. This approach is intended to facilitate project formation and accelerate regional decarbonisation efforts.

Against this backdrop, a study is being conducted to build a shared understanding amongst key stakeholders, such as industrial park operators, regarding the strategic direction of decarbonisation. The initiative aims to accelerate emission reduction efforts across ASEAN industrial parks and the global enterprises operating within them, whilst accounting for the specific circumstances and characteristics of each country.

- The study, titled Project to Promote Decarbonisation of Industrial Parks in ASEAN Countries, is undertaken by the Agency for Natural Resources and Energy–METI, the ASEAN Economic Ministers–METI Economic and Industrial Cooperation Committee, and Nippon Koei. It provides a structured analysis of effective decarbonisation by categorising industrial estates and examining tailored approaches to achieving carbon neutrality.
- In this analysis, ASEAN industrial parks, including those listed in Table 5-8, are classified as conventional industrial parks, electricity-intensive parks, and fuel-intensive parks (Table 5-9). Scenario-based assessments are then employed to explore viable pathways towards future carbon neutrality.

Table 5-9: Classification of Industrial Parks

Classification	Energy Demand	Model Industrial Park	
		Country	Industrial Park
Small-scale industrial park	-	Lao PDR	Pakse–Japan Small and Medium-sized Enterprises Special Economic Zone
Conventional industrial park (Inland industrial park)	Several hundred GWh/year	Viet Nam	Thang Long Industrial Park II
		Viet Nam	Long Duc Industrial Park
		Philippines	First Philippine Industrial Park (FPIP)
Electricity-intensive industrial park Data centre; large, high-tech industrial park	Several thousand GWh/year	Indonesia	Kota Deltamas GIIC
		Malaysia	Samalaju Industrial Park
		Indonesia	MM2100
Fuel-intensive industrial park (Coastal industrial park)	Industries with higher fuel use than electricity use (steel, chemical, paper and pulp, petroleum products)*	Thailand	Eastern Economic Corridor

GIIC = Greenland International Industrial Centre, GWh = gigawatt-hour, Lao PDR = Lao People's Democratic Republic.

*Energy consumption is based on actual industrial facility conditions in 2022.

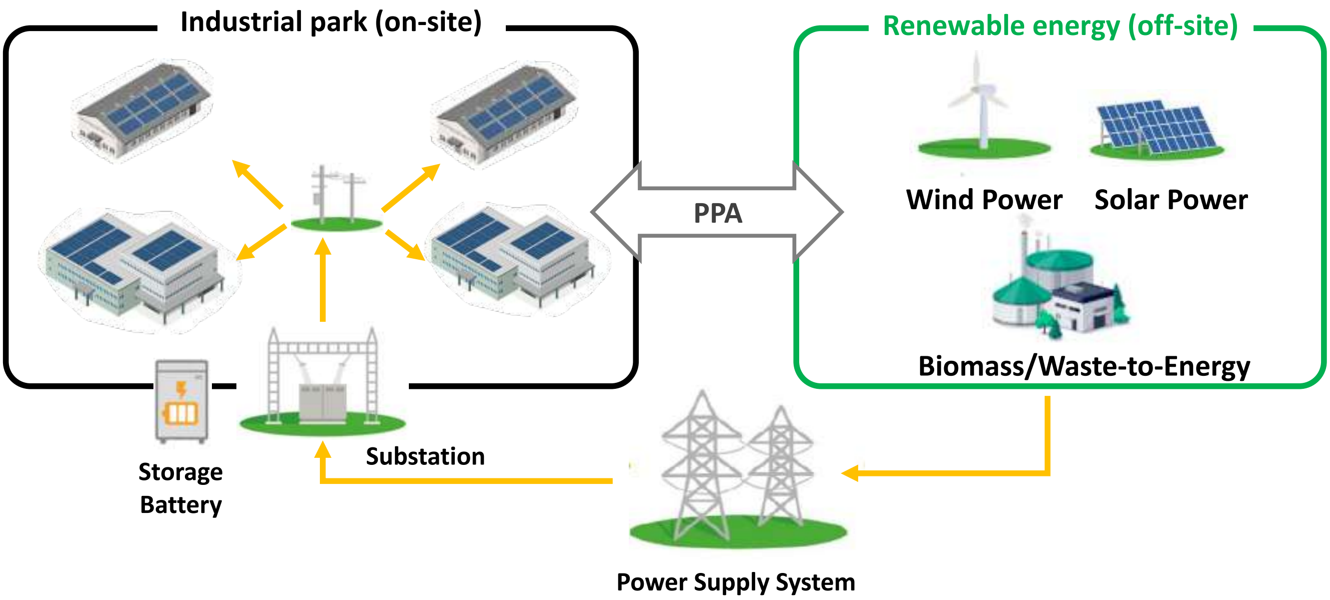
Sources: Agency for Natural Resources and Energy, ASEAN Economic Ministers–Ministry of Economy, Trade and Industry Economic and Industrial Cooperation Committee, and Nippon Koei (2025).

The following outlines the envisioned pathways towards carbon neutrality for each industrial park typology: conventional industrial parks, electricity-intensive industrial parks, and fuel-intensive industrial parks.

Conventional industrial parks (Figure 5-9)

- These parks pursue a balanced approach to carbon neutrality, focusing on electricity-related measures such as energy conservation and renewable energy solutions, both on-site and off-site, to meet the annual electricity demand of several hundred GWh.
- The carbon neutrality plan focuses on electricity decarbonisation, with 10%–30% of energy savings, 30%–50% on-site generation from rooftop solar panels, and 30%–50% off-site renewable generation, including wind power, solar power, or biomass and waste-to-energy.

Figure 5-9: Future Image of Carbon-neutral Industrial Park – Conventional Industrial Parks



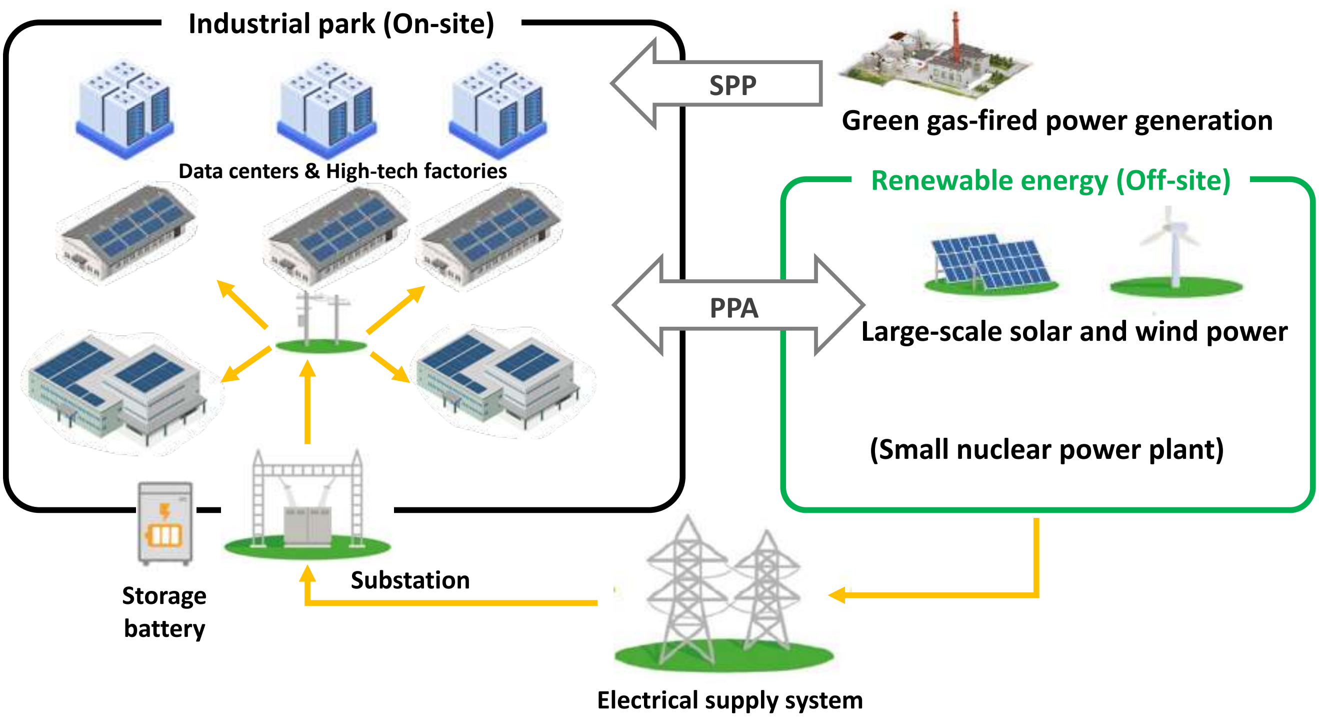
PPA = power purchase agreement.

Sources: Agency for Natural Resources and Energy, ASEAN Economic Ministers–Ministry of Economy, Trade and Industry Economic and Industrial Cooperation Committee, and Nippon Koei (2025).

Electricity-intensive industrial parks (Figure 5-10)

- High electricity demand facilities such as data centres, requiring several thousand GWh per year, cannot rely solely on on-site generation. Options must therefore include natural gas power plants (small power producers), large-scale solar and wind power, and, where feasible, small modular nuclear power plants (off-site).
- The carbon neutrality plan prioritises electricity decarbonisation, with 10%–30% energy savings, 10% on-site generation from rooftop solar panels, and 70% off-site renewable generation.

Figure 5-10: Future Image of Carbon-neutral Industrial Park – Electricity-intensive Industrial Parks



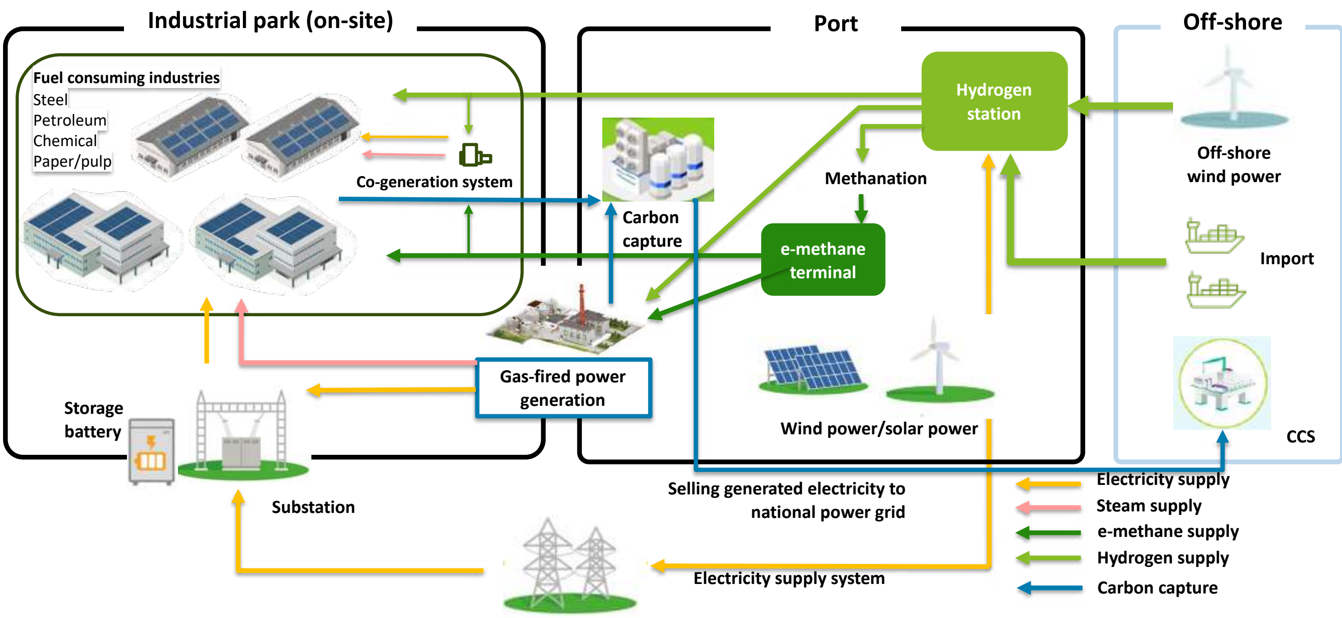
PPA = power purchase agreement, SPP = small power producer.

Sources: Agency for Natural Resources and Energy, ASEAN Economic Ministers– Ministry of Economy, Trade and Industry Economic and Industrial Cooperation Committee, Nippon Koei (2025).

Fuel-intensive Industrial Parks (Figure 5-11)

- Decarbonisation of fuels is a critical priority that must be actively pursued.
- The carbon-neutrality plan focuses on fuel decarbonisation, in collaboration with coastal supply chains, through measures such as gas-fired power generation, methanation, hydrogen utilisation, and CCUS.

Figure 5-11: Future Image of Carbon-neutral Industrial Park – Fuel-intensive Industrial Parks



Source: Agency for Natural Resources and Energy, ASEAN Economic Ministers– Ministry of Economy, Trade and Industry Economic and Industrial Cooperation Committee, Nippon Koei (2025).

5.3.2 Key policies and regulations

In response to these circumstances, AZEC partners countries are increasingly advancing industrial park initiatives, such as the development of carbon-neutral industrial parks, to enable tenant companies to access clean energy and implement energy-efficiency measures through coordinated participation.

A wide range of decarbonisation-related regulatory frameworks are exerting a growing influence on these efforts. These include policies promoting the use of renewable energy and sustainable fuels such as biofuels, hydrogen, and ammonia, as well as requirements for GHG emissions disclosure and the implementation of carbon credit systems.

- For instance, to facilitate renewable energy procurement, regulatory mechanisms have been established to support instruments such as PPAs and EACs. (See ‘Renewables’ under ‘Zero-emission Power Initiative’.)
- A review of key policies and regulations within each initiative reveals that AZEC partner countries are formulating or deliberating frameworks to accelerate decarbonisation.

Indonesia, Malaysia, and Viet Nam are making notable progress in promoting industrial park decarbonisation.

- Each of these countries is supporting the transition towards eco-industrial parks, including collaboration with international organisations such as UNIDO to implement decarbonisation strategies in industrial zones (Table 5-10).

Table 5-10: Policies for Promoting Decarbonisation in Industrial Parks by Country

Country	Overview
Australia	N/A
Brunei Darussalam	N/A
Cambodia	N/A
Indonesia	The Minister of Industry Decree (Number 3174 of 2022) establishes an inter-ministerial forum for eco-industrial park development, enhances industrial park competitiveness, and supports regional development. The government has launched the eco-industrial park concept with United Nations Industrial Development Organization (UNIDO) and other organisations and is working to convert several industrial parks into eco-industrial parks.
Japan	N/A
Lao PDR	N/A
Malaysia	Action Plan 3.4.1 of the New Industrial Masterplan 2030 aims to accelerate the transformation of industrial estates into eco-industrial parks by promoting the use of renewable energy, thereby reducing GHG emissions.
Philippines	N/A
Singapore	N/A
Thailand	N/A
Viet Nam	By 2030, 40%–50% of existing industrial parks are expected to have been converted into eco-industrial parks, and 8%–10% of new industrial parks will be built as eco-industrial parks. Since 2014, the Ministry of Planning and Investment has partnered with UNIDO to transform conventional industrial zones.

Sources: UNIDO (2023), Ministry of Investment, Trade and Industry (Malaysia) (2023).

5.4 Progress of Individual Projects

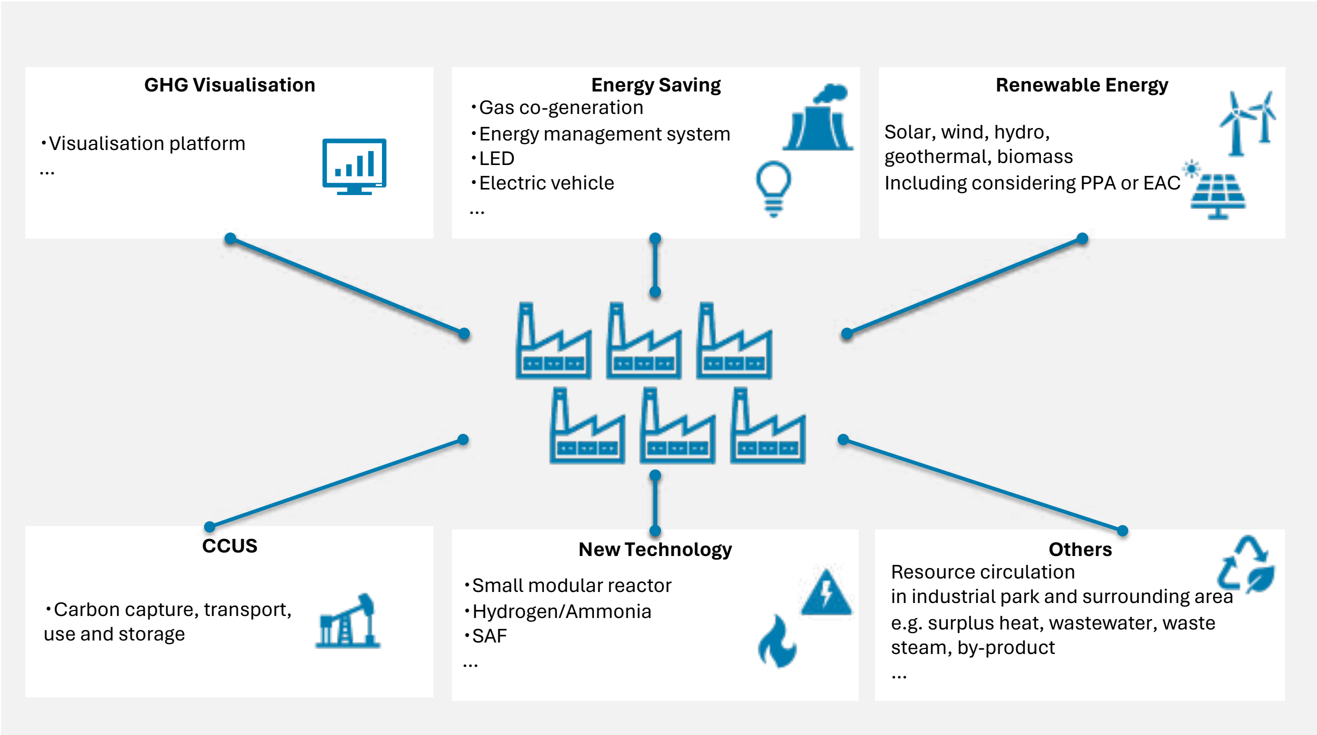
This initiative has mapped the decarbonisation landscape of the automotive industry and industrial parks.

Figure 5-12: Overview of Automotive Industry Project Coverage

BEV = battery electric vehicle, FCEV = fuel cell electric vehicle, HEV = hybrid electric vehicle, ICE = internal combustion engine, PHEV = plug-in hybrid electric vehicle.

Source: Author (2025).

Figure 5-13: Overview of Industrial Park Project Coverage



CCUS = carbon capture, utilisation, and storage; EAC = energy attribute certificate; GHG = greenhouse gas; LED = light-emitting diode; PPA = power purchase agreement; SAF = sustainable aviation fuel.

Note: These are merely examples of decarbonisation in industrial parks.

Source: Author (2025).

Several key industry projects in AZEC partner countries are presented below:

In relation to industrial parks, countries such as Indonesia and Viet Nam have undertaken projects designed to deliver decarbonisation solutions and enhance transparency of environmental impacts, including the calculation of GHG emissions. In Lao PDR, notable progress has been made in projects involving renewable-based hydrogen and ammonia.

Decarbonisation of Deltamas City and Greenland International Industrial Centre Industrial Park

- **Country.** Indonesia
- **Business entities and partners.** Sojitz Corp., Sinar Mas Land
- **Project overview.** Targets carbon neutrality in Deltamas City and the Greenland International Industrial Centre (GIIC) Industrial Park through a combination of renewable energy deployment, energy efficiency as a service (EaaS), and biogas utilisation
- **Project goal.** A 50% reduction in CO2 emissions by 2030 and full carbon neutrality by 2040/2050
- **Progress overview.** A decarbonisation road map has been developed for Deltamas City and the GIIC Industrial Park, focusing on renewable energy, EaaS, and biogas solutions. Discussions are underway with clients and local partners to implement these measures.

Digital Twin-based Assessment and Visualisation of Environmental Footprint

- **Country**. Indonesia
- **Business entities and partners.** Brownreverse Inc. (BRS), PT. Panca Amara Utama (PAU)
- **Project overview**. BRS and PAU are collaborating to validate 'environmentally conscious maintenance' at PAU's ammonia plant using BRS's digital twin technology. This project employs 3D modelling and methane emission data to study environmental impacts.
- **Project goal.** To validate sustainable, low-impact maintenance practices through digital twin technology and establish a replicable model
- **Progress overview.** In August 2024, 3D scanning of selected equipment at PAU's ammonia plant in Kalimantan Island was completed, and a digital twin environment was created using BRS software. Technical verification is underway to enable steady-state visualisation of methane emissions in 3D virtual reality. A demonstration was scheduled for 31 July 2025.

Memorandum of Understanding on Collaboration. Zeroboard (Japan), PT. Megalopolis Manunggal Industrial Development (Indonesia), PT KDDI Indonesia (Indonesia), and Kamar Dagang dan Industri Indonesia (Indonesia)

- **Country.** Indonesia
- **Business entities and partners.** Zeroboard Inc., PT. Megalopolis Manunggal Industrial Development (MMID), PT KDDI Indonesia, Kamar Dagang dan Industri Indonesia
- **Project overview.** In Marubeni-led MMID industrial parks, Zeroboard is providing GHG emission visualisation via a cloud platform, supported by PT KDDI Indonesia and KADIN Net Zero Hub workshops. Backed by a Japan External Trade Organization (JETRO) advanced digital transformation subsidy, the project is developing a model for effective GHG data sharing and visualisation in Indonesia.
- **Project goal.** To identify optimal data collection methods and enable visualisation of industrial park GHG emissions.
- **Progress overview.** The project began with a seminar in February 2024 to introduce tenants to carbon footprint tracking. Onboarding to the Zeroboard platform started in April 2024, followed by a seminar on decarbonisation fundamentals. To expand the data pool, a GHG survey was launched in January 2025 and closed in March 2025. Data analysis is underway to identify high-emission areas.

Memorandum of Understanding on the Study of a Coffee Roasting Project Using Green Hydrogen in the Pakse–Japan Economic Zone, Champasak Province

- **Country.** Lao PDR
- **Business entities and partners.** TSB GreeNex, Pheatsavang Joint Development Coffee Sole Co., Ltd.
- **Project overview.** The project will use hydropower-generated, renewable-based hydrogen as a heat source for roasting locally grown green coffee beans, producing hydrogen-roasted beans.
- **Project scale.** US$40 million
- Production scale. 5,000 tonnes per year
- **Project goal.** To ensure stable production of renewable-based hydrogen and hydrogen-roasted beans
- **Progress overview.** Backed by JETRO, the project will begin construction in September 2025 following a final investment decision in April 2025. Operations are scheduled to commence in January 2027. A follow-up green aluminium project is under discussion, with MoUs expected in 2025 for bauxite and electricity supply.

Green Ammonia and Low-carbon Fertiliser Project (Letter of Intent on Low-carbon Fertiliser Offtake Agreement)

- **Country.** Lao PDR
- **Business entities and partners.** Tsubame BHB Co., Ltd, Agri Laos Co., Ltd, State Enterprise for Agriculture Service
- **Project overview.** Tsubame BHB and Agri Laos are developing a renewable-based ammonia and low-carbon fertiliser project using hydropower and renewable energy. The State Enterprise for Agriculture Service has agreed to offtake the fertiliser.
- **Project scale.** US$37 million
- **Production scale.** 5,000 tonnes per year of ammonia and 20,000 tonnes per year of low-carbon fertiliser
- **Progress overview.** The project is creating a favourable business environment to support commercial-scale renewable-based ammonia and fertiliser production.

Cooperation Project for Decarbonisation through Energy Management Between Thang Long Industrial Park and North Hanoi Smart City

- **Country**. Viet Nam
- **Business entities and partners.** Sumitomo Corp., Thang Long Industrial Park Corp. (TLIP), North Hanoi Smart City Development Investment Joint Stock Company (NHSC), BRG Group
- **Project overview.** The project seeks to advance decarbonisation by expanding renewables in TLIP and NHSC, enhancing energy management across both sites, and introducing energy-saving solutions.
- **Project goal.** To expand renewable energy (rooftop solar, floating solar, biomass), enable mutual energy management between TLIP and NHSC via a private line, and promote energy efficiency through advanced equipment and green construction materials
- **Progress overview.** TLIP has installed 33 MWp of rooftop solar capacity as of April 2025. To expand other renewable initiatives, discussions with Vietnamese authorities are underway to clarify relevant regulations, supported by the Japanese government.

06

Market Enablers

6 Market Enablers

6.1 Transition Finance

6.1.1 Market trends

Achieving net-zero emissions requires financing not only fully decarbonised projects, such as renewable energy, but also transitional efforts of carbon-intensive sectors that still lack mature, economically feasible technologies for full decarbonisation. These include thermal power generation, steel, cement, chemicals, and transport. Transitional measures may encompass energy efficiency improvements, fuel switching, and the deployment of emission-reducing technologies such as CCUS. Given that immediate decarbonisation is not feasible for all countries, regions, or industries due to technological and economic constraints, the strategic use of transitional technologies is essential to achieve near-term emissions reductions.

To promote decarbonisation across these sectors, substantial funding is required. It is therefore essential to develop a financial environment that supports the implementation of effective transition strategies.

Sustainable finance describes financial flows that integrate consideration of impacts on climate and the natural environment. This reflects the growing understanding of the role that the financial system can play in addressing climate change and decarbonising the economy by engaging with relevant industries. Sustainable finance also includes transition finance, which supports mainly hard-to-abate and high-emitting sectors in aligning with science-based decarbonisation pathways.

Within sustainable finance, labelled instruments such as green, social, sustainability, sustainability-linked, and transition (GSS+) instruments have been developed. These instruments direct capital towards green or transitional projects with clear use-of-proceeds and reporting requirements, thereby enhancing transparency and investor confidence. They also provide clearer signalling, attract a broader range of environmental, social, and governance investors, and may deliver pricing or policy benefits.

While GSS+ instruments play a vital role, they remain insufficient to close the financing gap, particularly for transition projects, due to limited issuance, inadequate data disclosure, and inconsistencies across taxonomies. As a result, GSS+ instruments alone are unable to capture the dynamic, transitional efforts required across the full spectrum of climate solutions, thus constraining financial flows towards viable intermediate steps.

In this context, transition finance has emerged as an irreplaceable and more inclusive approach, supporting hard-to-abate and high-emitting sectors in aligning with science-based decarbonisation pathways.

The AZEC Progress Report places particular emphasis on transition finance as a broader set of financing mechanisms that contribute meaningfully to energy transition and decarbonisation goals.

Global trends

A universally accepted definition of transition finance has yet to be established.

From a market perspective, the International Capital Market Association (ICMA) positions transition as an investment theme that can be financed using existing frameworks for green, sustainability, and sustainability-linked bonds, whilst also recognising the development of 'climate transition'–labelled instruments. Based on evolving practices and interpretations amongst investors, ICMA categorises the overlapping interpretations of transition as follows:

- Economy-wide transition encompassing wider sustainability goals or Sustainable Development Goals (SDGs).
- Climate transition specifically targeting the goals of the Paris Agreement.
- Hard-to-abate transitions focusing on high-emitting industrial sectors.

The global sustainable finance market of labelled instruments continues to grow, driven by increasing investor demand for sustainable investments.

- Green bonds, the earliest GSS+ instruments introduced globally in 2007, continue to dominate. In 2024, green bond issuance reached a record US$632 billion. Within the bond market, the private sector remains the largest issuer, representing over 50% of issuances. Sovereign entities accounted for 19% of green bonds and 9% of sustainability bonds.

Figure 6-1: Sustainable Finance Market Trend, 2021–2024

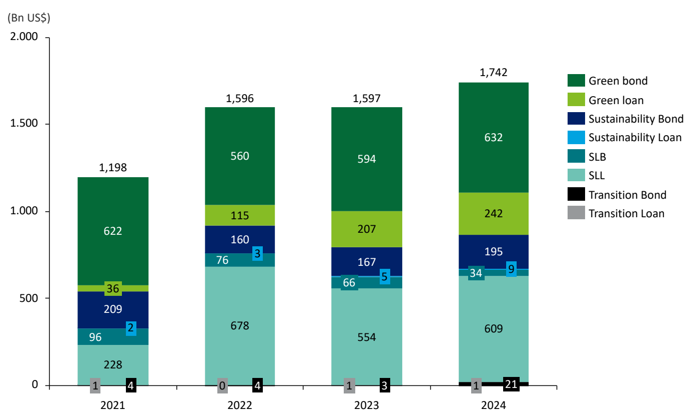
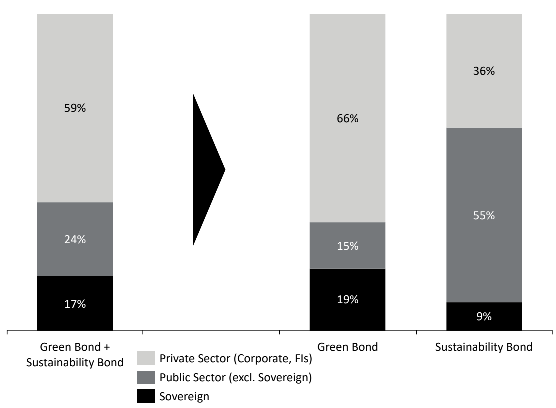


Figure 6-2: Green and Sustainability Bond Issuer Type by Share



Bn = billion, SLB = sustainability-linked bond, SLL = sustainability-linked loan.

Source: Environmental Finance Data (2025).

However, ICMA explicitly notes that whilst the sustainable bond market contributes meaningfully to climate transition, it ‘is not a major resource’ for the transition of companies in the fossil fuel sector and other hard-to-abate industries, highlighting that only about 3.6% of green, sustainability, and sustainability-linked bonds have been raised for those sectors.

Awareness of transition finance is growing globally. The Glasgow Financial Alliance for Net Zero (GFANZ) has demonstrated a policy shift in its communications, emphasising the mobilisation of capital for emerging and developing economies, an essential step towards achieving a just and effective net-zero transition. This reflects a broader shift in the international financial community towards addressing regional disparities in access to transition funding and ensuring that hard-to-abate sectors and vulnerable economies are not left behind.

Loans and especially transition bonds have recently attracted global attention due to their focus on financing the decarbonisation of hard-to-abate industries, which have largely remained underserved by traditional sustainable finance instruments such as green and sustainability bonds.

- Despite their growing importance, transition bonds and loans still represent a relatively small segment of the sustainable finance market. In 2024, transition bond issuance reached about US$21 billion, a significant increase from previous years, largely driven by the launch of the Japan Climate Transition Bonds.

In 2021, Japan published its *Basic Guidelines on Climate Transition Finance*, which provided a strong boost to the domestic transition bond market. From 2022 onwards, Japanese corporates became major issuers, and in 2024, the Japanese government issued its first sovereign climate transition bonds, the first of their kind, as sovereign transition bonds. Since then, the transition-labelled bond market has been dominated by yen-denominated issuance, now accounting for over 90% of global issuance. In Canada, the federal government and financial institutions such as the Royal Bank of Canada and TD Securities have initiated discussions on establishing a Canadian framework for transition bonds, aligned with the country’s net-zero ambitions and the recommendations of the Sustainable Finance Action Council.

In Europe and North America, leading financial institutions such as AXA Investment Managers, Natixis, Barclays, Prudential plc, and BMO Financial Group are actively developing and refining transition finance frameworks. These efforts range from AXA Investment Managers’s emphasis on issuer-level Paris alignment and quantified targets, and Natixi’s multi-criteria issuer assessment model, to Barclays’ sector-specific eligibility decision trees, Prudential’s emerging market-focused approach grounded in GFANZ principles, and BMO’s inclusion of high-emission industrial activities and nuclear energy under a newly established transition category aligned with Canada’s national taxonomy road map.

Collectively, these efforts aim to provide clear criteria and investment guidelines for supporting hard-to-abate sectors, reinforcing the role of transition finance as a core component of sustainable capital markets globally.

AZEC trends

Although the sustainable finance market in AZEC partner countries continues to grow, further expansion is necessary to adequately supply the funding required to realise the region's transition goals. According to *Asia Transition Finance Study Group Annual Report 2023*, issuance values in the ASEAN region are on an upward trend, mirroring the global market. However, ASEAN accounted for only about 2%–3% of global sustainable finance issuance as of 2022, despite representing about 6.5% of global GDP.

Table 6-1: Status of GSS+ Bond Issuance in AZEC Partner Countries

Country	GSS+ Bond Issuance Status
Australia	Issued its inaugural green treasury bond in June 2024, raising AUD7 billion. The government plans to scale up issuance under its green bond programme, with outstanding bonds reaching AUD9 billion.
Brunei Darussalam	N/A
Cambodia	Issued its first green bond in June 2024 through the Phnom Penh special economic zone, raising KHR41 billion (~US$10 million). Proceeds will fund green projects such as a wastewater treatment plant and sustainable infrastructure.
Indonesia	In 2023, the government mobilised US$2.2 billion in thematic bonds, bringing the sustainable debt market to over US$10 billion in value, more than double its size in 2020.
Japan	Issued JPY1.6 trillion in inaugural climate transition bonds in February 2024 under a new 10-year programme targeting JPY20 trillion in total issuance. By March 2025, more than JPY3 trillion had been issued. These bonds fund decarbonisation in priority sectors such as hydrogen, next-generation renewables, heavy industry, and clean mobility, aiming to catalyse more than JPY150 trillion in green transformation investments.
Lao PDR	Has not yet issued GSS bonds but signed a partnership with the International Finance Corp. in 2023 to develop green finance guidelines and prepare for future thematic bond issuance.
Malaysia	Issued the world's first US dollar–denominated sustainability sukuk in 2021, raising US$1.3 billion. The issuance supports green and social development aligned with the Sustainable Development Goals and remains a benchmark in Islamic sustainable finance.
Myanmar	N/A
Philippines	Raised US$3.55 billion in sustainability bonds from 2022 to 2023, including US$550 million in Samurai bonds. *2023 Sustainability Bond Allocation and Impact Report* confirmed full disbursement to green (47%) and social (53%) projects.
Singapore	Issued its first sovereign green bond in 2022 under the Singapore Green Bond Framework and plans to raise SGD35 billion by 2030. Proceeds fund national infrastructure aligned with net-zero goals.
Thailand	Issued Asia's first sovereign sustainability-linked bond in November 2024, raising THB30 billion (~US$880 million). The 15-year bond links interest rates to climate targets, including a 30% reduction in GHG gas emissions and 440,000 zero-emission vehicles by 2030. It was oversubscribed 2.7 times and complements earlier issuances of US$6 billion in sustainability bonds.

Country	GSS+ Bond Issuance Status
Viet Nam	Began issuing green bonds in 2021. Its Resource Mobilisation Plan under the Just Energy Transition Partnership, launched in 2023, targets US$15.5 billion in blended finance to support the energy transition, including transmission upgrades and offshore wind development.

GSS+ = green, social, sustainability, sustainability-linked, and transition.

Note: Sukuk refers to an Islamic financial certificate, similar to a bond, but structured in a way that complies with Sharia (Islamic law). Samurai bonds are yen-denominated bonds issued in Japan by a non-Japanese entity, such as a foreign government, corporation, or international organisation.

Sources: Australian Office of Financial Management (2025), ChannelNewsAsia (CNA) (2022), Climate Policy Initiative (2024), Department of Finance (2023), Global Green Growth Institute (2024), International Finance Corporation (2023), Ministry of Finance (2021), The GR Company (2024), Asian Development Bank (2024), United Nations Development Programme (2024).

This is partly attributable to the fact that, in the ASEAN region, financing is predominantly conducted through loans rather than bond issuance in capital markets. As a result, it is essential to adopt a comprehensive view of transition finance that encompasses both bond-based instruments and loan-based financing. Recognising the region's financing structure is critical to mobilising capital effectively, since bond instruments alone may not be sufficient to meet the diverse requirements of transition, where flexible and accessible loan-based solutions are often necessary.

Amongst AZEC partner countries, a growing number of initiatives are emerging under the transition finance framework. In some instances, corporates themselves are issuing transition-labelled bonds, whilst in others, commercial banks are acting as intermediaries by providing transition-aligned loans. It is therefore important to approach transition finance with this diversity in mind, recognising that it encompasses not only capital market instruments but also bank-mediated financing solutions.

- Leading ASEAN financial institutions – DBS Bank Ltd., United Overseas Bank Ltd. (UOB), and Malayan Banking Berhad (Maybank) – have each developed transition finance frameworks with differing levels of alignment to international standards such as *Climate Transition Finance Handbook* published by ICMA.
    - o DBS (Singapore) published *Sustainable and Transition Finance Framework and Taxonomy*, categorising financing under 'Green', 'UN SDGs', and 'Transition', whilst introducing a 'Corporate in Transition' label at the entity level. Transition labelling for use of proceeds is based on sectoral decarbonisation benchmarks, whilst corporate labelling requires companies to meet one of three conditions: withdrawal from carbon-intensive assets (divest), reduction in the share of such activities (diversify), or clear actions towards decarbonisation.
    - o UOB (Singapore) outlines eligible transition solutions in its *Transition Finance Framework*, including measures such as waste heat recovery, fuel switching from fossil fuels to LNG or ammonia, and CCUS. Whilst the focus is on project eligibility, the framework encourages investee companies to align with national or Paris-aligned net-zero targets and to report on progress.
    - o Maybank (Malaysia) introduced *Transition Finance Framework* based on the following:
        1) A principle-based approach, referencing international standards.
        2) An eligible activity–based approach, evaluating whether the financed activity aligns with sector transition goals.

3) A net-zero strategy and essential criteria approach, requiring companies to demonstrate alignment with long-term net-zero plans and to meet minimum safeguards (e.g. Do No Significant Harm and social impact considerations).

- Tenaga Nasional Berhad (TNB), Malaysia's largest energy company, regards sustainable finance as a key driver in achieving its 2050 net-zero target. In 2022, its subsidiary, TNB Power Generation Sdn. Bhd., released a sustainability framework. In 2024, TNB introduced a group-wide transition finance framework, the first of its kind in the ASEAN power sector, enabling sustainable finance transactions across the group. The framework covers sustainable and responsible investment *sukuk*, GSS bonds, transition bonds, and transition loans. It was developed in line with ICMA's *Climate Transition Finance Handbook* (2023), and aligns with ICMA's Green Bond Principles and Social Bond Principles, the Loan Market Association's *Green Loan Principles and Sustainability-Linked Loan Principles*, the ASEAN Capital Markets Forum's ASEAN Green Bond Standards (2018), and the *ASEAN Taxonomy* and the *ASEAN Transition Finance Guidance*.

When defining what qualifies as 'transition' finance, a range of perspectives exists, but two key criteria are commonly referenced:

1) A credible corporate transition strategy, ideally supported by objective assessments, demonstrating that the issuer or borrower is on a verifiable pathway towards decarbonisation. Where issuers or borrowers, such as small and medium-sized enterprises or those in emerging markets and developing economies, lack the resources to produce a comprehensive transition plan, reference to NDCs, power development plans, or other frameworks consistent with the Paris Agreement may demonstrate commitment.
2) Where use-of-proceeds is clearly defined, the underlying technologies or activities should be assessed for their alignment with transition objectives, including their potential to reduce emissions in hard-to-abate sectors.

Establishing such frameworks is particularly important in the AZEC context, where energy systems and industrial structures vary widely across countries, and where flexibility in financial instruments, combined with robust governance, can play a pivotal role in driving credible and inclusive climate transitions.

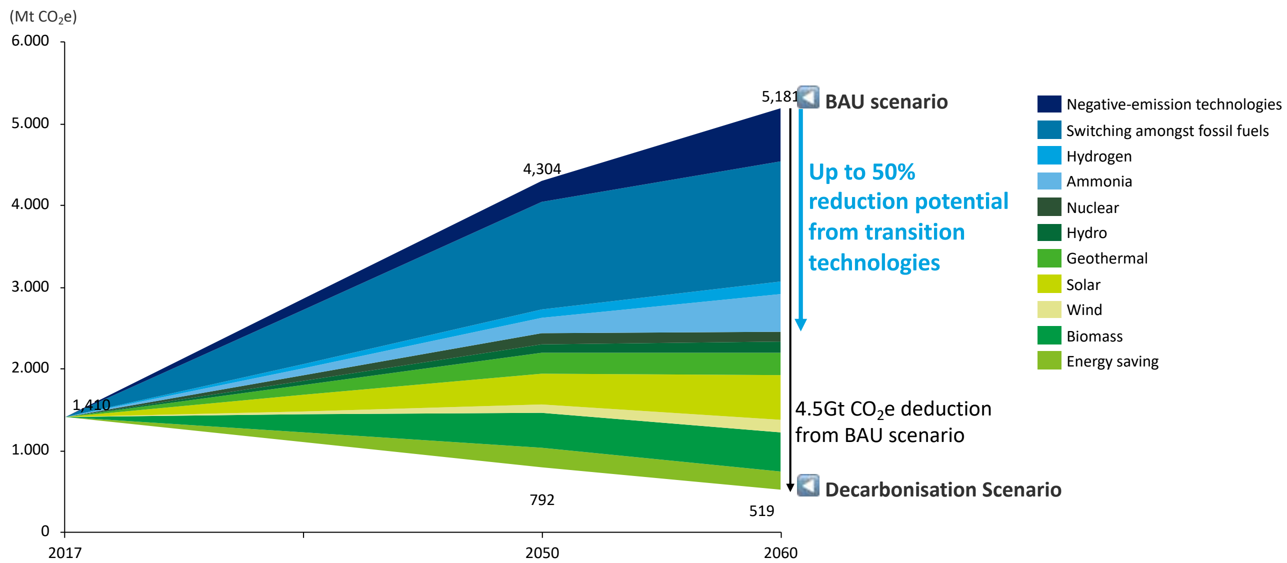
Transition finance encompasses a diverse range of projects across varying sectors and time horizons. For technologies requiring long-term market development, such as CCUS and low-carbon hydrogen, ongoing dialogue between the public and private sectors on policy frameworks and institutional design is of critical importance. These capital-intensive solutions often face early-stage bankability challenges, highlighting the need for blended finance mechanisms and appropriate risk-sharing arrangements to facilitate their deployment.

Simultaneously, opportunities exist for short-term transition measures, such as fuel switching from coal to lower-emission alternatives like natural gas or sustainable biofuels. Although such initiatives may present reputational risks for financial institutions, particularly with respect to concerns over carbon lock-in or greenwashing, they can still represent essential steps on a credible decarbonisation pathway, particularly in emerging economies where coal remains dominant. Financial institutions must therefore assess such projects against transparent criteria, including scientific alignment with net-zero objectives, NDCs, power development plans, or other Paris-aligned references, and credible transition plans, rather than excluding them solely due to reputational considerations.

- For example, ASEAN will need to abate up to 5 gigatonnes of CO_2 equivalent ($GtCO_2e$) per year by 2060, compared to the business-as-usual scenario, to meet its decarbonisation commitments. By employing both green and transition technologies, an estimated 4.5 $GtCO_2e$ reduction can be achieved under the decarbonisation scenario (Figure 6-3).

- Transition technologies such as CCUS, fuel switching, hydrogen, and ammonia could collectively address up to 50% of ASEAN's emission gap on the path to net zero.

Figure 6-3: ASEAN Carbon Dioxide Emissions: Business-as-usual and Decarbonisation Scenarios with Green and Transition Technologies



BAU = business as usual, $MtCO_2e$ = million tonnes of carbon dioxide equivalent.

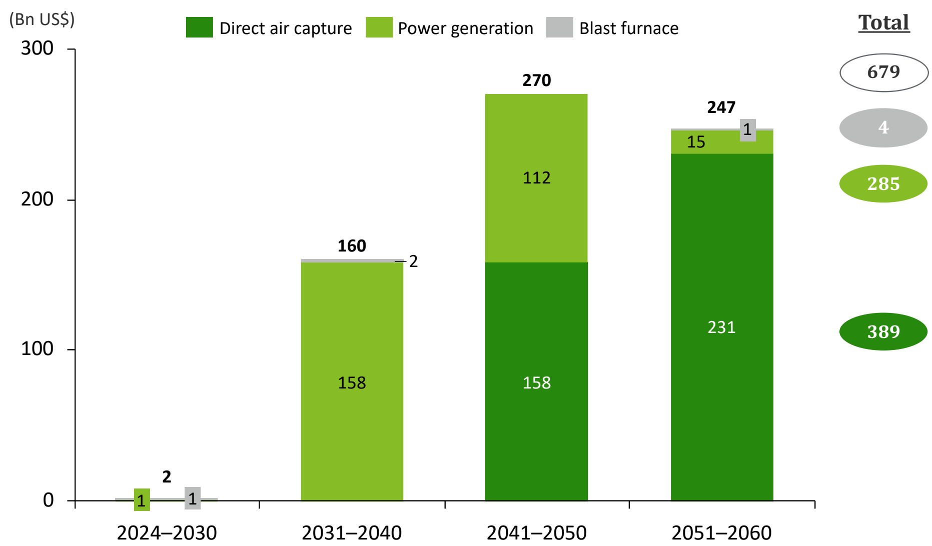
Source: Economic Research Institute for ASEAN and East Asia (2024).

Whilst substantial funding is necessary for the adoption of transition technologies, it must be complemented by the development of an enabling market environment. For example, although cost reductions through the commoditisation of CCUS technologies are essential for commercial viability, they alone are insufficient to ensure financial feasibility. A robust legal and regulatory framework is also required, alongside functional markets, such as carbon pricing mechanisms, that accurately reflect the environmental value of CO_2 mitigation.

In the ASEAN region, the deployment of CCUS could require up to US$679 billion by 2060 (Figure 6-4). Under current financing conditions, securing funding at this scale presents significant challenges:

- **Limited precedents and recipient capacity.** Financial institutions face high uncertainty due to the scarcity of successful case studies and the limited technical or financial capacity of potential recipients of transition finance.
- **Lack of policy clarity and coordination.** The absence of sector-specific transition roadmaps hinders coordinated efforts across stakeholders.
- **Fragmented standards and taxonomies.** Divergences in transition-related standards and classification systems across countries lead to confusion and delay, highlighting the urgent need for regional harmonisation.
- **Unattractive risk–return profiles.** Many transition projects are characterised by high perceived risks and low expected returns, exacerbated by the lack of effective de-risking mechanisms.
- **Need for enhanced collaboration and financial innovation.** Addressing these barriers requires strengthened public–private collaboration, improved risk-sharing frameworks, and the development of innovative financial instruments tailored to the unique characteristics of transition finance.

Figure 6-4: Capital Expenditure Required for Carbon Capture, Utilisation, and Storage in ASEAN



Key Takeaways

- The growth in carbon capture volume is expected to grow significantly until 2050, and subsequently plateau.
- For power generation assets, new capex needs are minimal after 2050.
- Carbon capture from Direct Air Capture facilities is expected to begin after 2041 and will account for most of the capex needs after 2050 due to the high unit capex.

ASEAN = Association of Southeast Asian Nations, Bn = billion, capex = capital expenditure,
Source: Asia Transition Finance Study Group (2024).

To accelerate transition finance and support the achievement of net-zero targets in ASEAN, the greater involvement of the private sector is essential. At the same time, public sector participation remains essential. Accordingly, the concept of blended finance is gaining traction, including in discussions within the Asia Transition Finance Study Group.

Although definitions vary slightly across organisations, blended finance generally refers to the strategic use of public or philanthropic funds to mobilise private sector investment. These funds, provided by development finance institutions, governments, or foundations, can be deployed through concessional loans, equity investments, or grants, as well as through non-financial support such as technical assistance.

Blended finance enables organisations with different objectives to invest alongside one another whilst pursuing their own objectives, whether financial returns, social impact, or a combination of both.

Regardless of the structure, blended finance attracts private capital by using public or philanthropic concessional capital to de-risk investments and improve risk–return profiles. It helps address key barriers for private sector participants, such as project sponsors, insurers, financiers, service contractors, and off-takers, by mitigating high perceived and real risks and by enhancing returns relative to comparable investments. Governments and other public entities, able to accept lower returns, can provide the concessional capital that bridges the risk gap and catalyse private investment.

Whilst blended finance is not a panacea and cannot eliminate all risks associated with transition projects, it can help mitigate several critical risks:

1) **Credit risk.** Concessional funds and guarantees lower credit costs, whilst technical assistance enhances the capabilities of project sponsors.
2) **Development risk**. Grants and concessional debt or equity support early-stage projects, with technical expertise helping to smooth the development process.
3) **Construction risk.** Construction equity, guarantees, and insurance reduce exposure during the building phase, supported by technical assistance to ensure delivery.
4) **Political risk.** Multilateral institutions and similar entities can provide political risk insurance to mitigate country-specific or policy-related uncertainties.

Box 6 -1

Labelled GSS+ Finance: Four Main Categories

Green Bonds and Loans

- The first category includes use-of-proceeds (UoP) instruments dedicated to financing green projects. These are typically aligned with internationally recognised frameworks, such as *Green Bond Principles* published by the International Capital Market Association (ICMA). They fund projects that deliver measurable environmental benefits, including investments in renewable energy (e.g. solar and wind power), energy efficiency improvements, and green building developments.

Transition Bonds and Loans

- The second category also consists of UoP instruments but targets transition projects. These are aligned with frameworks such as ICMA's *Transition Finance Handbook.* Transition instruments support the decarbonisation of hard-to-abate sectors, including steel, cement, and heavy industry, through measures such as coal-to-gas fuel switching; carbon capture, utilization, and storage; and the deployment of other transitional technologies.

Sustainability-linked Bonds and Loans

- Unlike green or transition bonds and loans, sustainability-linked instruments are not tied to specific projects. Instead, they may be used for general corporate purposes, with financial terms contingent upon the issuer's achievement of predefined sustainability performance targets. These instruments typically follow guidelines such as ICMA's *Sustainability-Linked Bond Principles.*

Transition-linked Bonds and Loans

- A specialised subtype of sustainability-linked instrument, transition-linked bonds link financing terms to the issuer's achievement of predefined transaction performance targets. These targets must be credible, science-based, and aligned with the Paris Agreement and long-term decarbonisation pathways. They are structured in accordance with frameworks such as *Sustainability-Linked Loan/ Bond Principles, Climate Transition Finance Handbook* (ICMA), and other national guidelines.

Social Bonds and Loans

- The final category consists of UoP instruments designed to finance projects that deliver social benefits. These are aligned with standards such as *Social Bond Principles orSocial Loan Principles*, published by ICMA and loan market associations such as the Loan Market Association, the Asia Pacific Loan Market Association, and the Loan Syndications and Trading Association. Common focus areas include affordable housing, education, healthcare, and improved access to essential services.
- Promote the establishment of green energy industrial parks to support carbon-neutral manufacturing in the region.

Sources: ICMA (2022), Climate Transition Finance Handbook (2024), Japan Airlines (2024).

6.1.2 Key policy and regulation

Across the AZEC partner countries, efforts are underway to develop investment criteria tailored to local conditions. In emerging economies, where project risks tend to be higher, the public sector often takes a leading role in providing funding to ensure steady progress in the energy transition.

The ASEAN region faces the complex challenge of transitioning from an energy supply–demand structure heavily dependent on fossil fuels, whilst simultaneously maintaining robust economic growth and energy security. With electricity demand rising alongside economic development, it is crucial to promote decarbonisation practically and steadily.

ERIA has played a pivotal role in facilitating this transition by doing the following:

- Building common understanding amongst stakeholders through support for the Asia Transition Finance Study Group and the drafting of a joint report with ADB and Japan's METI.
- Providing comprehensive technological insights and decision-making guidance for financial institutions and policymakers through the publication of Technology List and Perspectives for Transition Finance in Asia.

For the transition to succeed, it is essential to establish financing tools that are tailored to the specific energy systems and economic conditions of each country.

Efforts to develop transition finance taxonomies are gaining traction across AZEC partner countries. Australia, for example, has introduced its own taxonomy, and a regional trend is emerging towards frameworks that incorporate 'amber' categories and transition activities alongside green classifications. This approach reflects the growing recognition that credible climate transitions require flexible frameworks capable of accommodating intermediate technologies and sector-specific decarbonisation pathways, particularly in hard-to-abate sectors.

However, for such taxonomies to function effectively and mobilise capital at scale, they must be supported by comprehensive national policy packages. These should include clearly articulated transition pathways and sectoral roadmaps, alignment with long-term net-zero targets, and a foundation rooted in scientific evidence and economic realities. Establishing these elements ensures that taxonomies are not purely conceptual tools but are instead integrated into broader national strategies that guide investment, regulation, and private sector engagement coherently and credibly.

Under many taxonomy frameworks, transition projects are commonly classified as 'amber', a tier between 'green' and 'red'. This category is deliberately designed to accommodate technologies and activities that are not yet fully aligned with net-zero targets but are nonetheless considered critical components of credible and time-bound decarbonisation pathways.

Projects within the amber category are subject to enhanced due diligence, including the submission of a detailed decarbonisation road map, demonstration of a credible technology trajectory, and a robust justification of the project's transitional role.

Although financial institutions may adopt a more cautious stance toward such projects, the amber classification serves as an enabling mechanism. It allows for the mobilisation of transition finance to support activities that are essential in bridging the gap between high-emission practices and long-term climate goals.

Table 6-2: Development Status of Taxonomies and Aligned Policies in AZEC Partner Countries

Country	Taxonomy and Aligned Policies	Overview and Key Features
ASEAN	ASEAN Taxonomy for Sustainable Finance	Provides a common framework for classifying sustainable economic activities across ASEAN Member States. Serves as the overarching guideline for aligning national taxonomies within the region.
	ASEAN Transition Finance Guidance	Encourages financial institutions to channel capital towards transitioning companies by aligning with investor demand and incentivising the development of credible transition plans.
Australia	Australian Sustainable Finance Taxonomy	Released in June 2025, the initial phase offers a framework for classifying economic activities contributing to sustainability objectives. In its initial version, the primary focus is on climate change mitigation. Designed to guide private capital allocation towards activities that support Australia's net-zero transition, the taxonomy includes both 'green' and 'transition' criteria. It recognises the need for progressive decarbonisation in high-emission sectors, enabling capital flows to facilitate an economy-wide energy transition.
	Net Zero Plan	Developed by the Department of Climate Change, Energy, the Environment and Water, the plan covers six key sectors: electricity and energy, transport, industry, agriculture and land, resources, and the built environment. It sets out long-term emissions reduction pathways aligned with 2050 net-zero targets and supports credible transition finance strategies.
Brunei Darussalam	N/A	N/A
Cambodia	N/A	N/A
Indonesia	Indonesia Taxonomy for Sustainable Finance	Originally published in February 2024, with an updated version in February 2025, the taxonomy adopts a principles-based approach using a traffic light system (green, amber, red) to classify sustainability levels. It also includes transitional support for key industries, such as coal-fired plants used in nickel smelting.
	Energy Transition Roadmap	Developed with International Energy Agency and International Renewable Energy Agency support, the road map outlines pathways to achieve net-zero emissions by 2060, including the expansion of renewables, early coal retirement, and enhanced power grid reliability.

Country	Taxonomy and Aligned Policies	Overview and Key Features
Japan	Sector-specific technology roadmaps	Published by the Ministry of Economy, Trade and Industry in 2022–2023, these roadmaps outline decarbonisation pathways for high-emission sectors. They serve as official benchmarks for assessing the credibility of transition finance in alignment with national climate goals and the Paris Agreement.
Lao PDR	N/A	N/A
Malaysia	Climate Change and Principle-based Taxonomy	Published in April 2021, this taxonomy classifies economic activities based on climate risk and environmental impact. Activities are categorised into climate-supporting, transitioning, and watchlist, enabling financial institutions to align lending decisions with national climate targets.
	National Energy Transition Roadmap	Launched in 2023, this road map identifies six energy transition levers to enable transition finance: renewable energy, hydrogen, bioenergy, energy efficiency, carbon capture and storage, and grid infrastructure. It supports Malaysia's goal of achieving net-zero GHG emissions by 2050.
Philippines	Philippine Sustainable Finance Taxonomy Guidelines	Released in February 2024, these guidelines serve as an interim assessment tool for activities pending the development of a full taxonomy. They provide guiding questions and decision trees to assist regulated entities in evaluating activities.
	Power Development Plan 2023–2050	Sets out sectoral strategies to achieve a 35% renewable energy share by 2030 and 50% by 2040. Supported by policy reforms, green auctions, and international financing partnerships.
Singapore	Singapore–Asia Taxonomy for Sustainable Finance	Launched in December 2023, the taxonomy classifies transition activities across eight carbon-intensive sectors: energy, transport, industry, buildings, and others. It uses a traffic light system (green, amber, red) to assess alignment with climate mitigation targets and guides financial institutions in credible transition financing.
Thailand	Thailand Taxonomy	Phase 1: Published in June 2023, covering two key sectors: energy and transport, focusing on climate change mitigation
		Phase 2: Scheduled for 2025, expanding to include manufacturing, agriculture, construction and real estate, and waste management. It will also incorporate broader environmental objectives, such as climate adaptation, pollution control, and the circular economy.
	Clean Energy Finance and Investment Roadmap	Developed with Organisation for Economic Co-operation and Development support, the road map provides decarbonisation targets and investment priorities to support the country's long-term low-emission development strategy and net-zero vision.
Viet Nam	Just Energy Transition Partnership Resource Mobilisation Plan	Launched in 2023, the plan outlines Viet Nam's strategy to accelerate power sector decarbonisation with international support. Backed by US$15.5 billion in pledged public and private finance, the plan supports just transition measures, regulatory reforms, and investment mobilisation towards a low-carbon economy.

Sources: ASEAN Taxonomy Board (2024), Australia Sustainable Finance Institute (2024), Financial Services Authority (2025), Bank Negara Malaysia (2021), Ministry of Economy, Trade and Industry (2023).

Moreover, in emerging countries where project risks tend to be higher, many initiatives, especially those led by the public sector, play a key role in providing transition financing.

Table 6-3: Transition Finance Initiatives in ASEAN

#	Initiative	Recipient	Channelling Institutions	Overview of the Initiative
1	Energy Transition Mechanism (ETM)	Indonesia	Asian Development Bank (ADB), World Bank Group, PT Sarana Multi Infrastruktur, others	A blended finance initiative led by ADB to accelerate the retirement of coal-fired power plants and support their replacement with clean energy. The mechanism seeks to reduce emissions whilst ensuring a just and affordable transition in developing Asia. It covers multiple initiatives, including: - ADB's Energy Transition Mechanism and the World Bank Group programme - Indonesia's ETM platform
2	Just Energy Transition Partnership	Indonesia	Public: International Partners Group Private: Glasgow Financial Alliance for Net Zero (GFANZ)	A public–private partnership designed to accelerate the early retirement of coal-fired power plants and halt the development of new on-grid, off-grid, and captive coal plants, in alignment with Presidential Regulation No. 122/2022. This initiative integrates diplomatic, policy, and financial instruments from donor countries with private capital mobilised through GFANZ.
3	Japan Climate Transition Bond Framework	Japan	Government of Japan	First published in November 2023 and revised in July 2025, the framework outlines principles, targets, eligible sectors, and transparency requirements for issuing transition bonds. It focuses particularly on hard-to-abate industries, such as steel and transport.
4	Clean Energy Financing Partnership Facility	Asia-Pacific	ADB	A dedicated facility managed by ADB that supports clean energy investments throughout Asia and the Pacific. It provides project grants and technical assistance to reduce carbon intensity and improve energy access through renewable energy and energy efficiency initiatives.
5	Global Green Growth Institute (GGGI)	Developing and emerging countries globally	GGGI	An intergovernmental organisation that fosters sustainable economic growth by assisting governments in designing and implementing green investment frameworks, driving policy reforms, and developing project pipelines to accelerate the transition to a resilient, low-carbon economy

#	Initiative	Recipient	Channelling Institutions	Overview of the Initiative
6	Green Climate Fund	Developing countries globally	World Bank Group, United Nations Framework Convention on Climate Change	A global climate fund supporting mitigation and adaptation in developing countries. It provides blended finance for climate-resilient infrastructure, clean energy projects, and carbon reduction initiatives. Access is channelled through accredited international, regional, or national entities.
7	World Bank Green Bond	World Bank borrowers globally	World Bank Group	Funds raised from fixed-income investors are allocated to eligible climate and environmental projects, including those facilitating the transition to low-carbon and climate-resilient growth
8	Australia Climate Finance Partnership	ASEAN and Pacific	Department of Foreign Affairs and Trade, ADB	A concessional finance facility managed by ADB to mobilise private investment in low-emission, climate-resilient infrastructure. It supports projects such as electric mobility and geothermal energy in Viet Nam and Indonesia.
9	Australian Development Investments	ASEAN	Department of Foreign Affairs and Trade	An impact investment fund that supports high-growth businesses in clean energy and inclusive finance sectors, mobilising private capital whilst delivering climate and gender equity outcomes

Source: Economic Research Institute for ASEAN and East Asia. (2025).

Efforts to promote blended finance have commenced across ASEAN to accelerate the mobilisation of private capital.

Table 6-4: Blended Finance Initiatives in AZEC Partner Countries

Country	Blended Finance Initiatives
ASEAN	Advancing green infrastructure investments through blended finance via the ASEAN Catalytic Green Finance Facility (ACGF), supported by the ASEAN Infrastructure Fund and managed by the Asian Development Bank (ADB). The ACGF seeks to leverage public and private capital to finance clean energy, sustainable transport, and water infrastructure projects. Since its inception, it has mobilised commitments exceeding US$2 billion for sustainable infrastructure.
Australia	Expanded blended finance initiatives through the Department of Foreign Affairs and Trade to attract private capital for development and climate objectives. Efforts focus on clean energy, gender equality, and resilient infrastructure, including strategic co-investments with development finance institutions (DFIs) and initiatives to mobilise climate-focused private capital.

Country	Blended Finance Initiatives
Brunei Darussalam	No specific blended finance initiatives
Cambodia	Enhancing the domestic debt market and blended finance framework via the Integrated National Financing Framework (INFF), supported by the United Nations. The INFF aims to align public and private finance more effectively with the country's Sustainable Development Goals.
Indonesia	Launching the Indonesia Just Energy Transition Partnership (I-JETP) in 2022, in collaboration with the International Partners Group (IPG) and led by ADB as the primary development partner. The I-JETP aims to mobilise US$20 billion in public and private finance over 3 to 5 years through a mix of grants, concessional loans, market-rate loans, guarantees, and private investments.
Japan	In June 2023, the Mitsubishi UFJ Financial Group Bank and the Nippon Export and Investment Insurance signed a memorandum of understanding to create a blended finance scheme combining public and private capital to fund decarbonisation projects across the region. This initiative supports the Asia Zero Emission Community and the Asian Energy Transition Initiative, addressing climate change, ensuring a stable energy supply, and fostering inclusive economic growth.
Lao PDR (Lao PDR)	The Bank of Lao PDR (central bank), in collaboration with the International Finance Corporation, is developing green finance guidelines and sustainable finance frameworks. A cooperation agreement signed in December 2023 aims to establish standards for green lending and mobilise private capital for climate-friendly projects.
Malaysia	Established the National Energy Transition Facility (NETF) in 2023, with an initial seed fund of MYR2 billion, to mobilise multiplier capital for the energy transition. The NETF co-invests alongside multilateral development banks (MDBs) and DFIs in key projects and supports the creation of bankable project pipelines through technical assistance and matching platforms that aggregate sub-scale opportunities. In April 2025, the Bank Pembangunan Malaysia Berhad partnered with the United Nations Development Programme to launch the Climate Finance Innovation Lab (CFIL). Supported by the Joint Committee on Climate Change, the CFIL develops innovative financing instruments, including blended finance and impact investments, to mobilise private capital for climate action.
Philippines	Piloting the ADB's Energy Transition Mechanism (ETM). In November 2022, ACEN Corp. completed the first market-based ETM transaction, enabling the early retirement of a coal-fired power plant through low-cost, long-term blended finance. Proceeds from the divestment are being reinvested into a renewable energy portfolio, advancing the Philippines' transition towards sustainable energy.
Singapore	Launched the Financing Asia's Transition Partnership to mobilise US$5 billion for climate action across Asia. The blended finance platform leverages concessional funding from the Singapore government, MDBs, DFIs, and philanthropic organisations to attract commercial capital. It focuses on three key investment areas: energy transition acceleration, green investments, and clean technologies.
Thailand	No specific blended finance initiatives

Country	Blended Finance Initiatives
Viet Nam	Introducing the Resource Mobilisation Plan (RMP) under the JETP in December 2023, aiming to mobilise an initial US$15.5 billion over 3 to 5 years. The plan prioritises power transmission, energy storage, and offshore wind development. It combines US$8 billion in public finance from IPG financial institutions with US$7.5 billion in private finance mobilised through the GFANZ. The RMP supports Viet Nam's objectives to transition from fossil fuels to clean energy by 2030 and achieve net-zero emissions by 2050.

Sources: ADB (2025), Department of Foreign Affairs and Trade (Australia) (2025), United Nations Capital Development Fund (2022), PwC (2024), Mitsubishi UFJ Financial Group, Inc. (2023), International Finance Corporation, World Bank Group (2023), Ministry of Economy (Malaysia) (2025), United Nations Development Programme (2025), Charlton Media Group (2023), Fintech News Singapore (2023), Initiative for Climate Action in Asia and Climate Policy Initiative (2024).

Intergovernmental collaboration to identify and support transition projects is gaining momentum, particularly in Viet Nam, the Philippines, and Indonesia, where the energy transition presents both urgent challenges and significant investment needs. These countries are actively engaging in structured government-to-government (G2G) dialogues through platforms such as the AZEC and the Just Energy Transition Partnerships (JETP).

For example, Indonesia's JETP involves coordinated planning with international partners on coal phase-down strategies and financing frameworks; Viet Nam conducts G2G consultations to align power development plans with international transition finance standards; and the Philippines is exploring bilateral cooperation on renewable energy and natural gas as part of its broader transition road map.

Such G2G engagement has proven effective in facilitating mutual understanding of national policy directions, identifying priority sectors for transition finance, and shaping enabling conditions for public and private capital mobilisation. These dialogues not only build trust between governments but also accelerate alignment on regulatory frameworks and investment signals, both of which are critical to advancing credible and inclusive transition pathways.

Box 6 -2

Policy Implications from ERIA's Research on Transition Finance

Whilst accelerating green finance remains essential, policies must also strengthen funding assurance for transition activities, such as upgrading power grids, and facilitating the decarbonisation of the hard-to-abate sectors.

ERIA has conducted extensive research on this topic. This section highlights several key perspectives as an introduction.

Market Understanding and Transparency
A deeper understanding of the market is essential for fundraisers to evaluate the risks and opportunities associated with corporate transition strategies and technology investments. Enhanced corporate reporting is also necessary to strengthen transparency and investor confidence.

- Provide tailored guidance and roadmaps for the region, such as national power development plans and Japan's approach to developing national sectoral technology roadmaps, which serve as good examples.
- Encourage standardised disclosure frameworks aligned with the International Sustainability Standards Board, along with comparable, high-quality emissions data and transition indicators.

Innovative Instruments
To secure additional funding for transition technologies, policymakers should facilitate the development of transition finance markets and promote innovative financial structures.
- Promote financial mechanisms that attract private sector participation in funding transition technologies by mitigating investment risks and clearly defining risk allocations between private and public sectors, for example, through blended finance models.
- Establish mechanisms to channel carbon pricing revenues, such as carbon taxes, towards supporting research, development, and deployment of transition technologies, as exemplified by Japan's climate transition bonds.
- Enhance investment predictability to boost confidence by integrating carbon capture, utilization, and storage into national climate policies and long-term energy roadmaps.

Regional Collaboration
Enhanced regional collaboration and partnerships are critical to advancing the adoption of transition finance across the region.
- Foster stronger cooperation through initiatives such as the ASEAN Transition Finance Guidance, the ASEAN Taxonomy for Sustainable Finance, the Asia GX Consortium Initiative, and the Asia Transition Finance Study Group. These platforms enable countries to harness shared resources, knowledge, and expertise to achieve collective sustainability objectives.

Sources: Asian Development Bank, Ministry of Economy, Trade and Industry, Economic Research Institute for ASEAN and East Asia (2025).

6.1.3 Progress of individual projects

The utilisation of transition finance in AZEC partner countries remains at an early stage; consequently, examples are limited. However, several key projects demonstrate how transition finance schemes are being deployed effectively across the region. Representative examples include fuel switching in Japan, cross-border renewable energy integration under the APG, and the early retirement of coal-fired power plants in the Philippines.

Fuel Switching and Transition Finance in Sumitomo Chemical's Power Facilities

- **Country.** Japan
- **Business entities and partners.** Sumitomo Chemical Co., Ltd.; participating financial institutions
- **Project overview.** Sumitomo Chemical is switching its Ehime and Chiba power plants from oil and petroleum coke to LNG, to reduce Scope 1 and 2 emissions by 50% by 2030. The company secured JPY18 billion in transition-labelled loans to support alignment with Japan's carbon neutrality goals and prepare for future hydrogen integration.
- **Production scale.** Annual emissions reduction of 890,000 tCO_2
- **Progress overview.** Guided by its transition strategy, Sumitomo Chemical has installed high-efficiency gas turbines that meet strict environmental standards whilst maintaining readiness for future conversion to hydrogen. This project exemplifies the effective use of transition finance to reduce emissions and serves as a model for decarbonisation efforts within the chemical industry.

Cross-border Grid Integration Under the ASEAN Power Grid (APG) to Enable Renewable Energy Trade

- **Countries.** ASEAN Member States (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Viet Nam)
- **Business entities and partners.** ASEAN Centre for Energy, Electricité du Laos, Electricity Generating Authority of Thailand, Tenaga Nasional Berhad, Keppel Electricity, multilateral development banks, regional financial institutions
- **Project overview.** The APG is a regional initiative designed to facilitate multilateral renewable electricity trading by enhancing cross-border transmission infrastructure and harmonising technical and regulatory standards. Transition finance tools, such as blended finance and guarantees, are key to mobilising US$16 billion for 18 priority projects, particularly in countries with below-investment-grade credit ratings.
- **Production scale.** Target expansion in interconnection transmission capacity from 7.7 GW to 17.6 GW by 2040
- **Progress overview.** The Laos–Thailand–Malaysia–Singapore Power Integration Project represents ASEAN's first multilateral renewable electricity trade initiative and serves as a flagship case study for transition finance. The project adopts a cost-sharing model (e.g. transmission line rehabilitation), mitigates financial risks, and harmonises settlement mechanisms and wheeling charges across borders. ASEAN is considering designating APG projects as 'projects of common interest' to improve bankability and attract private capital for renewable-focused infrastructure.

Early Retirement of the Mindanao Coal-fired Power Plant Under the Asian Development Bank's Energy Transition Mechanism

- **Country.** Philippines
- **Business entities and partners.** ADB, Power Sector Assets and Liabilities Management Corporation (PSALM), STEAG State Power Inc., Monetary Authority of Singapore (MAS)
- **Project overview.** ADB and PSALM are assessing the early retirement or repurposing of the 232-MW Mindanao coal-fired power plant, which was originally scheduled to be transferred to PSALM in 2031. The plan leverages blended finance and transition credits to facilitate early decommissioning whilst supporting renewable energy development.
- **Production scale.** 232 MW
- **Progress overview.** Since December 2023, ADB has served as transaction advisor by developing a transition credit pilot and a Just Transition framework. Its financing model combines blended capital and carbon credits to improve project feasibility. In addition, this initiative is supported by MAS through its TRACTION carbon financing scheme.

Blended Finance Portfolio – Catalysing Private Investment in the Indo-Pacific

- **Country.** Australia and the Indo-Pacific
- **Business entities and partners.** Department of Foreign Affairs and Trade (DFAT), ADB, Australian Development Investments (ADI), Australian Climate Finance Partnership (ACFP), Private Infrastructure Development Group (PIDG), International Development Investor Group (IDIG)
- **Project overview.** DFAT's blended finance strategy combines concessional capital, guarantees, and design grants to mobilise private investment in climate, gender, and infrastructure sectors. Since 2013, DFAT has committed AUD180 million in official development assistance, attracting over AUD441 million in private capital and positioning Australia as a strategic early-stage investor in regional markets.
- **Production scale.** The portfolio amounts to AUD493 million across 44 transactions, achieving mobilisation ratios of up to 1.5 in some cases. Investments are concentrated in transport (30%) and energy (27%), supporting nearly 10,000 jobs, half of which are held by women.
- **Progress overview.** Through ADI, PIDG, and ACFP, DFAT supports high-growth companies, early-stage infrastructure, and climate finance projects, such as e-mobility and geothermal energy initiatives in Viet Nam and Indonesia. Investor engagement is deepening through IDIG, launched in 2024, whilst innovation efforts focus on climate finance design grants, a net-zero transition bond, and a non-governmental organisation–led blended finance accelerator targeting both climate and gender outcomes.

6.2 Carbon Market and Carbon Pricing

Through the AZEC International Conference to Develop Carbon Markets, discussions will be advanced on emissions visualisation, carbon pricing mechanisms, and the establishment of a high-quality carbon market, including the development and trading of carbon credits. The outcomes of these deliberations will be reported.

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Annex: AZEC Projects

The following project overviews summarise progress supported by AZEC partner countries, organised alphabetically by country and, within each country, by the responsible entity.

MOU Project

APAC-wide GHG Accounting and Carbon Offsetting Collaboration Agreement

ASUENE TEM

Project Overview	A collaboration with TEM, a local Australian company, for GHG calculation and Carbon Offsetting in APAC region.
Responsible Entity	Asuene Tasman Environmental Markets.

Hitachi Energy's HVDC technology to power Marinus Link, toward Australia's Net Zero ambitions

HITACHI

Project Overview	Hitachi Energy selected to supply Marinus Link Pty Ltd a high-voltage direct current (HVDC) project, which will augment the connection capacity up to 1,500MW between mainland Australia and Tasmania's grid.
Responsible Entity	Hitachi Energy Marinus Link Pty Ltd
Production Scale	750MW
Project Goals/KPI	To transmit clean renewable energy including Tasmania's worldclass wind and hydro storage resources. In line with Australia's Net Zero ambitions, this link will result in saving up to 140 million tonnes of CO_2 equivalent emissions by 2050. A transmission project of national significance to play a key role in Australia's energy transition to power 1.5 million homes.
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	Commercial Order received from Marinus Link. Hitachi Energy will supply its HVDC Light® voltage source converter (VSC) stations in the first stage of 750MW of the project. The project is under progress
Planned Business Agreement Period	May 2024
Planned Business Consideration/FID Period	May 2024
Planned Construction Period	2030
Planned Commercial Operation Start Period	2030
URL	https://www.hitachi.com/New/cnews/month/2024/05/240524a.html

HVDC Light® Valve Hall

HyNQ North Queensland Clean Energy Project: IHI to Join Japanese and Australian Green Ammonia Production and Export Joint Venture

Project Overview	The project would tap abundant solar and wind power to produce and export 500,000 metric tonnes per year of green ammonia at the Abbot Point port in North Queensland together with JV members Energy Estate Pty Ltd, an Australian renewable energy developer, CS Energy, a Queensland government-owned and based power company, and Idemitsu Renewable Development Australia Pty Ltd.
Responsible Entity	IHI Corporation Energy Estate CS Energy Idemitsu Renewable Development
Production Scale	500,000 metric tonnes of green ammonia per year
Project Goals/KPI	to comprehend LCOA based on the current condition
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	Completed pre-FEED; currently discussing with JV members whether to proceed to FEED.
URL	https://www.ihi.co.jp/en/all_news/2023/resources_energy_environment/1200312_3523.html

Gladstone Green Hydrogen Project

Sumitomo Corporation
Enriching lives and the world
Summit Hydrogen Gladstone
RioTinto

Project Overview	1. Sumitomo and SHG, Sumitomo's green hydrogen business development vehicle in Queensland, have been developing a large-scale green hydrogen production project in Gladstone. 2. The project development is divided into three phases. The 1st phase is the pilot demonstration project where Sumitomo and Rio Tinto join forces to demonstrate the hydrogen calcination at Rio Tinto's Yarwun alumina refinery. 3. The 2nd phase aims to establish a commercial scale green hydrogen production facility in Gladstone to supply green hydrogen to domestic off-takers including Rio Tinto's alumina refineries. 4. The last phase is the potential exportation opportunity. However, Sumitomo has been so far focusing on the domestic use of green hydrogen to increase the technical and commercial feasibility of the project.
Responsible Entity	Sumitomo Corporation (Sumitomo)/ Summit Hydrogen Gladstone Pty Ltd (SHG) Rio Tinto
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	1. The pilot demonstration project (phase 1) has made some good progresses and the project expects to mark its first hydrogen calcination trial in later part of 2025. 2. The feasibility study of the proposed large scale green hydrogen production project in Gladstone (phase 2) has been completed. 3. The feasibility study provided us with quite valuable and practical information to evaluate the feasibility and the challenges of the project. 4. The commercialisation project is currently trying to develop a plan for the studies of the subsequent phase and the subsequent phase is expected to commence in 2025 with the aim to produce the first green hydrogen product from the project in 2030.
Planned Demonstration Period	From 2025
Planned Commercial Operation Start Period	2030

Image of the proposed commercial scale green hydrogen production facility (phase 2)

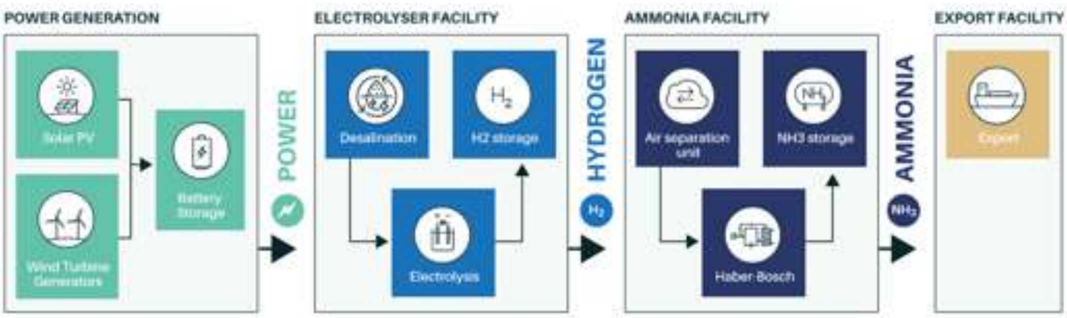
Setouchi / Shikoku CO_2 Hub Concept

Project Overview	Sumitomo Corporation (Sumitomo), JFE Steel Corporation (JFE), Sumitomo Osaka Cement (SOC), Kawasaki Kisen Kaisha, Ltd. ('K' LINE) and Woodside Energy Ltd (Woodside) jointly conduct a business feasibility study aimed at aggregating CO_2 from the Setouchi and Shikoku regions and then transporting those emissions to Australia for permanent storage. This study will investigate the feasibility of collecting CO_2 by small-sized vessels from emitters scattered in multiple areas in Setouchi and Shikoku regions, storing those emissions temporarily at a hub port in Japan before the CO_2 is transported to Australia by large-sized vessels for sequestration/storage. By collectively handling CO_2 emitted from multiple regions, industries, and companies in the Setouchi and Shikoku regions, the consortium aims to scale up and reduces costs, and works together to build a CCS value chain that would be difficult for individual companies to achieve.
Responsible Entity	Sumitomo Corporation JFE Steel Corporation Sumitomo Osaka Cement Co., Ltd. Kawasaki Kisen Kaisha, Ltd. Woodside Energy Ltd
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Aiming at identifying the total value chain costs and cost reduction measures, the consortium is currently conducting technical and commercial studies refining CAPEX/OPEX for the entire value chain, from CO_2 separation/capture, accumulation at hub ports, and transportation to storage sites, and identifying optimal operation patterns.
URL	https://www.sumitomocorp.com/en/jp/news/topics/2023/group/20231218_1

Heads of Agreement for investment and offtake from Murchison Green Hydrogen Project in Western Australia

Project Overview	Development and Offtake for Green Ammonia Production Project in Western Australia
Responsible Entity	Sumitomo Corporation (under study for investment) Copenhagen Infrastructure Partners
Project Scale (US$)	US$8 billion
Production Scale	856,334 tonnes per year of ammonia
Project Goals/KPI	Front end engineering: 2025~early 2026 FID: End of 2026 COD: Q3/4 2029
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The project was awarded Commonwealth Major Projects status in 2024 and is the only project to be successful in the Australian Federal Government's Hydrogen Head start Program, where it was awarded $814 million in March 2025. With pre-FEED completed, the Project is presently undertaking an ECI process that will lead into FEED in late 2025 with a schedule to take FID in late 2026 and commence production in 2029.
Planned Business Agreement Period	End of 2026
Planned Business Consideration/FID Period	End of 2026
Planned Construction Period	2027 – 2029
Planned Commercial Operation Start Period	2029
URL	https://www.murchisonrenewables.com.au/

Supply Chain outline



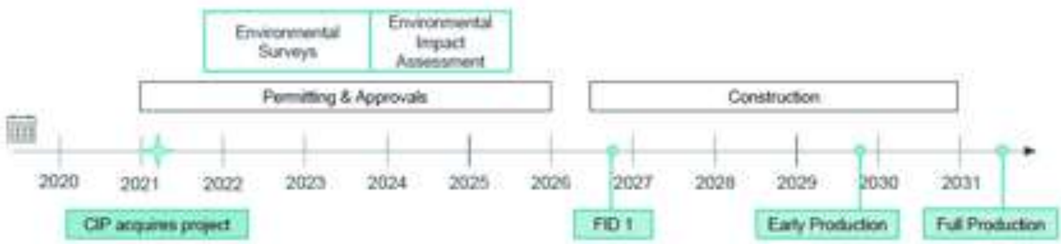
Stage 1: Renewable energy capacity 3GW, electrolyser capacity 1.5GW, ammonia production volume 3,600 tonnes per day

Stage 2 to double the capacity

Project location: 20 km north of Kalbarri, Western Australia

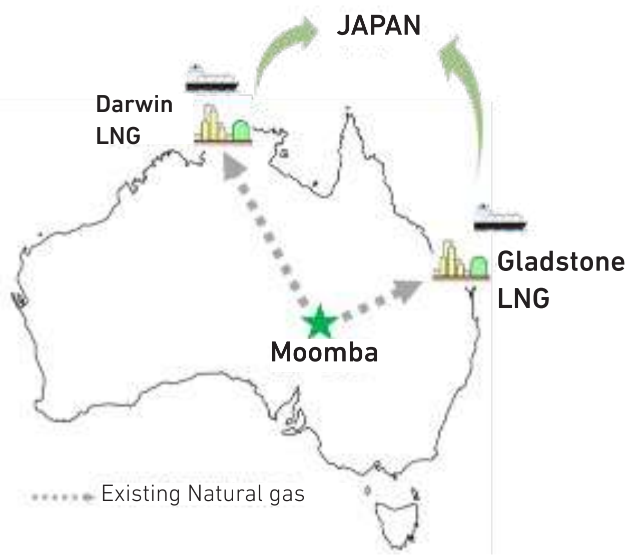
Manufacturing plant image

Schedule



Joint Study Agreement for Pre-FEED Study on e-methane production in Cooper Basin

Project Overview	Conduct Pre-FEED activities for the e-methane production (methanation), which is synthesised from renewable hydrogen and CO_2 at Moomba, in the Cooper Basin.
Responsible Entity	Tokyo Gas Co., Ltd. Osaka Gas Australia Pty Ltd. Toho Gas Co., Ltd. Santos Ltd
Production Scale	More than 130,000 tonnes of e-methane per year (equivalent to about 180 million m^3 of city gas)
Project Goals/KPI	To produce and export more than 130,000 tonnes of e-methane per year (equivalent to about 180 million m^3 of city gas) in Moomba, Australia, after 2030.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Santos Ltd, Tokyo Gas, Toho Gas and Osaka Gas are undertaking a Pre-FEED study for the e-methane production and export of e-methane to Japan at Moomba in the Cooper Basin in Australia.
Planned Commercial Operation Start Period	2030 onwards



MOU amongst erex Co.,Ltd,SPHP (Cambodia) Co.,Ltd. and the Ministry of Mines and Energy of the Kingdom of Cambodia on Biomass Project

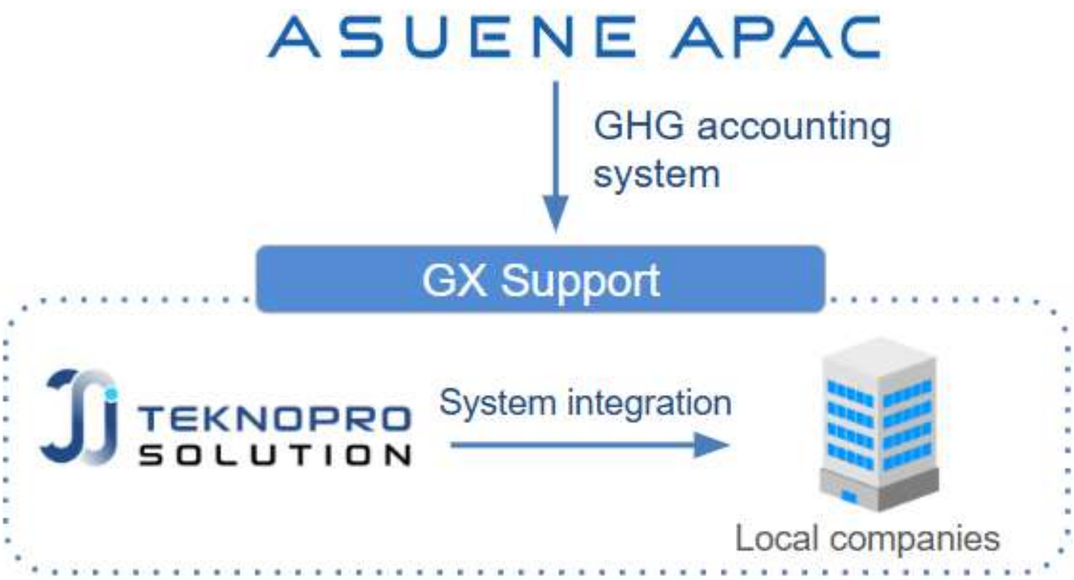
erex

Project Overview	The MOU confirms the roles and cooperation framework for energy development, including biomass fuels and biomass power generation in Cambodia.
Responsible Entity	erex Co.,Ltd SPHP (Cambodia) Co., Ltd. Ministry of Mines and Energy
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	A feasibility study for a biomass power generation project was completed. The Cambodian Ministerial Council approved the Group's power generation investment project, including biomass (50 MW), at the end of September 2024.

Considering development of a biomass power plant in a province in the southern part of Cambodia.

Cooperation agreement to promote GX management with GHG calculation

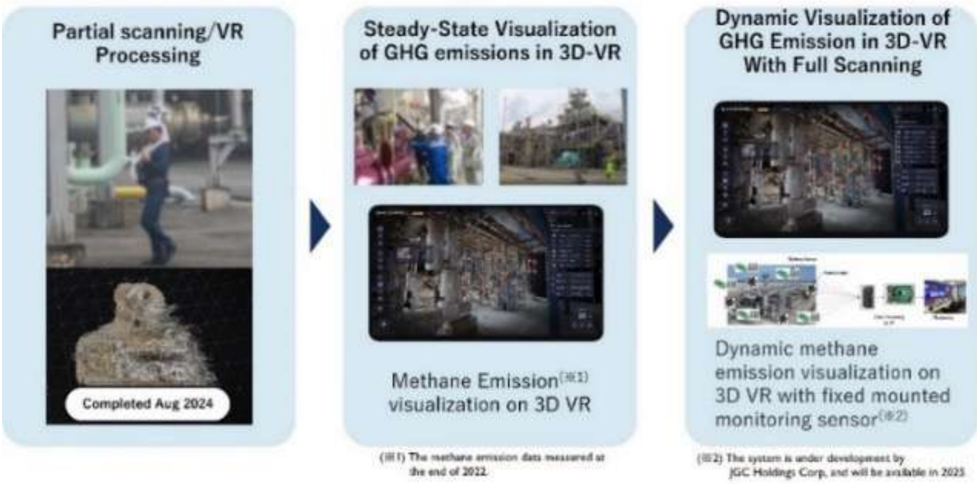
Project Overview	Signed a collaboration agreement with Teknopro, a local Indonesian company, for GHG calculation of ASUENE.
Responsible Entity	Asuene APAC Teknopro



Digital Twin Based Assessment and Visualisation of Environmental Footprint

Brownreverse | essa PT Panca Amara Utama

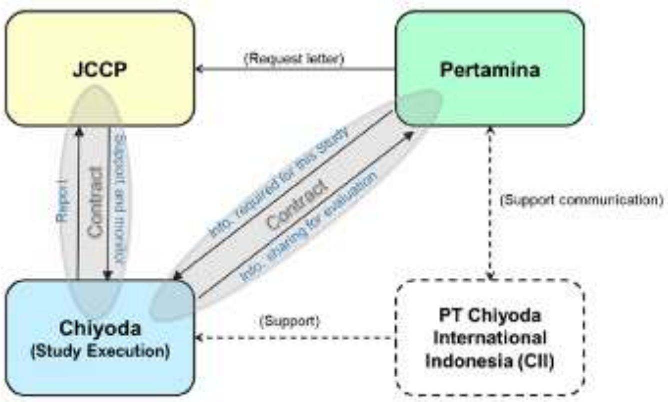
Project Overview	Brownreverse Inc.(BRS) and PT. PANCA AMARA UTAMA(PAU) aim to collaborate on the validation of 'environmentally conscious maintenance' at PAU's ammonia plant using BRS's technology. This cooperation involves providing and utilising 3D models and methane emission data to study the environmental impact.
Responsible Entity	Brownreverse Inc. PT PANCA AMARA UTAMA
Project Goals/KPI	To validate the effectiveness of environmentally considerate maintenance using Digital Twin technology. To set an example that expands maintenance practices considering environmental sustainability and minimising environmental impact.
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	In August 2024, 3D scanning of selected equipment was conducted at an ammonia plant located on Kalimantan Island in the partner country. Following VR processing, a digital twin environment was established using software developed by BRS. Looking ahead, technical verification is underway to enable steady-state visualisation of methane emissions in 3D VR.
Planned Demonstration Period	31 July 2025
URL	https://www.jgc.com/en/news/2024/20240913.html



Development of the Application of CO_2 Reforming Technology in Indonesia

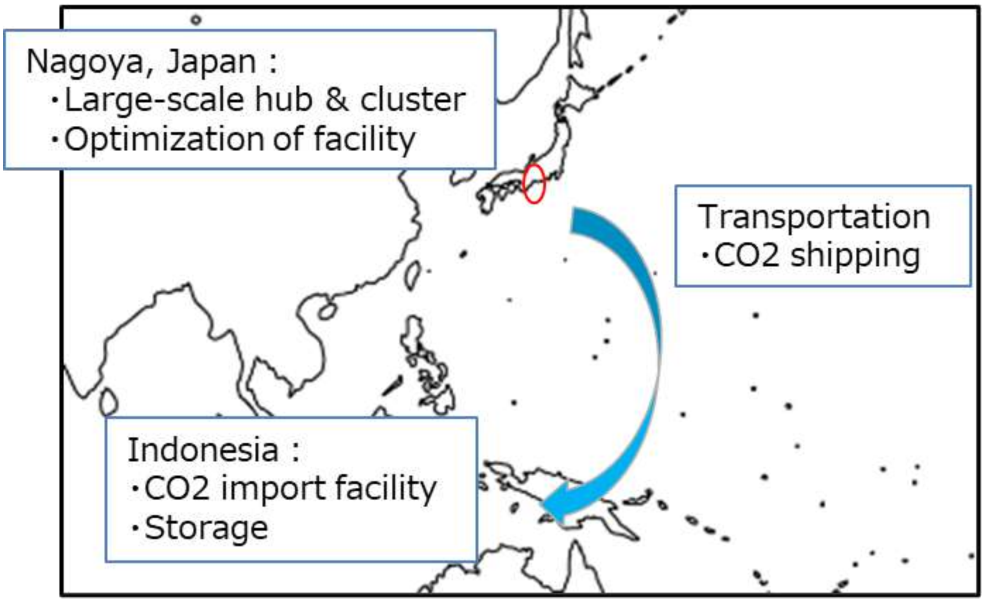
Project Overview	To achieve a carbon-neutral society by 2050, Indonesia needs to introduce renewable energy as well as realise and establish new ways of CO_2 utilisation, centered on CO_2 separation, capture, storage, and effective utilisation. To this end, the CT-CO_2AR™ (pronounce as 'CT-CORE') technology developed by a Japanese company is applied: a technology to efficiently produce synthesis gas with a wide range of H_2/CO ratios from carbon dioxide, and to convert and produce high value-added chemicals to directly utilise and resource natural gas with a high ratio of CO_2 content. Reducing CO_2 emissions outside the system, it is expected to not only to contribute in decarbonising the existing chemical industry, but also to promote new industries and ensure economic viability.
Responsible Entity	Chiyoda Corporation PT Pertamina (Persero)
Project Goals/KPI	The best case has been determined and recommended, to proceed to the next phase of FEED, followed by actual facility implementation for commercialisation.
Progress Status as of March 2025	The MOU project is completed (or expected to be completed), but there are no plans for subsequent phases
Progress Overview	Process calculations were conducted for the production of the following two cases, which were determined as candidates, using gas from two existing gas fields (#1 and #2) as the feedstock gases for this study. The process calculations were performed to obtain the material and energy balance and to compare from the viewpoints incl. CO_2 emissions, CAPEX, OPEX, Profit, and ROI. • Oxo-alcohol: n-butanol, (H_2/CO = 1.0) • Coproduction of Methanol and CO (H_2/CO = 1.2) According to the evaluation, the most favorable results were obtained in the case of Oxo-Alcohol production with #1 gas.

Project organisation



Cooperation between Chubu Electric Power Co.,Inc. and BP Berau Ltd. on international CCS hub & cluster model

Project Overview	Developing a CCS value chain from Port of Nagoya to Tangguh in West Papua Province, Indonesia, and realising a commercial CCS project contributing to decarbonisation in both countries.
Responsible Entity	Chubu Electric Power Co.,Inc. BP Berau Ltd.
Production Scale	5-20 MTPA (toward 2050)
Project Goals/KPI	Realisation of commercial CCS project from Nagoya to Tangguh, Indonesia.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Based on the MOU, optimisation across the value chain, business model studies and proposals for the legal system, etc. are underway.
Planned Commercial Operation Start Period	From 2030 onwards
URL	https://www.chuden.co.jp/english/corporate/releases/pressreleases/1214411_5163.html



Feasibility study for the project to convert existing coal-fired power plant to CCGT

Project Overview	• The feasibility study for the project to convert the existing subcritical coal-fired power plant to a state-of-the-art gas turbine combined cycle that enables to reduce CO_2 emissions to approximately one-third. • The feasibility study on the possibility of future implementation of state-of-the-art combustion technology that enables hydrogen combustion to further reduce CO_2 emissions.
Responsible Entity	Electric Power Development Co., Ltd. (JPOWER) PT PLN Indonesia Power
Production Scale	Reducing CO_2 emissions to approximately one-third. Ultimately, our target to combust hydrogen.
Project Goals/KPI	JPOWER and PT PLN Indonesia Power plan to develop CCGT project to contribute to the energy transition in Indonesia by potential future hydrogen co-firing.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	JPOWER had completed of the feasibility studies for the two existing power plants at the end of February 2025 and investigated the possibility of future implementation of state-of-the-art combustion technology for hydrogen combustion. Discussions will be held with PT Perusahaan Listrik Negara (PLN), PT PLN Indonesia Power, and other Indonesian government agencies in order to narrow down the development to one power plant.

Memorandum on the roadmap for CCO/SAF Projects derived from non-standard coconuts with the Indonesian National Research and Innovation Agency

Project Overview	Specific research topics are currently being discussed, and preparations are underway for the conclusion of a formal agreement following the signing of the MOU.
Responsible Entity	Green Power Development Corporation of Japan ABE (PT. ABE Indonesia Berjaya) BRIN (Badan Riset dan Inovasi Nasional)
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)

Construction of Crude Coconut Oil as SAF feedstock utilising Closed Loop System

Project Overview	Construct CCO (Crude Coconut Oil) factory as the feedstock of SAF (Sustainable Aviation Fuel) in Banyusin Prefecture, South Sumatera, Indonesia.
Responsible Entity	Green Power Development Corporation of Japan Coordinating Ministry for Economic Affairs of the Republic of Indonesia, South Sumatera province, IJBNet
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Factory construction is under planning and being started within this year.

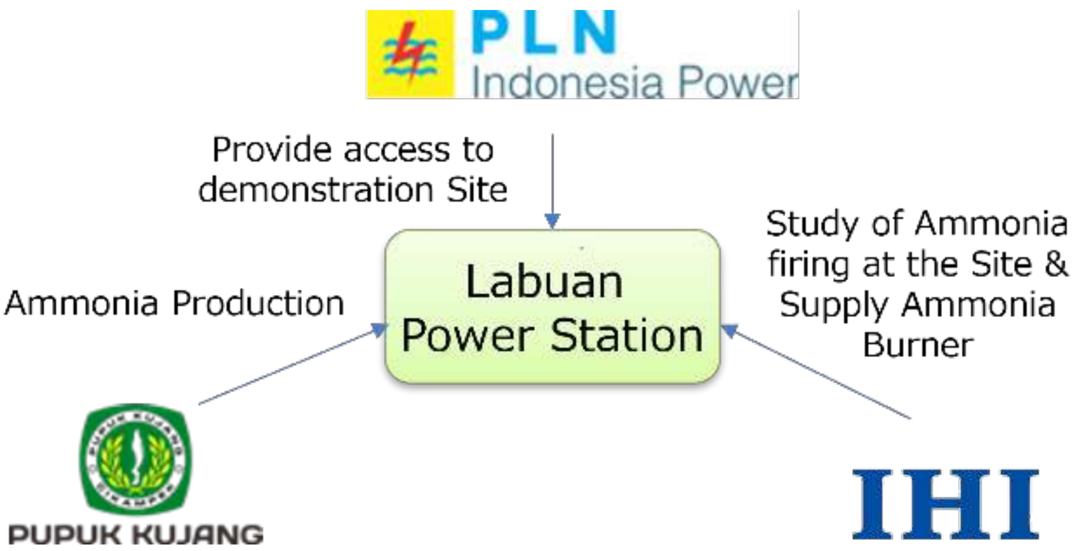
Indonesia's Energy Transition - Net Zero

HITACHI

Project Overview	a) Letter of Intent (LoI) – Signed with MEMR (June 2023) b) Memorandum of Understanding (MoU) – Signed with PLN (November 2023) *The MoU was made under the LoI. The objectives of the above LoI and MoU are 1) to conduct knowledge sharing regarding energy transition planning for Indonesian energy stakeholders and 2) to carry out macro-level technical studies for electric energy systems and techno-economic analysis for project feasibility.
Project Goals/KPI	The Indonesian government is committed to the following goals, and to achieve them, the Ministry of Energy and Mineral Resources (MEMR) is collaborating with Hitachi Energy. • Reduce GHG emissions in the energy sector by 2030: - 358 million tonnes of CO_2 (12.5%) through domestic efforts - 446 million tonnes of CO_2 (15.5%) with international assistance • Achieve Net Zero Emissions (NZE) by 2060 or earlier.
Responsible Entity	Hitachi Energy Indonesia Ministry of Energy & Mineral Resources (MEMR) Perusahaan Listrik Negara (PLN)
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Completed 12months workshop and knowledge sharing with PLN for Impact Study of HVDC power grid in Java-Sumatra. As next step, Hitachi Energy and PLN will move to next workshop in 2 areas; * Technical design of HVDC * Operation and maintenance of HVDC
URL	https://www.hitachienergy.com/news-and-events/features/2023/06/the-ministry-of-energy-and-mineral-resources-indonesia-and-hitachi-energy-sign-letter-of-intent-for-green-energy-technology-development https://www.hitachienergy.com/us/en/news-and-events/features/2023/11/hitachi-energy-signs-mou-with-indonesia-s-utility-company-pln?utm_source=chatgpt.com

MOU amongst PT PLN Indonesia Power, PT Pupuk Kujang and IHI to study green ammonia firing at Labuan Power Station

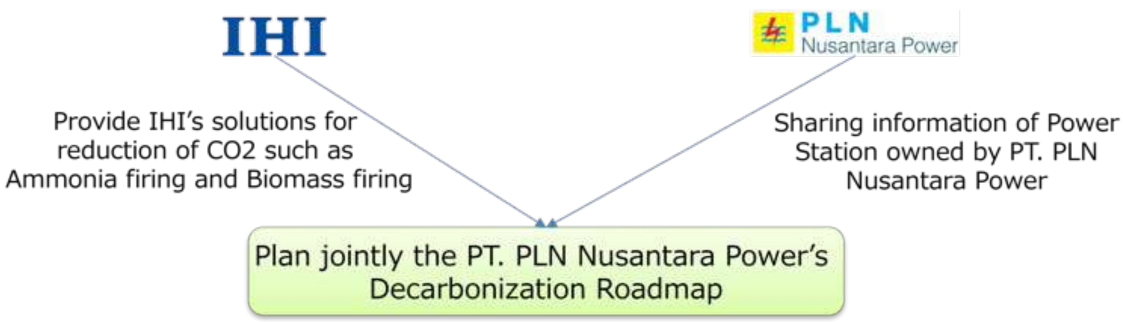
Project Overview	To conduct a study involving the entire ammonia value chain from the supply to combustion of green ammonia, including demonstration at the Labuan coal-fired power plant (Site). PT PLN Indonesia Power will provide access to the Site
Responsible Entity	IHI Corporation PT PLN Indonesia Power PT Pupuk Kujang
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	Conducted the ammonia firing demonstration in February 2025. Having discussion to share the results and issues and for the next step.
URL	https://www.ihi.co.jp/en/all_news/2024/resources_energy_environment/1201049_13691.html



Project Scheme of this project including each party's role.

MOU between PT. PLN Nusantara Power and IHI for joint study of Decarbonisation Roadmap

Project Overview	Conduct a study and plan a decarbonisation roadmap including CO_2 reduction plan through ammonia/biomass combustion at the coal-fired power plant owned by PT PLN Nusantara Power (PNP).
Responsible Entity	IHI Corporation PT PLN Nusantara Power
Progress Overview	Continuing Discussioin
Progress Status as of March 2025	Continuing the MOU project



Project Scheme of this project including each party's role.

Expansion of Sarulla Geothermal Project ('Sarulla 2 (Sibual-buali) Project')

Project Overview	ITOCHU, Kyushu, INPEX, Medco and ORMAT are discussing in detail to develop and implement the expansion project (Sarulla 2 (Sibual-buali) Project) after the evaluation of the results of various efforts such as output recovery plan and tariff optimisation to strengthen the financial position of the existing/current Sarulla Geothermal Project.[1]
Responsible Entity	ITOCHU Corporation (ITOCHU) Kyushu Electric Power Co., Inc. (Kyushu) INPEX CORPORATION (INPEX) PT Medco Power Indonesia (Medco) PT Ormat Geothermal Indonesia (ORMAT)
Production Scale	50MW (1st Phase) 120MW (2nd Phase) 110MW (3rd Phase)[2]
Project Goals/KPI	• Successful recovery of the financial and operational conditions of the existing/current Sarulla Geothermal Project in 2025.[3] • Submit the Notice of Intention to Develop (NOID) in 2027 for the first phase development (approximately 50MW) of East Sibual-buali field, of which the prospect has been classified as 'proven' reserve, (Sarulla 2-1, or Sibual-buali 1) in accordance with the existing Joint Operation Contract (JOC) between PT Pertamina Geothermal Energy Tbk (PGE) and Sarulla Operations Ltd (SOL) as well as Energy Sales Contract (ESC) amongst PT PLN (PLN), PGE and SOL.[4] • To support North Sumatra Regional Geothermal Potential as stated in the National Medium Term Development plan 2025-2029(RPJMN) and PLN Electricity Supply Business Plan 2025-2034(RUPTL).[5]
Progress Status as of March 2025[6]	• Implementing the MOU project but facing challenges, causing delays compared to the initial plan

[1] Sentences are from MOU for Sarulla Expansion dated 3 March 2023 Clause 2.
[2] The information was provided to ESDM/EBTKE from SOL with the letter dated 15 November 2024.
[3] The information is in Outline of MOU sent to METI by sponsors and published in METI website
[4] The information was provided to ESDM/EBTKE from SOL with the letter dated 15 November 2024.
[5] The information is in line with the intention of the letter to EBTKE from SOL regarding Letter of Request for Data to Support the Geothermal Power Project in the Proposed Longlist Projects under the 2025-2029 Bappenas National Medium-Term Development Plan (RPJMN) dated 17 February 2025
[6] Must be selected from the pulldown option embedded.

Progress Overview	• Discussions are actively underway with stakeholders to restore the economic viability of the existing Sarulla Geothermal Project. • Resource surveys are being conducted as part of feasibility studies for Sarulla 2 (Sibual-buali) Project. [7]
Planned Business Consideration/FID Period	2027 (1st Phase)[8]
Planned Commercial Operation Start Period	2029 (1st Phase)[9]

Project Site

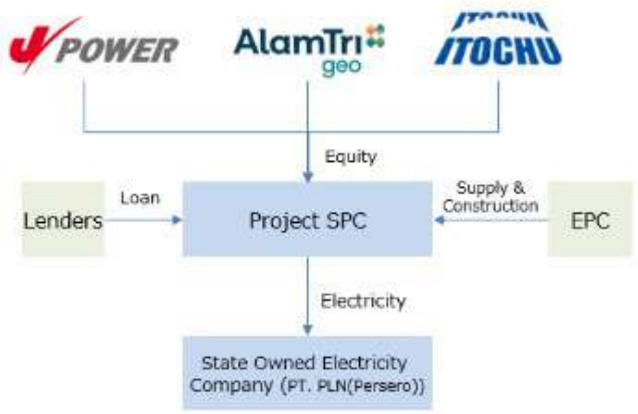
Existing Project

[7] this means study by Invert.
[8] The information was provided to ESDM/EBTKE from SOL with the letter dated 15 November 2024.
[9] The information was provided to ESDM/EBTKE from SOL with the letter dated 15 November 2024.

MOU amongst 3 companies for Feasibility Study for development of CCGT Power Plant in Indonesia

Project Overview	To achieve a future carbon-neutral and net-zero society in Indonesia, Electric Power Development Co., Ltd., PT Alamtri Power Indonesia (previously known as PT Adaro Power), and ITOCHU Corporation will conduct FS to develop a Combined Cycle Gas Turbine (CCGT) power plant in Central Java, Indonesia.
Responsible Entity	Electric Power Development Co., Ltd., ITOCHU Corporation PT Alamtri Power Indonesia (previously known as PT Adaro Power)
Project Goals/KPI	The companies plan to develop the project to contribute to the energy transition in Indonesia by potential future hydrogen co-firing. Firstly, the companies plan to complete FS.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The companies are currently conducting FS for the project development by engaging external consultants. The companies are currently observing for the issuance of upcoming 2025-2034 Electricity Supply Business Plan (RUPTL) by the State Electricity Company 'PT PLN (Persero)'. The scale (capacity) of the project will also be promoted in line with RUPTL.
Planned Construction Period	FY 2027
Planned Commercial Operation Start Period	FY 2030
Other Milestones	The companies will assess the business viability after the completion of FS.

Assumed Project Scheme



Project Site

MOU between Pertamina and JCCP -Capability development and technical cooperation in the energy sector-

Project Overview	MOU between JCCP and Pertamina for decarbonisation course program and joint workshop covering transition technology, decarbonisation economy, and decarbonisation technology strategy
Responsible Entity	JCCP Pertamina
Progress Status as of March 2025	Continuing the MOU Project

JCCP-Indonesia Cooperation Plan for FY2023-2024 -Capability development and technical cooperation in the energy sector-

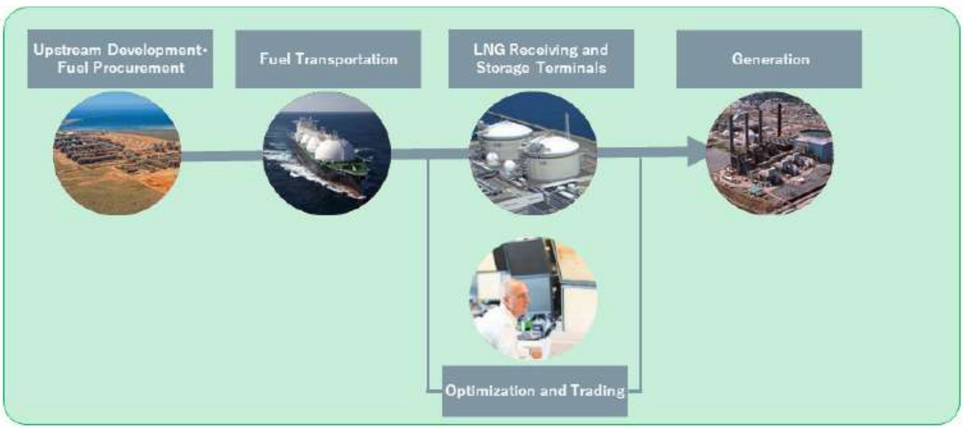
PERTAMINA

Project Overview	A capability development program conducted in Japan and Indonesia with topics including: - Business model for natural gas and LNG - Circular economy - CCS/CCUS technology and strategy - Joint workshop for zero carbon community economic methods and technology
Responsible Entity	JCCP ESDM Pertamina
Progress Status as of March 2025	The MOU project is completed (or expected to be completed), but there are no plans for subsequent phases

MoU between JERA and PERTAMINA on LNG/LCF Value Chain Collaboration

Project Overview	To explore collaboration with Pertamina for LNG/LCF value chain as a key Energy Transition factor to achieve Indonesian Net Zero Emission in 2060. The area of potential collaboration is (1) Potential LNG/LCF value chain investment, (2) value addition through optimisation/trading, (3) CC(U)S, (4) Other decarbonisation activities and (5) Capacity building through training and/or exchange.
Responsible Entity	JERA Co., Inc. PT Pertamina (Persero)
Project Goals/KPI	With value addition through optimisation/trading, to create potential LNG/LCF value chain opportunities, which eventually will contribute to Net Zero Emission in Indonesia.
Progress Status as of March 2025	Continuing the MOU Project
Progress Overview	We are exploring the collaboration with Pertamina for LNG/LCF value chain as a key Energy Transition factor to achieve Indonesian Net Zero Emission by 2060.
URL	https://www.jera.co.jp/en/news/information/20231215_1756

Business Areas under Consideration for Collaboration



MoU between JERA and PLN EPI for LNG Value Chain Establishment in Indonesia

Project Overview	LNG Value Chain Establishment in Indonesia, which is expected to contribute to achieve both a stable supply of electricity and energy transition, as well as net zero emissions by 2060.
Responsible Entity	JERA Co., Inc. PT PLN Energi Primer Indonesia (PLN EPI)
Project Goals/KPI	To establish sustainable, affordable, and stable LNG Value Chain in Indonesia to contribute to the achievement of both a stable supply of electricity and energy transition, as well as net zero emissions by 2060.
Progress Status as of March 2025	Continuing the MOU Project
Progress Overview	Discussion on going regarding business plan/scheme
Planned Demonstration Period	In 2026
Planned Business Agreement Period	In 2026
Planned Business Consideration/FID Period	In 2026
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	In 2025
URL	https://www.jera.co.jp/en/news/information/20240209_1816

Memorandum of Cooperation regarding the feasibility study of electricity transmission business between Kansai /Kansai TD, the Ministry of Energy and Mineral Resources of Indonesia (BBSP/ MEMR), and PT PLN

Kansai Electric Power

Kansai Transmission and Distribution

Project Overview	Indonesia has strong potential for renewable energy, but its generation areas are unevenly distributed, causing a mismatch between supply and demand. To achieve carbon neutrality by 2060, inter-island transmission lines are essential. However, due to financial challenges faced by the state-owned electricity utility, it is necessary to explore various business schemes, including the introduction of private sector investment, to enhance efficiency and promote the development of such infrastructure. As part of this initiative, the stakeholders have been discussing how to proceed with the study and have selected a pilot project. Based on this pilot project, a feasibility study is currently being carried out to explore the potential for development of inter-island transmission lines
Responsible Entity	The Kansai Electric Power Company., Inc . Kansai Transmission and Distribution., Inc. PLN The Ministry of Energy and Mineral Resources of Indonesia (BBSP/MEMR)
Project Goals/KPI	To promote decarbonisation through the development of inter-island transmission lines using various business schemes, to achieve carbon neutrality in Indonesia
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	In close collaboration with PLN and BBSP, a pilot project has been selected. Feasibility studies are currently ongoing to explore the potential for project implementation.

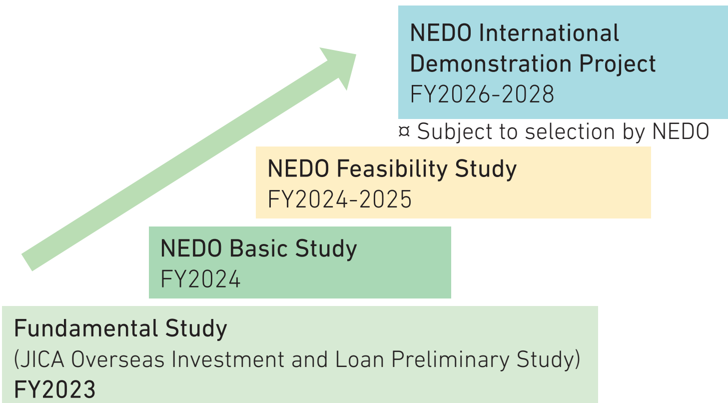
Image of Inter-Island transmission line

Organisational structure

Development of Renewable Energy Business between PLN Indonesia Power and Kyudenko

Project Overview	Kyudenko Corporation has been engaged in stabilising power supply in remote areas, including a joint project with the Indonesian government in 2017 to demonstrate the stabilisation of renewable energy power supply in an isolated microgrid on Sumba Island, Eastern Indonesia. As a subsidiary of the PLN Group, PLN Indonesia Power is actively involved in regional renewable energy projects. Given the alignment of their objectives, the two companies have signed an MOU to establish a collaborative partnership.
Responsible Entity	Kyudenko Corporation PT PLN Indonesia Power
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	The MOU was utilised as a framework for comprehensive cooperation. In 2023, Kyudenko's renewable energy stabilisation project on Nunukan Island, North Kalimantan, was selected for the NEDO international demonstration project (feasibility study for demonstration requirements). Consequently, Kyudenko signed a new MOU with Indonesia Power in August 2024 to focus on this initiative (Project No. 117).
Future Plan	Transitioning to the new MOU

Summary of MOU/Business Partnership:
Indonesia has set a policy to increase the share of renewable energy generation. However, introducing renewable energy to the numerous scattered remote islands remains an urgent challenge. Kyudenko, leveraging its EMS (Energy Management System), collaborates with PLN Indonesia Power in solving these issues and developing projects.
Significance and Purpose of this Cooperation:
PLN Indonesia Power is a core company of PLN, the state-owned power company, and plays a crucial role in Indonesia's electricity business. Through this initiative, introducing renewable energy stabilisation technologies will make PLN Indonesia Power an optimal partner for expanding such solutions in Indonesia.
Additional Information:
As a pilot project, discussions are underway to conduct demonstration operations on remote islands in North Kalimantan. This will include a combination of multiple renewable energy sources and large-scale battery storage for stable power supply and transmission.



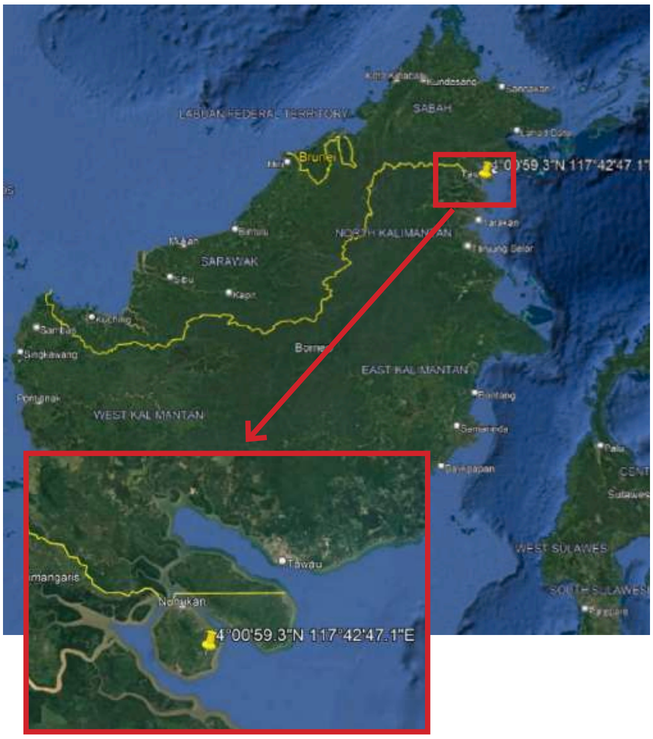
Development of Renewable Energy Business between PLN Indonesia Power and Kyudenko

Project Overview	**(Background)** • Based on its experience in Japan's domestic renewable energy sector, Kyudenko Corporation developed the 'Kyudenko EMS' technology, which enables the stable supply of renewable energy-derived electricity with consistent waveforms, even in vulnerable power grids such as those on remote islands. In 2017, with support from Japan's Ministry of the Environment, Kyudenko built a demonstration facility on Sumba Island in eastern Indonesia, where it gained practical experience under actual local power conditions. • In 2019, under JICA's 'Private Sector Partnership Program for Disseminating Japanese Technologies', senior officials from Indonesia's Ministry of Energy and Mineral Resources (MEMR) and the state-owned power company PLN visited Japan. During this visit, they proposed using a remote island in North Kalimantan as a model case to verify the dissemination of renewable energy technologies. • Subsequently, with advice from relevant departments, including Japan's Agency for Natural Resources and Energy, Kyudenko submitted a proposal to NEDO's international demonstration project in fiscal year 2023. With cooperation from the Indonesian government, preparations for the demonstration project are currently underway. **(Regarding the MOU)** In March 2023, Kyudenko Corporation and Indonesia Power—a subsidiary of the PLN Group, Indonesia's state-owned electricity company—signed a comprehensive Memorandum of Understanding (MOU) aimed at the stable introduction of renewable energy in island regions. Later, in July 2023, a project on a remote island in North Kalimantan, Indonesia, was selected for NEDO's feasibility study phase under its international demonstration program. The project passed the stage-gate review in June 2024 and advanced to the pre-demonstration study phase. In line with this progress, an agreement for joint study was signed focusing on this demonstration project, further strengthening the collaborative relationship between the two companies on August 2024.
Responsible Entity	Kyudenko Corporation PT PLN Indonesia Power
Project Scale (US$)	Approx. US$20 million
Production Scale	Biomass 2.5MW PV 2.0MW Battery 7MWh
Project Goals/KPI	Undecided (at the time of signing)
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)

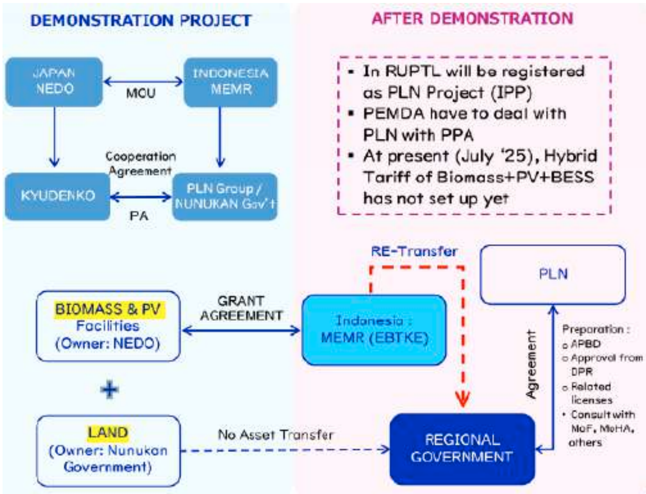
Progress Overview	• Currently, a 'pre-demonstration study' under NEDO's international demonstration program is underway. Kyudenko is working closely with relevant organisations, in preparation for NEDO's final evaluation to start the full-scale demonstration project • To ensure the commercial and economic viability of the project after the demonstration phase, efforts are being made to reduce costs in both CAPEX and OPEX. Additionally, the Indonesian government has been requested to promptly establish a 'hybrid tariff' that sets electricity selling prices for multiple energy sources. At present, Indonesia only has feed-in tariffs for single-source generation under a presidential decree, making the formulation of a hybrid tariff a critical factor not only for this demonstration project but also for the subsequent commercialisation phase. • We also aim to utilise EFB (Empty Fruit Bunches from oil palm), an underutilised local fuel, as a baseload power source in microgrids on remote islands, by developing efficient combustion methods to enable low-cost biomass power generation. Although there are several challenges—such as :(1) addressing harmful components during combustion, (2) establishing a fuel supply chain to remote islands, (3) and setting up a reliable maintenance system after operations begin—we are working in collaboration with relevant companies to conduct verification studies with the goal of achieving a locally-produced, locally-consumed energy solution using this raw material. • The local provincial government is also providing various forms of support, such as offering land for the demonstration site. Expectations from the local community for a stable renewable energy supply are extremely high. This project is being prepared with the aim of making it a successful case study for the broader deployment of renewable energy-based electricity in Indonesia, an archipelagic nation.
Planned Demonstration Period	Construction scheduled to begin in FY2026 (subject to approval by NEDO).
Planned Business Agreement Period	FY2029
Planned Business Consideration/FID Period	FY2026-28
Planned Construction Period	Scheduled for completion by the end of FY2027 (if selected for the demonstration project).
Planned Commercial Operation Start Period	After FY2029

Planned Period for Signing MOU or Similar Agreements (until around October 2025)	Around October 2025 (Planned by PLN Indonesia Power, the local government (PEMDA), and Kyudenko)
Other Milestones	NEDO Project Commercialization Assessment (final evaluation before demonstration): End of FY 2025 MOU signing between NEDO and the partner country's government: First half of FY 2026

1. Location (Nunukan Is.)

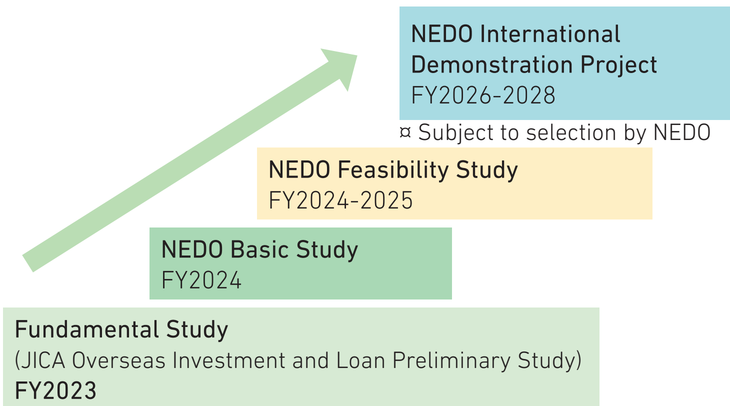


2. Project Scheme (As of Apr.2025) *Subject to change in the future.



*The grant scheme is subject to the approval of NEDO and the consent of the Indonesian Government (MEMR).

3. Milestone



Efforts Towards Decarbonisation and Low Carbon Industrial Heat Demand in Indonesia

Project Overview	LNG Japan Co., Ltd. and Toho Gas Co., Ltd. have invested in PT Bayu Buana Gemilang (BBG) that supplies industrial natural gas in Indonesia. The aim is to reduce carbon emissions in the industrial sector by expanding natural gas infrastructure. BBG will also explore business opportunities in areas such as biomethane, hydrogen, and e-methane, which have the potential to further advance decarbonisation.
Responsible Entity	LNG Japan Corporation Toho Gas Co., Ltd. PT Bayu Buana Gemilang
Production Scale	Natural gas supply contributing to low carbonisation: 28 mmscfd
Project Goals/KPI	- Natural gas supply contributing to low carbonisation: 57 mmscfd - Decarbonised fuel supply: 1% of the above natural gas supply
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	BBG is strengthening its efforts to acquire new customers by utilising its sales proposals and fuel conversion know-how to target Japanese companies operating locally, and promote further low carbonisation in Indonesia by advancing initiatives to expand BBG's sales volume. BBG is also promoting networking and partnering to participate in new businesses such as biomethane and LNG.
Other Milestones	- Number of new natural gas supply contracts concluded after participation: 4 - We gave a speech at the exchange meeting with the aim of expanding the supply chain in the biomethane business.
URL	https://bbg.co.id/

BECCS (Bioenergy with Carbon Capture and Storage) Project

Marubeni JAPEX 石油資源開発株式会社 PERTAMINA

Project Overview	The project involves capture of bioenergy-derived CO_2 emitted from a pulp mill operated by Marubeni, and transportation and storage of the CO_2 into deep saline aquifers near Syncline Limau Niru field operated by Pertamina.
Responsible Entity	Marubeni Corporation Japan Petroleum Exploration Co., Ltd. PT Pertamina (Persero), PT Pertamina Hulu Energi
Production Scale	The project aims for capture, transportation and storage of bioenergy-derived CO_2 from 300,000 tonnes per year in the 1st phase, expandable to around 1,000,000 tonnes per pear in the later phase.
Project Goals/KPI	By realising carbon negativity, the Project aims to contribute to the reduction of CO_2 emissions and generate revenue through the creation and trading of carbon-negative credits.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The feasibility study for the Project is being implemented, based the signed Joint Study Agreement by/amongst the Parties. The feasibility study is expected to be finalised by around middle of 2026.
Planned Commercial Operation Start Period	The commercial operation (the 1st injection of the CO_2) is expected to be around 2030.

Project Site Map

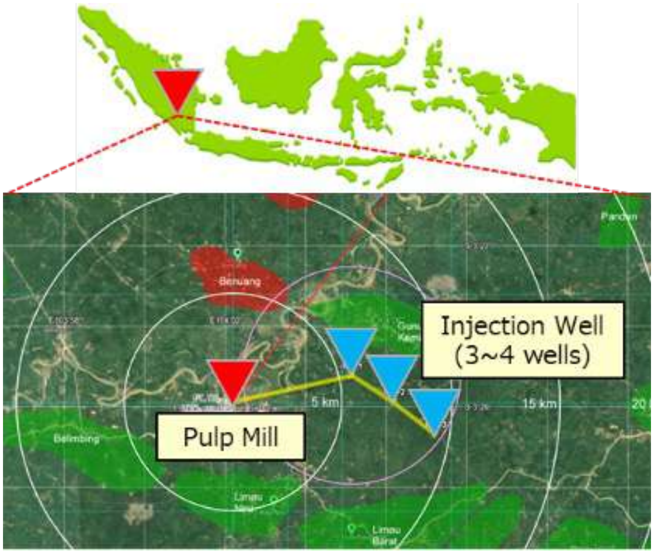
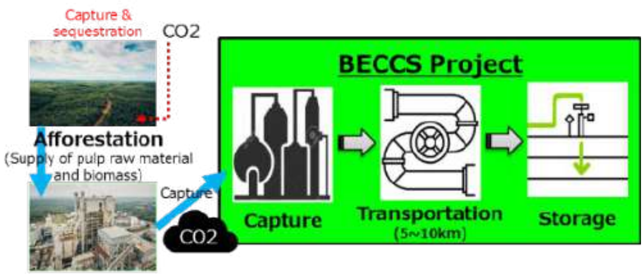


Illustration of the Project Concept



MOU related with Energy Management Utilising Battery

Project Overview	Mitsubishi Corporation and PT Indonesia Comnets Plus, subholding of Indonesia's state-run electricity company, have agreed to explore collaboration related to utilisation of renewable energy and energy management systems in Indonesia. Considering the characteristics of renewable energy which is being increasingly implemented in Indonesia, we will study energy management using batteries and pursue efficient energy utilisation.
Responsible Entity	Mitsubishi Corporation PT Indonesia Comnets Plus
Progress Status as of March 2025	Continuing the MOU project

Image of energy management utilizing battery charging station

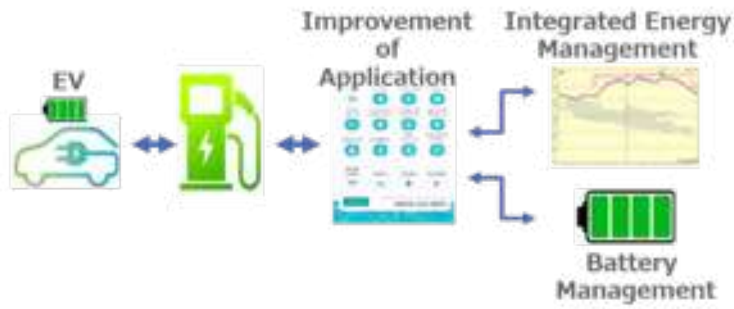
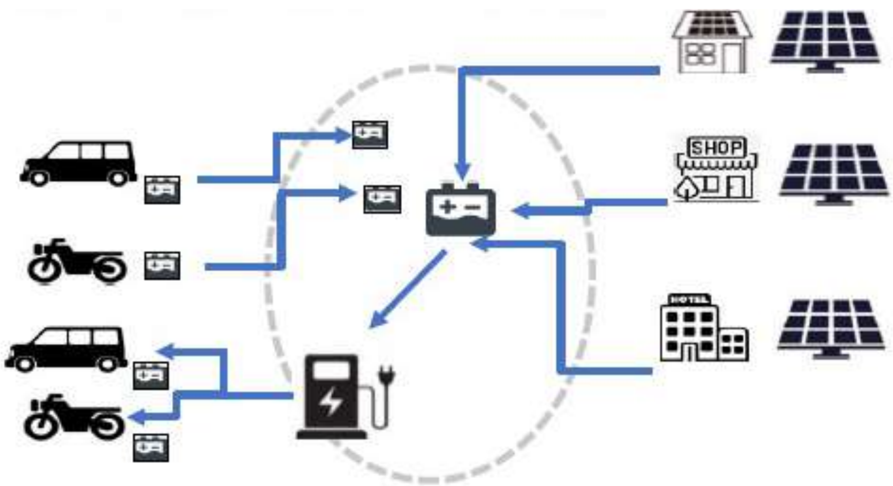


Image of energy management utilizing battery



MOU on decarbonisation cooperation between PT. PLN Nusantara Power and Mitsubishi Heavy Industries, Ltd.

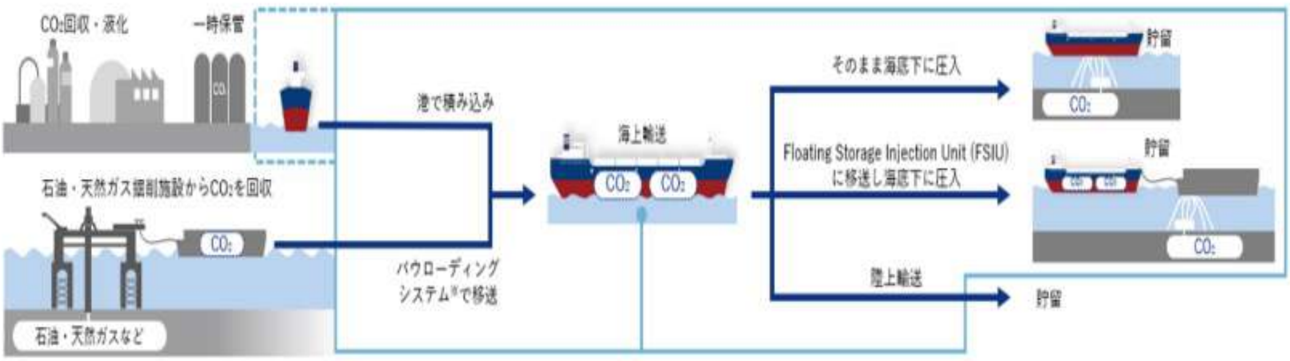
Project Overview	Toward decarbonisation of energy in Indonesia, PT. PLN Nusantara Power (PNP), a subsidiary of Indonesia's state-owned electricity company, and Mitsubishi Heavy Industries, Ltd. (MHI) will commence discussions on feasibility studies co-firing less carbon intensive fuels at power plants owned and operated by PNP.
Responsible Entity	Mitsubishi Heavy Industries, Ltd. PT. PLN Nusantara Power
Progress Overview	Discussions are ongoing between PNP and MHI, toward conducting a feasibility study for the power plants covered by the MOU.
URL	https://power.mhi.com/news/20230323.html

Mizuho Bank and Pertamina International Shipping: ESG and Credit Rating Advisory

Project Overview	Assist Pertamina International Shipping's decarbonisation initiatives through ESG advisory that helps diversify funding, including the development of sustainable finance framework.
Responsible Entity	Mizuho Bank Pertamina International Shipping
Progress Overview	Pertamina International Shipping obtained a Baa3 Credit Rating from Moody's
URL	https://www.pertamina-pis.com/news/obtaining-a-baa3-rating-from-moody-s-pis-business-evaluated-as-investment-worthy-and-promising

MoU with Indonesian State-Owned and Subsidiary of Pertamina for Cooperation in Liquefied CO_2 Business

Project Overview	Collaboration aimed at joint marketing and the creation of business opportunities related to the transportation of liquefied CO_2 associated with the Republic of Indonesia.
Responsible Entity	Nippon Yusen Kabushiki Kaisha (NYK Line) PT PERTAMINA INTERNATIONAL SHIPPING
Project Goals/KPI	To engage in LCO_2 transportation projects associated with Indonesia
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	In discussions with the partner, aiming to participate in projects that have specific demand for LCO_2 transport vessels.
Planned Demonstration Period	2031
Planned Business Agreement Period	2028
Planned Business Consideration/FID Period	2028
Planned Construction Period	2028 to 2031
Planned Commercial Operation Start Period	2031



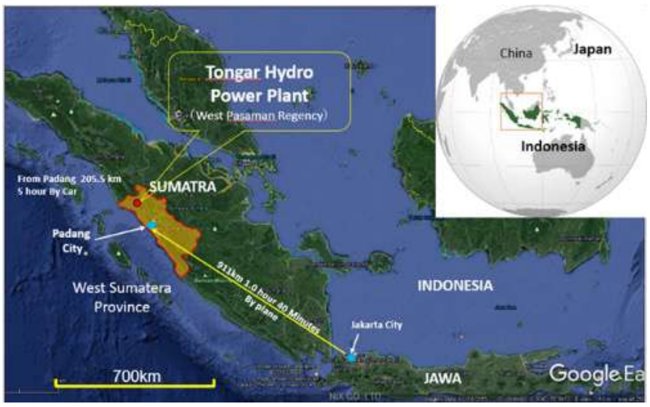
Commercial operation contract signed with PT. PLN, Indonesia's state-owned power company, for Tongar Hydro Power Plant

NiX JAPAN

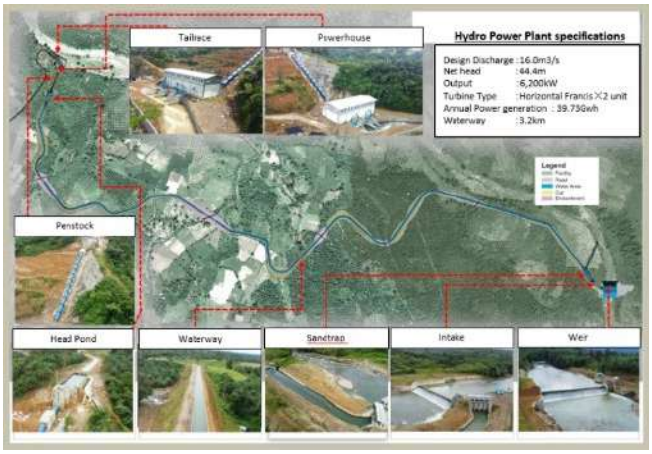
PLN

Project Overview	NiX JAPAN GROUP has signed a contract with PT. PLN, an Indonesian state-owned power company, for commercial operation of the 6.2 MW Tongar Hydro Power Plant, developed as its own hydro power plant in West Pasaman, West Sumatra, Indonesia, and has already commenced commercial operation. The power generated will be sold to PT. PLN for the next 25 years.
Responsible Entity	NiX JAPAN Co., Ltd. PT. PLN (Persero)
Project Scale (US$)	Approximately US$14 million (Approximately ¥1.5 billion at the time)
Production Scale	Annual Power Generation: 38.7GWh Estimated GHG Emission Reductions: 18,474tCO_2/year
Progress Overview	Commercial operation commenced on November 1, 2023. Even after operation began, power generation has exceeded projected output, it continues to operate smoothly and stably.
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Planned Commercial Operation Start Period	1 November 2023
URL	https://nix-japan.co.jp/en/

Project Location



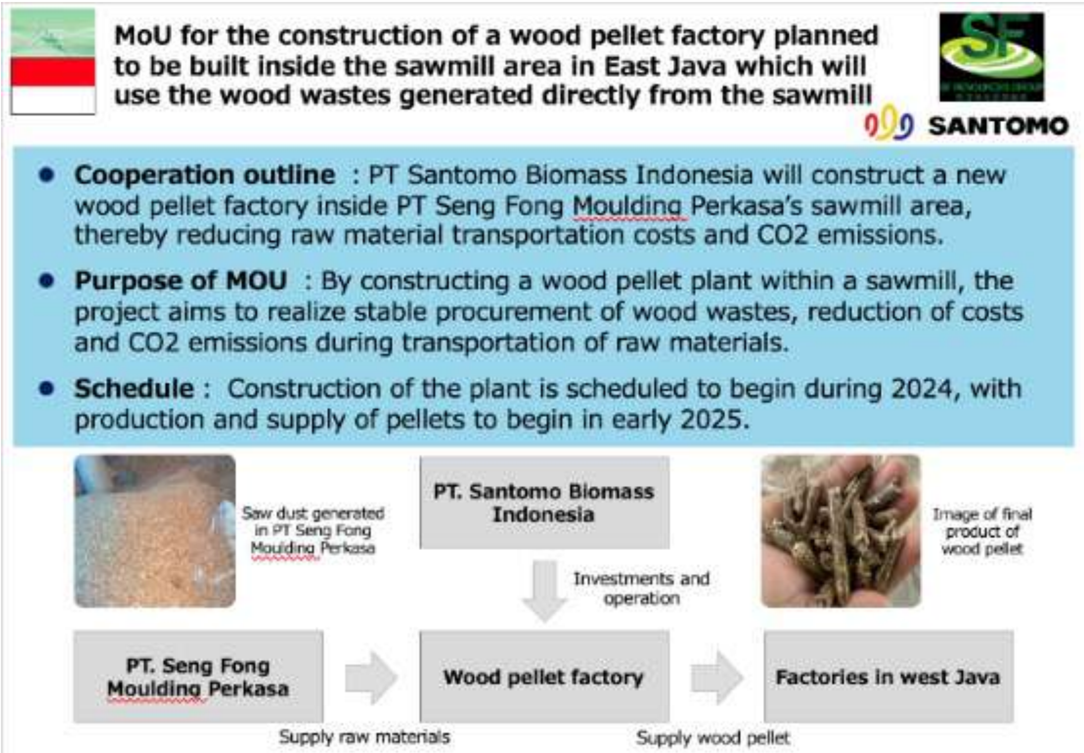
Tongar Hydro Power Plant Overview



MoU for the construction of a wood pellet factory planned to be built inside the sawmill area in East Java which will use the wood wastes generated directly from the sawmill

Project Overview	PT Santomo Biomass Indonesia will construct a new wood pellet factory inside PT Seng Fong Moulding Perkasa's sawmill area, thereby reducing raw material transportation costs and CO_2 emissions.
Responsible Entity	PT Santomo Biomass Indonesia PT Seng Fong Moulding Perkasa
Project Scale (US$)	US$1.35 million/Y
Production Scale	12,000MT/Y
Project Goals/KPI	Aiming for operation in July 2025, we will supply wood pellets domestically in Indonesia and export them to Rep. of South Korea and Japan.
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	Originally, we planned to begin construction of the factory by the end of 2024 and start operations in early 2025. However, due to an unfortunate incident involving the representative of the partner company, we restarted negotiations and decided to change the location of the wood pellet factory from the premises of PT Seng Fong Moulding Perkasa to a warehouse in East Java.
Planned Demonstration Period	September 2025: Start of factory operations
Planned Business Agreement Period	Agreed (PT Santomo Biomass Indonesia will independently construct the factory)
Planned Business Consideration/FID Period	FID already
Planned Construction Period	April 2025
Planned Commercial Operation Start Period	September 2025
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	No planned other contracts

The below MOU attachment is the previous scheme.



The changes from the MOU are that the source of sawdust will be procured from multiple suppliers other than PT Seng Fong Moulding Perkasa, and the construction site for the wood pellet factory has been changed from inside the PT Seng Fong Moulding Perkasa factory to a warehouse in the Surabaya area.

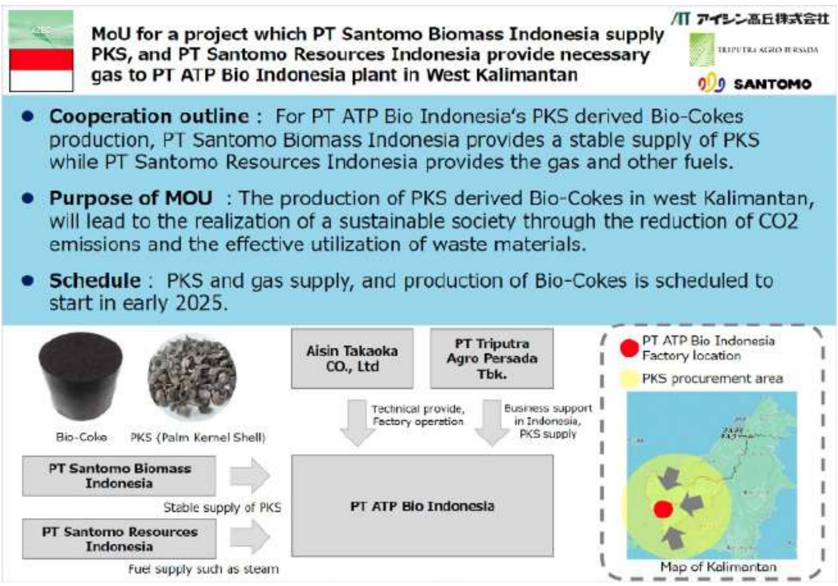
MOU on Co-Study of EV Society

Project Overview	Project overview is as stated below; > Installation of Battery Swapping Stations (BSS): BSS the charging infrastructure for Electric Motorcycles which provides battery swapping service and is deployed in the UNHAS campus. > Rental of electric motorcycles: electric motorcycles unit has been provided by rental to UNHAS. > Training for students: workshops and training sessions on EV and Solar PV have been executed for UNHAS students. > Discussions on the use of Solar PV for EV charging have been executed.
Responsible Entity	PT Santomo Green Power Management University of Hasanuddin (UNHAS)
Project Scale (US$)	8,000 – 15,000
Production Scale	Currently we are executing this pilot project with the capacity of 5.5kW of Solar PV, but along with demand expansion of electric vehicle, we consider 2,750kW generation can be potentially shifted to Solar PV in commercial scale.
Project Goals/KPI	> kWh production from Solar PV > kWh consumption by Electric Motorcycle Users > Reduced CO_2 emission through this project
Progress Status as of March 2025	Executed MOU with UNHAS, conducted field survey at Solar PV site, finalized installation and construction of Solar PV and running small scale commercial project currently.
Progress Overview	Currently, this pilot project of supply of renewable energy to EVs through small rooftop Solar PV has already been technically proven feasible through this project. However, when introducing Solar PV to each EV charging station (battery swap station), the capacity of solar panels inevitably becomes small, making it difficult to estimate the payback for investment, which is the current challenge. In addition, buildings such as convenience stores in Indonesia where our company has installed battery swap stations typically have weak roofs, which are not durable enough to support the weight of silicon panels and this is the challenge that we are facing.
Planned Demonstration Period	Already the project has been commenced to small scale commercial phase.

Planned Business Agreement Period	2 years from signing date.
Planned Business Consideration/FID Period	Already the project has been commenced to small scale commercial phase, but we have not decided when to start large scale of commercial projects.
Planned Construction Period	Already completed for this project.
Planned Commercial Operation Start Period	Already the project has been commenced to small scale commercial phase, but we have not decided when to start large scale of commercial projects.
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	As of now none, but planning to execute the MOU with a company which runs convenience store chain business in Indonesia for operation of BSS and Solar PV.
URL	https://san-tomo.com/posts/i4xsV3hz

MoU for a project which PT Santomo Biomass Indonesia supply PKS, and PT Santomo Resources Indonesia provide necessary gas to PT ATP Bio Indonesia plant in West Kalimantan

Project Overview	For PT ATP Bio Indonesia's PKS derived Bio-Cokes production, PT Santomo Biomass Indonesia provides a stable supply of PKS while PT Santomo Resources Indonesia provides the gas and other fuels.
Responsible Entity	PT Santomo Resources Indonesia, PT Santomo Biomass Indonesia PT. ATP Bio Indonesia
Project Scale (US$)	Approx. US$71 million
Production Scale	Maximum production scale for Bio-Cokes: 90,000MT/Y
Project Goals/KPI	We plan to expand to the maximum production scale by 2030.
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	The initial schedule for starting the fuel supply (PKS, gas, etc.) and bio-formed coal production was in the early 2025, however the project is now progressing to achieve to start in November 2025.
Planned Demonstration Period	October 2025
Planned Business Agreement Period	Agreed already
Planned Business Consideration/FID Period	FID already
Planned Construction Period	April 2025
Planned Commercial Operation Start Period	November 2025
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	Plans to conclude LNG sales/purchase agreement and PKS supply agreement

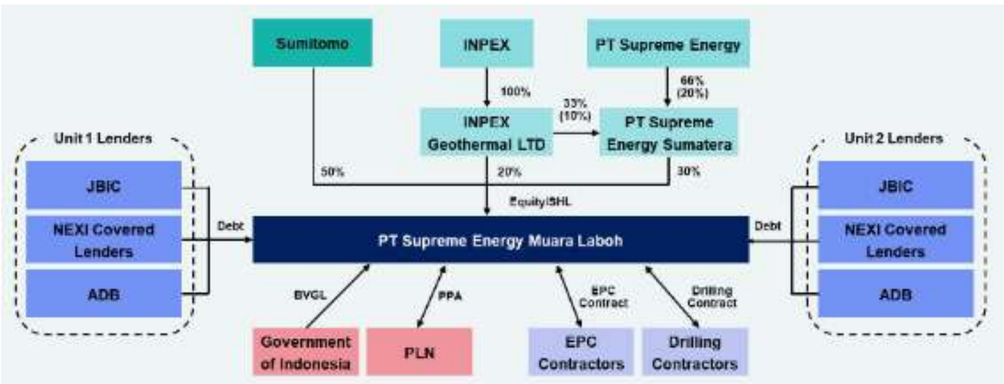


Muara Laboh Geothermal Power Expansion Project

Project Overview	This is an expansion project of geothermal power plant to newly build a Unit 2 of a similar scale as the Unit 1 (85MW) which commenced commercial operation in 2019 in West Sumatra. The project finance agreement was signed with the lenders including JBIC in January 2025, and the construction commenced in April 2025. The commercial operation is scheduled to commence in October 2027. After that, the electricity will be sold to Indonesia's state-owned electricity company, PLN, for approximately 25 years until the end of 2052, with the combined capacity of Unit 1 and Unit 2 expected to contribute to the electricity supply for the equivalent of 900,000 households.
Responsible Entity	PT Supreme Energy Muara Laboh (SEML) Shareholders: Sumitomo Corporation/INPEX Corporation/PT Supreme Energy PT Supreme Energy
Project Scale (US$)	US$ 494 million
Production Scale	83 MW
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	On 18 December 2023, in the presence of Mr. Saito, Japan's Minister of Economy, Trade and Industry, Mr. Arifin, Indonesia's Minister of Energy and Mineral Resources, and Mr. Airlangga, Indonesia's Coordinating Minister for Economic Affairs, SEML and PLN signed an amended Power Purchase Agreement (PPA) for the Muara Laboh Geothermal Power Expansion Project. Following certain subsequent adjustments to the terms, SEML and PLN signed a further amended PPA on 23 December 2024. On 10 January 2025, the project finance agreement was signed with the lenders including JBIC. (The following day, Japan's Prime Minister Mr. Ishiba and Indonesia's President Mr. Prabowo welcomed this agreement during their bilateral summit.) On 18 April 2025, construction works commenced and the project is currently under way with the aim of commencing commercial operations in October 2027.
Planned Construction Period	From April 2025 to October 2027
Planned Commercial Operation Start Period	October 2027
URL	https://www.supreme-energy.com/en/assets/pt-supreme-energy-muara-laboh

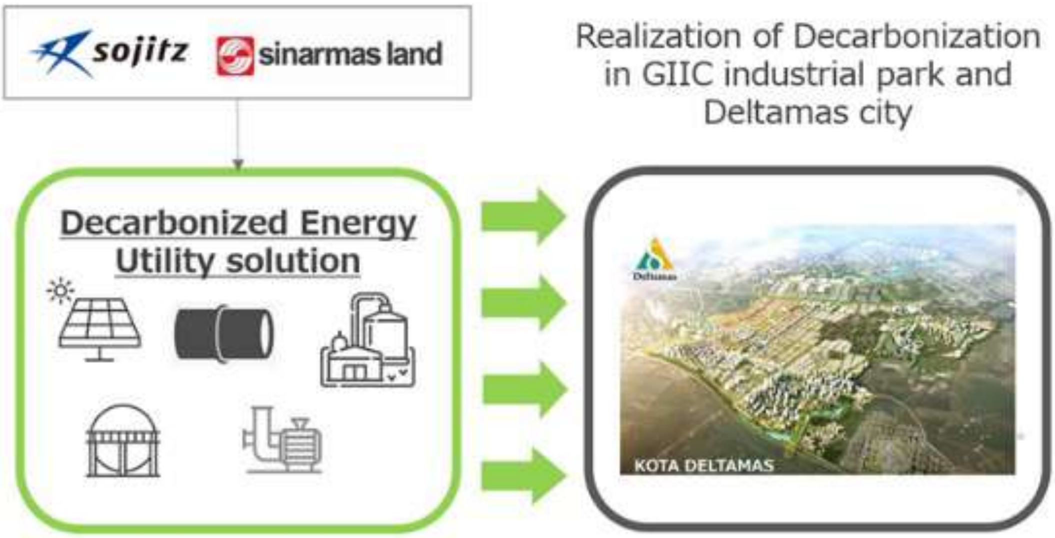
Map

Project Scheme



Decarbonization of Deltamas City and GIIC Industrial Park

Project Overview	This project aims to achieve carbon neutrality across the Deltamas City and the GIIC Industrial Park, which are jointly developed by Sojitz Corporation and Sinar Mas Land. To support this goal, a wide range of decarbonisation solutions will be implemented, including Renewable energy, Energy efficiency services (EaaS), Biogas utilisation and so on.
Responsible Entity	Sojitz Corporation Sinar Mas Land
Project Goals/KPI	Through the expansion of various decarbonisation solutions, a 50% reduction in CO_2 emissions is aimed for by 2030, and carbon neutrality is targeted by 2040/2050.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	A roadmap toward the decarbonization of the Deltamas City and the GIIC Industrial Park by 2040/2050 has been developed, focusing on renewable energy, energy services (EaaS), and biogas utilization. Discussions are currently underway with clients and local partners to implement these solutions.



Demonstration Research for Sorghum Value Chain that Contribute to Decarbonisation and Energy Transition (Indonesia)

住友商事

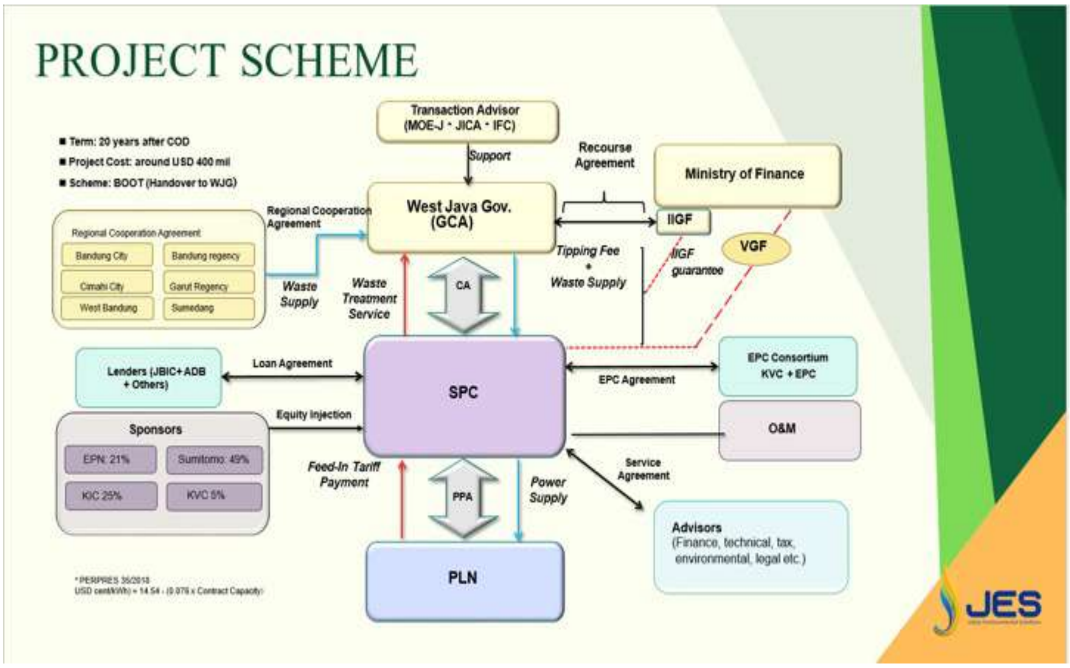
Project Overview	This empirical research project aims to promote decarbonisation and energy transition in Indonesia, Japan, and other Asian countries through the demonstration of a value chain business that cultivates high-yielding sorghum on a large scale in Indonesia and produces, sells, and uses biofuel.
Responsible Entity	Sumitomo Corporation
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The basic study under implementation

Legok Nangka Waste to Energy Power Plant

Project Overview	This project involves the incineration of municipal solid waste in West Java and the utilisation of the resulting waste heat energy for power generation. This Build-Own-Operate-Transfer (BOOT) project consists of the following two components: 1. A waste management project contracted by West Java Provincial Government, which involves the processing of municipal solid waste 2. Electricity sales to PLN
Responsible Entity	Sumitomo Corporation Kyuden International Corporation Kanadevia Corporation PT. Energia Prima Nusantara
Project Scale (US$)	Approx. US$400 million
Production Scale	Waste Processing Volume: 1853–2131 tonnes/day Power Plant Capacity: Approx. 40 MW
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Tentative Cooperation Agreement (CA) for waste management was signed with the West Java Provincial Government in June 2024. Discussions are currently underway with the aim of signing the final CA with West Java Provincial Government, Power Purchase Agreement (PPA) with PLN, and Guarantee Agreement (GA) with IIGF by June 2025.
Planned Construction Period	March 2026 ~ August 2029 (Assuming the signing of primary contracts in June 2025 and achieving Finance Close in March 2026)
Planned Commercial Operation Start Period	August 2029 (Assuming the signing of primary contracts in June 2025 and achieving Finance Close in March 2026)
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	June 2025: Signing of Final CA with West Java Provincial Government Signing of PPA with PLN Signing of GA with IIGF
Other Milestones	March 2026: Finance Close August 2029: COD


JES
WTE LEGOK NANGKA
PT JABAR ENVIRONMENTAL SOLUTIONS
PROJECT SUMMARY


JES
PROJECT SUMMARY
Project Site :
Jl. Raya Nagreg, Citaman, Kec. Kabupaten Bandung, Jawa Barat 40215
WTE area: 20Ha
Connection Point: GI New Rancakasumba


PROJECT SCHEME
■ Term: 20 years after COD
■ Project Cost: around USD 400 mil
■ Scheme: BOOT (Handover to WJG)
Transaction Advisor (MOE-J・JICA・IFC)
Support
Recourse Agreement
Ministry of Finance
West Java Gov. (GCA)
IIGF
VGF
IIGF guarantee
Regional Cooperation Agreement
Regional Cooperation Agreement
Bandung City
Bandung regency
Cimahi City
Garut Regency
West Bandung
Sumedang
Waste Supply
Waste Treatment Service
CA
Tipping Fee + Waste Supply
Lenders (JBIC+ADB + Others)
Loan Agreement
SPC
EPC Agreement
EPC Consortium KVC + EPC
O&M
Sponsors
Equity Injection
EPN: 21%
Sumitomo: 49%
KIC 25%
KVC 5%
Feed-In Tariff Payment
PPA
Power Supply
Service Agreement
Advisors (Finance, technical, tax, environmental, legal etc.)
PLN
*PERPRES 35/2018
USD cent/kWh) = 14.54 - (0.076 x Contract Capacity)
JES

Collaborative Study on Biomass Conversion to Existing Coal Fired Power Plants Owned by PT PLN Nusantara Power to Support Decarbonisation and Carbon Neutral Policies in Indonesia's Energy Sector

Sumitomo Heavy Industries, Ltd.

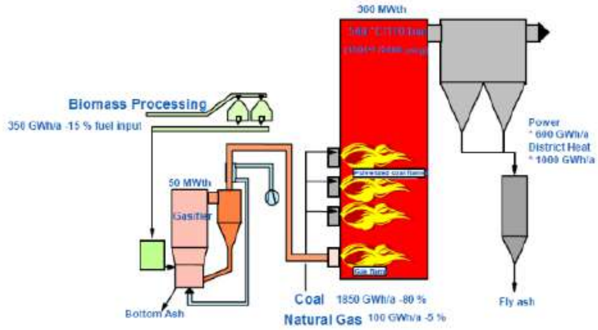
PLN Nusantara Power

Project Overview	Through various dialogues between PNP and SHI, PNP and SHI will take following actions. 1) Feasibility Study of Co-firing with Coal and Biomass for Pulang Pisau Coal Fired Power Station 2) Feasibility Study of Retrofitting Gasification Facility to Paiton Coal Fired Power Station 3) Keep monitoring if the plan for fuel conversion from coal to biomass for Unit 1 of Paiton Coal Fired Power Station be revisited.
Responsible Entity	Sumitomo Heavy Industries, Ltd. PT. PLN Nusantara Power
Project Scale (US$)	be estimated during or after the Feasibility Studies.
Project Goals/KPI	1) Materialising conversion of Pulang Pisau Power Station from Coal Fired to Co-firing with Coal and Biomass once the Feasibility Study finds it feasible. 2) Materialising retrofitting Gasification Facility to Paiton Coal Fired Power Station once the Feasibility Study finds it feasible. 3) Resuming further Feasibility Study for fuel conversion from coal to biomass for Unit 1 of Paiton Coal Fired Power Station if the plan is revisited.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Agreement to carry out the Feasibility Studies has just reached between PNP and SHI. Scope, period, schedule of the Feasibility Studies will be elaborated shortly.
Planned Construction Period	To be elaborated during or after the Feasibility Studies.
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	Once result of the Feasibility Studies found feasible, PNP and SHI may enter into specific MOU to materialise the projects.

1) Feasibility Study of Co-firing with Coal and Biomass for Pulang Pisau Coal Fired Power Station

Pulang Pisau Coal Fired Power Plant

2) Feasibility Study of Retrofitting Gasification Facility to Paiton Coal Fired Power Station



Conceptual Image of Gasification Facility

3) Keep monitoring if the plan for fuel conversion from coal to biomass for Unit 1 of Paiton Coal Fired Power Station be revisited.

Unit 1 Paiton Power Station Overview

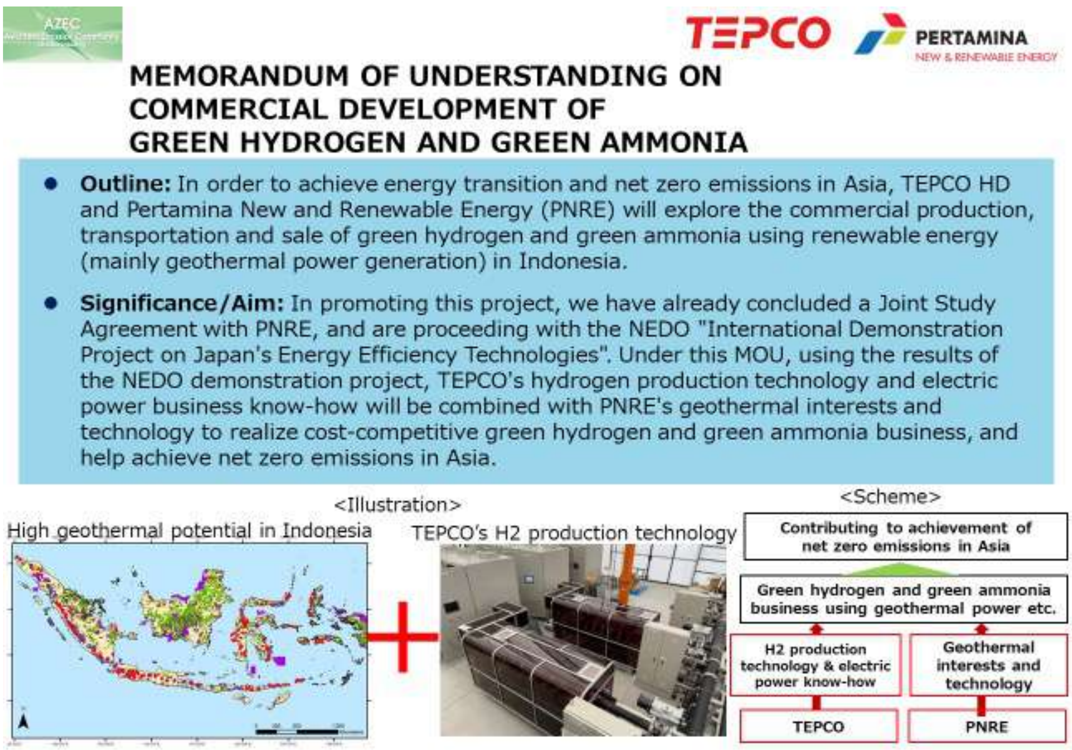
MOU regarding cooperation to support the development of LNG and e-methane VC

Project Overview	PLN EPI, a PLN subsidiary that operates in fuel procurement and transportation, and Tokyo Gas Asia will advance the planning of small-scale LNG value chain throughout Indonesia, as well as the examining of decarbonisation measures (emethane). The collaboration also includes PLN EPI human resources development to support the LNG value chain development and e-methane study.
Responsible Entity	TOKYO GAS ASIA PT PLN EPI
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	To explore the feasibility of producing e-methane in Indonesia, we are conducting a project study utilising Tokyo Gas's knowledge of e-methane.

MoU on Commercial Development of Green Hydrogen and Green Ammonia

TEPCO PERTAMINA NEW & RENEWABLE ENERGY

Project Overview	In order to achieve energy transition and net zero emissions in Asia, TEPCO HD and Pertamina New and Renewable Energy (PNRE) will explore the commercial production, transportation and sale of green hydrogen and green ammonia using renewable energy (mainly geothermal power generation) in Indonesia. This MOU project is based on 'Demonstration of hydrogen technology that utilises surplus electricity and exhaust heat from geothermal power generation to achieve economically viable hydrogen production and transportation', which was selected as an 'International demonstration of Japanese technology that will contribute to decarbonisation and energy conversion' by the New Energy and Industrial Technology Development Organization (NEDO).
Responsible Entity	Tokyo Electric Power Company Holdings, Inc. Pertamina New and Renewable Energy (PNRE)
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	After consulting with NEDO, PNRE and TEPCO HD agreed to terminate the NEDO Project in February 2025. PNRE and TEPCO HD agreed to amend the commercial project MOU, reviewing the plan and schedule.
Future Plan	MOU is currently being revised



Strategic Technology Partnership between PT PLN Nusantara Power (PLN-NP) and Toshiba Energy Systems & Solutions Corporation (TESS) for introducing Carbon Capture technology to PLN-NP power generation assets

Project Overview	Establishing the framework of the strategic technology partnership for future introduction of Carbon Capture technology between PLN-NP and TESS. Both parties will conduct the Feasibility Study including the future implementation of its pilot plant to the existing PLN-NP power generation assets.
Responsible Entity	Toshiba Energy Systems & Solutions Corporation (TESS) PT PLN Nusantara Power (PLN-NP)
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	TESS and PLN NP are discussing study base of power plant (case of CO_2 emission)

Candidate plant Paiton (TESS OEM)

Signing Memorandum of Understanding for Joint Study on the Full-scale Geothermal Utilisation between PT Geo Dipa Energi and Toyo Engineering Corporation

Project Overview	Toyo Engineering Corporation (TOYO) has signed a Memorandum of Understanding (MOU) with PT Geo Dipa Energi (GDE) regarding joint research on the comprehensive utilisation of geothermal energy. The MOU aims for TOYO and GDE to conduct joint research on comprehensive geothermal utilisation, including geothermal closed-loop technology, and mineral extraction from geothermal brine, etc.
Responsible Entity	Toyo Engineering Corporation (TOYO) PT Geo Dipa Energi (GDE)
Project Goals/KPI	TOYO and GDE will promote joint research on the comprehensive utilisation of geothermal energy and contribute to the realisation of a sustainable society and the economic development of Indonesia through social implementation.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Formulation of a study plan for joint research on comprehensive geothermal utilisation, including geothermal closed-loop technology, and mineral extraction from geothermal brine, etc.
URL	https://prtimes.jp/main/html/rd/p/000000043.000107878.html

Signing Memorandum of Understanding toward developing full potential of geothermal energy between PT Medco Power Indonesia and TOYO Engineering Corporation

Project Overview	Toyo Engineering Corporation (TOYO) has signed Memorandum of Understanding (MOU) with PT Medco Power Indonesia (MPI) regarding joint research on developing full potential of geothermal energy.
Responsible Entity	Toyo Engineering Corporation (TOYO) PT Medco Power Indonesia (MPI)
Project Goals/KPI	Geothermal energy, as a renewable energy, has a huge potential including production of green fuel and is the key for carbon neutral society. To fully utilise this potential, TOYO and MPI will promote joint study on the opportunity of developing full potential of geothermal energy and contribute to the realisation of sustainable society and the economic development in Indonesia.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Formulation of a study plan for developing the full potential of geothermal energy.
URL	https://prtimes.jp/main/html/rd/p/000000064.000107878.html

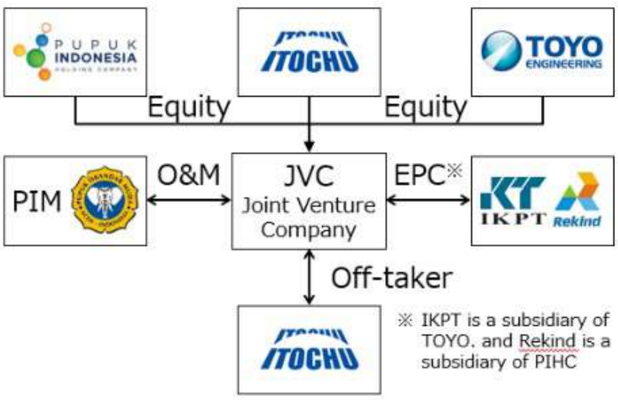
A Letter of Intent for Indonesian Geothermal Master Plan between The Survey and Testing Center for Electricity, New, Renewable Energy and Energy Conservation of The Ministry of Energy and Mineral Resources, and Toyo Engineering Corporation

Project Overview	Geothermal energy, as a renewable energy, holds immense potential including the production of green fuels, and plays a pivotal role in achieving a carbon neutral society. In line with our ongoing efforts to fully harness this geothermal potential and realise the 'Geothermal Carbon Neutral Park', we are honored to announce the conclusion of a Letter of Intent between the Ministry of Energy and Mineral Resources (MEMR), and TOYO. The LOI aims to develop a Geothermal Master Plan in alignment with Indonesia's Net Zero Emission (NZE) 2060 targets. Through this development, we aspire to further strengthen the relationship between the Indonesian and Japanese governments and accelerate the growth of TOYO and its group company's geothermal business.
Responsible Entity	Toyo Engineering Corporation (TOYO) Survey and Testing Center of Electricity, New Energy, Renewable Energy and Energy Conservation (BBSP KEBTKE), a government agency under the Directorate General of New, Renewable Energy and Energy Conservation, Ministry of Energy and Mineral Resources (MEMR)
Project Goals/KPI	Through this development, we aspire to further strengthen the relationship between the Indonesian and Japanese governments and accelerate the growth of TOYO and its group company's geothermal business.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Updating the geothermal roadmap towards the development of a geothermal master plan.
URL	https://prtimes.jp/main/html/rd/p/000000096.000107878.html

Green Ammonia Initiative from Aceh (GAIA)

Project Overview	The project aims to produce green ammonia at an existing plant originally designed and built by TOYO in the 2000s. This plant is currently owned and operated by PIM, a subsidiary of Pupuk Indonesia, and is located in the Special Economic Zone (SEZ) of Aceh. ITOCHU will procure the green ammonia as marine fuel, thereby establishing a comprehensive value chain. This initiative represents both Indonesia's first and the world's first commercial-scale green ammonia production for marine fuel, utilising part of the production capacity of the existing plant.
Responsible Entity	Toyo Engineering Corporation, ITOCHU Corporation PT Pupuk Indonesia (Persero), ITOCHU Corporation
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The consortium is steadily advancing the project toward a Final Investment Decision (FID) through close collaboration with relevant partners. Following the Joint Development Agreement announced at the 2nd Ministerial Meeting of the Asian Zero Emission Community (AZEC), the consortium is currently conducting the Front End Engineering Design (FEED. As part of the process to establish a joint venture company (JVC) in Q2 2025, Shareholders Agreement (SHA) was signed in November 2024 and publicly announced at COP29. The FID is targeted for the second half of 2025.
Planned Business Consideration/FID Period	The consortium is currently progressing the business consideration through the ongoing FEED, aiming to ensure technical and economical viability. Final Investment Decision (FID) is targeted in the 2nd half of 2025, followed by the establishment of the Joint Venture Company (JVC) planned in Q2 2025.
Planned Commercial Operation Start Period	2027

【Structure Outline】



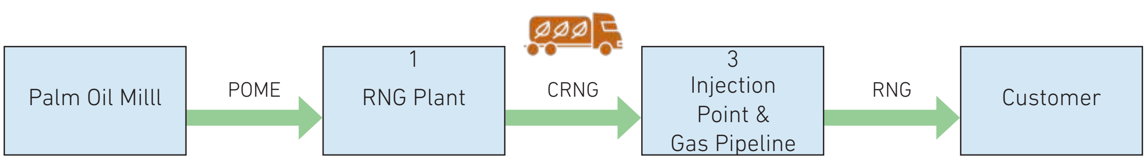
※ IKPT is a subsidiary of TOYO, and Rekind is a subsidiary of PIHC

【Location of PIM's Existing Ammonia Plant】

Renewable Natural Gas Supply

PERTAMINA
GAS NEGARA

Project Overview	Developing Renewable Natural Gas (RNG) Supply derived from Palm Oil Mil Effluent (POME) as green alternative fuel of Natural gas.
Responsible Entity	PT. Toyota Tsusho Indonesia (TTI) PT. Perusahaan Gas Negara Tbk (PGN)
Project Scale (US$)	US$6–8 million per RNG Plant Expected total about 15 projects
Production Scale	84,000–100,000 MMBTU/year Total volume about 1.6 million MMBTU/year
Project Goals/KPI	Deployment of RNG project in Indonesia to: - Contribute to Indonesia carbon neutrality target and national energy security. - Contribution to GHG reduction from industrial fuel & heat usage.
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	PGN, TTI and the customer will enter into Head of Agreement.
Planned Demonstration Period	Start of Supply expected to start in 2027
Planned Business Agreement Period	Expected that Business Agreement (Sales and Purchase of RNG) to be concluded in 2025
Planned Business Consideration/FID Period	FID expected to reach in 2025
Planned Construction Period	Construction Period estimated in 2026
Planned Commercial Operation Start Period	Commercial Period expected to start in 2027
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	HoA expected to sign in 2025



Project Overview
1. RNG Plant: receive POME from Palm Oil Mill, capture biogas from POME and produce RNG
2. Deliver the RNG to Injection by Compressed RNG Truck.
3. RNG Injected into Natural Gas Pipeline and delivered to customer*

*as the RNG is injected into natural gas pipeline and mix with natural gas, a **biomethane certificate** need to be issued to certify the quantity of the biomethane injected and delivered to customer.

Project Overview

	2025	2026	2027	~	~	onward
HoA						
Feasibility Study						
Agreement						
FID						
Construction						
COD						

Eastern GX Corridor (EGXC) Initiative in the east of Jakarta

Project Overview	Integrated and multi-pathway approach for Green Energy Transformation (GX) from 1. West Java Industrial area (GX Industrial Park), 2. Patimban Port area (GX Port & Vessels) and 3. Industry area to Port Logistics (GX Logistics) Multi-pathway approach of green energy: Bio (Biomethane, Biodiesel), Renewable Energy (Green Electricity), Hydrogen and Ammonia
Responsible Entity	PT Toyota Tsusho Indonesia PT Pertamina (Persero)
Production Scale	Under consideration estimated to reduce about 5 million tonnes CO_2/year at 2050.
Project Goals/KPI	Contribution of sustainable society and economic growth in Indonesia by a. Achievement of Indonesia CN Target b. Enhancement of Indonesia National Energy security c. Competitive advantage in global green industry, by realising GX in Patimban Port and its related industrial value chain (EGXC)
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	• MOU signed with PLN, a public power company, for renewable energy and hydrogen cooperation in the EGXC (October 2024) • Preparation of Master Plan FS (Master Plan Development Study of the Global South Future-oriented Co-creation Project) to be finalised in FY2025.
Planned Demonstration Period	Demonstration of initial implementation in 2026
Planned Business Agreement Period	Expected in FY2026
Planned Business Consideration/FID Period	FID Expected in FY2026
Planned Construction Period	For Demonstration: FY2026
Planned Commercial Operation Start Period	FY2028

Project Schedule

	2025	2026	2027	2028	~~	onward
Master Plan FS	→					
Demonstration		→	→			
Commercial				→	→	→

Memorandum of understanding on collaboration between Zeroboard (Japan) / PT. Megalopolis Manunggal Industrial Development (Indonesia) / PT KDDI INDONESIA (Indonesia) / KAMAR DAGANG DAN INDUSTRI INDONESIA (Indonesia)

Project Overview	Cooperation outline: In industrial parks operated by MMID (60% owned by Marubeni), Zeroboard will promote GHG emission visualisation for tenants using its cloud service. PT KDDI Indonesia will handle tenant inquiries about the system, and KADIN (Indonesian Chamber Of Commerce and Industry) Net Zero Hub will hold decarbonisation workshops for awareness. Purpose or objectives of MOU: Through this project, which has been awarded a JETRO ADX subsidy, we will verify methods of data sharing and necessary functions specific to Indonesia, thereby creating a model case for efficient visualisation of GHG emissions at the industrial park level.
Responsible Entity	Zeroboard Inc. PT. Megalopolis Manunggal Industrial Development PT KDDI INDONESIA KAMAR DAGANG DAN INDUSTRI INDONESIA
Project Goals/KPI	Identify ideal methods of data collection. Visualise GHG emissions at Industrial park level.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The project was kicked-off with a joint seminar in February of 2024 held in person at MMID office. The goals were to inform tenants companies of the carbon footprint calculation and visualisation initiative, explain how calculations are made, and request their cooperation. From April, onboarding to the Zeroboard platform began as well as data collection and emissions calculations. In January and February of 2025, a survey was developed and disseminated using the Zeroboard platform to increase the volume of data collected. A second seminar was held in January 2025 to announce the survey, explain what data was necessary and how to respond. The survey was closed at the end of March and data is currently being was analyzed to identify areas of largest GHG emissions.
Other Milestones	January 2024 – Project kickoff seminar April 2024 – Onboarding to Zeroboard platform begins July 2024 –Seminar introducing the basics of decarbonisation and Zeroboard's GHG visualisation system January 2025 – Survey announcement seminar March 2025 – Survey close
URL	https://en.zeroboard.jp/news/5677

Memorandum of Understanding on the Study of a Laos-Grown Coffee Roasting Project Using Green Hydrogen in the Pakse-Japan Economic Zone, Champasak Province, Lao PDR

Project Overview	Green hydrogen will be produced using locally generated hydropower, and this green hydrogen will be utilised as a heat source for roasting Laos-grown green coffee beans, resulting in the production of hydrogen-roasted coffee beans.
Responsible Entity	TSB GreeNex Pheatsavangjoint Development Coffee Sole Co., Ltd
Project Scale (US$)	US$40 million
Production Scale	5,000 tonnes per year
Project Goals/KPI	Stable Production of Green Hydrogen Stable Production of Roasted bean
Progress Status as of March 2025	The MOU project is completed and has progressed to the next phase (e.g., demonstration)
Progress Overview	The project has been selected as a major demonstration initiative for the Global South. A contract was signed with JETRO on 1 April 2025, and a contract was signed with an equipment supply and construction service provider on 16 July 2025.
Planned Demonstration Period	Operation Start from January 2027
Planned Business Agreement Period	Agreement on Dec 2024
Planned Business Consideration/FID Period	FID on April 2025
Planned Construction Period	Construction Start from November 2025
Planned Commercial Operation Start Period	Operation Start from March 2027
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	As a next project, green alumina production is under consideration, and negotiations are currently underway with an electricity supplier for the signing of a Memorandum of Understanding (MoU) in Year 2025.
Other Milestones	As a next project, green aluminum production is under consideration, and negotiations are currently underway with a electricity supplier for the signing of a Memorandum of Understanding (MoU) in Year 2025

The Global South Future-Oriented Co-Creation Project:
Selected Companies (1st Application)

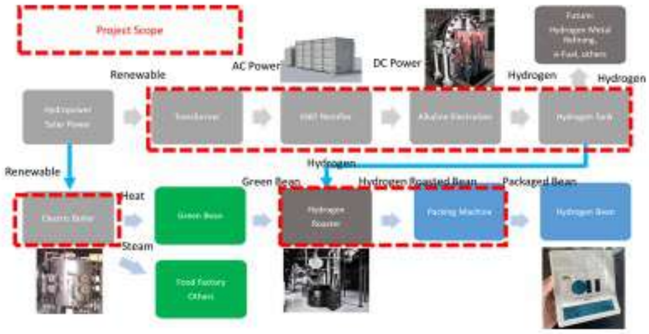
TSB GreeNex Co., Ltd.
"Pakse Japan Special Economic Zone Carbon Neutralization Demonstration Project"

◆ Head office: Tokyo ◆Unlisted on Tokyo Stock Exchange
◆ Founded: 2024
◆ Business area: Renewable Energy Business
◇ MZEC CO., Ltd and Lao Green Hydrogen Co., Ltd will implement the project.

事業計画

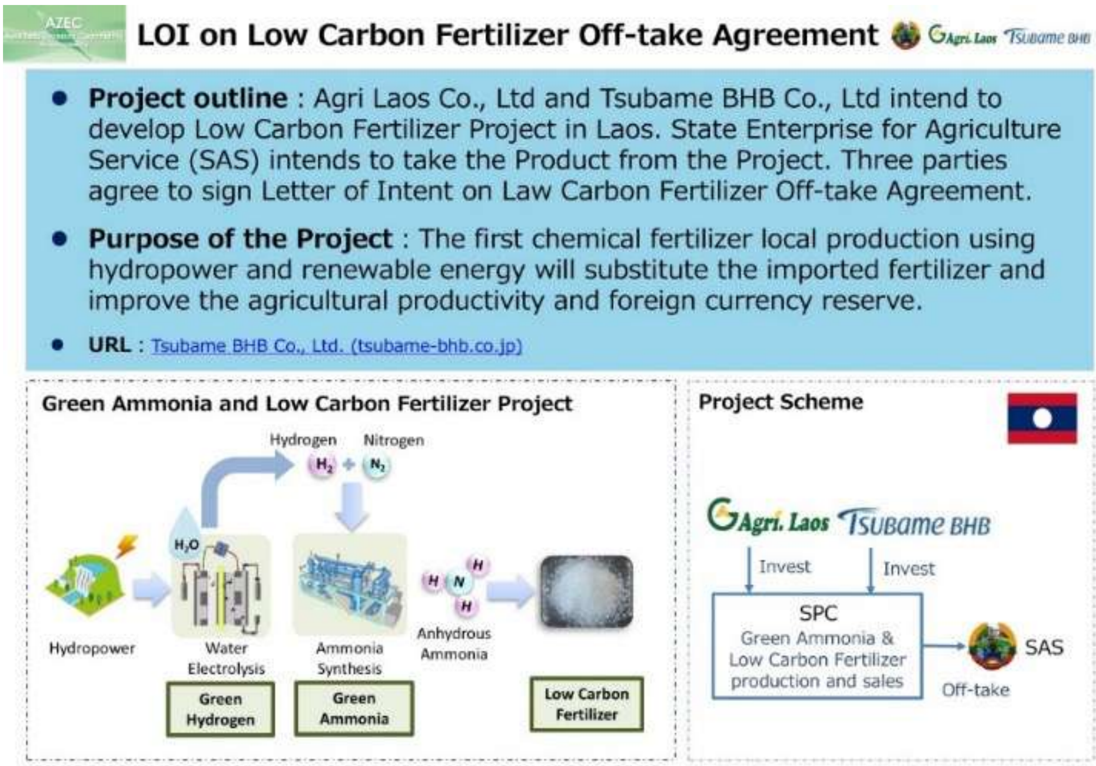
"Achieving carbon neutralization by introducing Japanese water electrolysis equipment"

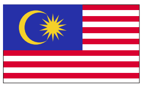
<Outline>
・The project will finish in November 2027.
・By using green hydrogen as a heat source at the factories in SEZ, we will establish the production system of carbon-neutral products throughout SEZ.
<Expected results>
・Pakse Japan Special Economic Zone will attract worldwide attention as eco-friendly and sustainable industrial area.
・Japanese companies in Pakse Japan SEZ will enhance worldwide competitiveness by carbon neutralization.



Green Ammonia and Low Carbon Fertilizer Project (LOI on Low Carbon Fertilizer Off-take Agreement)

Project Overview	Tsubame BHB and Agri Laos are developing Green Ammonia and Low Carbon Fertilizer project using hydropower and renewable energy in Lao PDR. SAS is willing to offtake its Low Carbon Fertilizer.
Responsible Entity	Tsubame BHB Co., Ltd Agri Laos Co., Ltd State Enterprise for Agriculture Service
Project Scale (US$)	US$37 million
Production Scale	5,000t/y Ammonia production and 20,000t/y Low Carbon Fertilizer production
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	We are cultivating the business environment suitable for commercial green ammonia and low carbon fertiliser production.



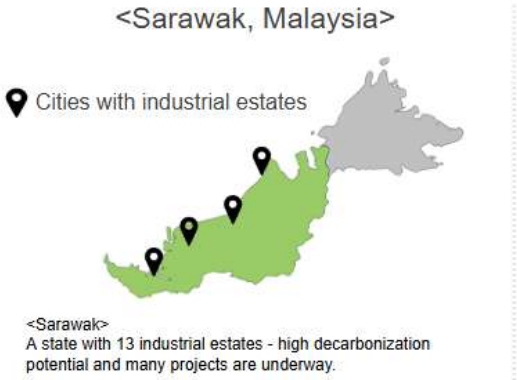


ESG Promotion Collaboration in Sarawak, Malaysia

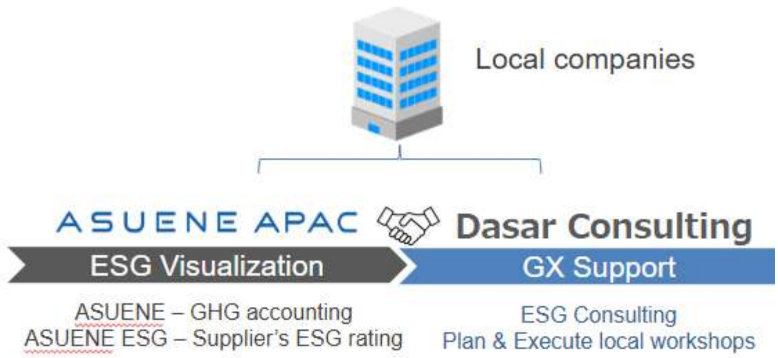
ASUENE APAC
Dasar Consulting

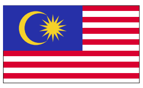
Project Overview	Memorandum of Understanding between Dasar Consulting, a local Malaysian company, and ASUENE to promote ESG and GHG accounting by local companies in Sarawak, Malaysia.
Responsible Entity	Asuene APAC Dasar Consulting

Project site



Project scheme





Cooperation agreement on support for ESG management of local companies

ASUENE APAC

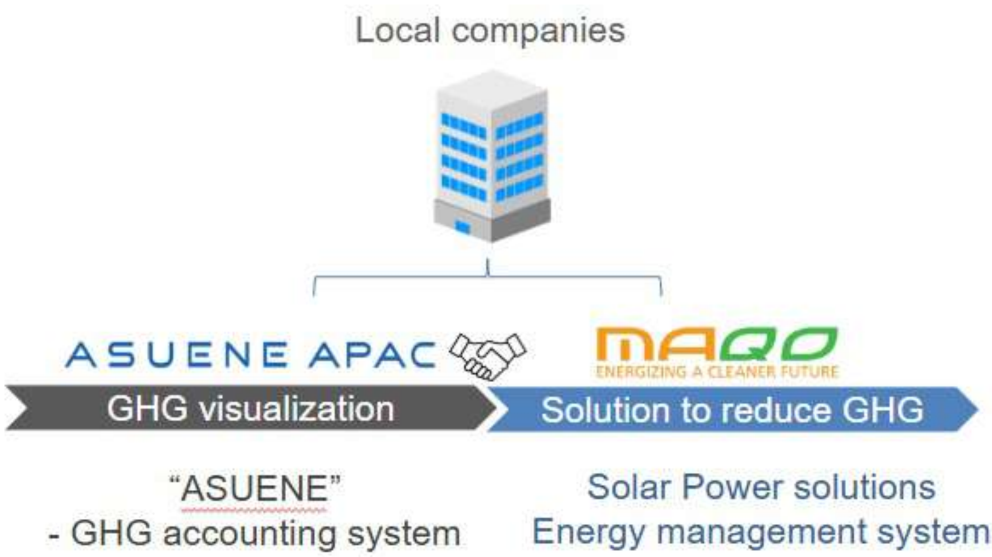
Project Overview	Signed a collaboration agreement with Mitsusho, a local Malaysian company, for GHG calculation of ASUENE.
Responsible Entity	Asuene APAC Mitsusho

Collaboration agreements in decarbonisation solutions

ASUENE APAC

MAQO ENERGIZING A CLEANER FUTURE

Project Overview	Signed a collaboration agreement with Maqo Solar, a local Malaysian company, for GHG calculation of ASUENE.
Responsible Entity	Asuene APAC Maqo Solar



Green Hydrogen / MCH production project in Sarawak, Malaysia (Project H2ornbill)

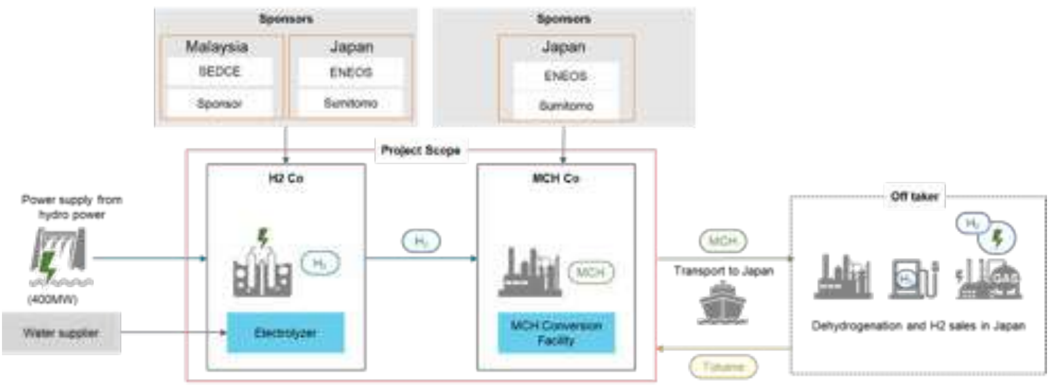
ENEOS
Sumitomo Corporation
SEDC ENERGY

Project Overview	Green hydrogen and MCH production and export project utilising abundant hydropower in Sarawak, Malaysia.
Responsible Entity	ENEOS corporation Sumitomo corporation SEDC Energy
Project Goals/KPI	Commercial operation starts within the fiscal year 2030 on the basis of green H_2 and MCH production delivered to Japan via marine transportation.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The FEED is currently underway, aiming for completion within this year of 2025. In parallel, preparations for EPC are also being conducted for the target to achieve commercial production in the fiscal year 2030.
Planned Commercial Operation Start Period	FY2030

•Description
This project, "H2ornbill Project", is a hydrogen and MCH production and supply chain construction project jointly promoted by ENEOS Corporation and Sumitomo Corporation in collaboration with SEDC Energy, a subsidiary of Sarawak Economic Development Corporation (SEDC). Located in Sarawak, Malaysia, the project is set to become the first large-scale hydrogen plant in Southeast Asia. The H2ornbill project focuses on the production of green hydrogen derived from renewable energy, utilising Sarawak's abundant water resources. This collaboration also aims to promote regional economic development and sustainable energy supply.

Project site

Project scheme



Collaboration to Accelerate Development of Sustainable Aviation Fuel for the Aviation Industry

Project Overview	To enhance capabilities across the supply chain and optimise the route to market for Sustainable Aviation Fuel (SAF) to producing lower carbon energy solutions for customers worldwide.
Responsible Entity	Idemitsu Kosan Co.,Ltd Petroliam Nasional Berhad (PETRONAS)
Project Goals/KPI	to conduct a feasibility study to scale-up bio feedstock possibilities including non-edible plants, production cost analysis and security in ensuring a steady and efficient supply chain for the sustainable development of SAF
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	In the year of 2024, we have conducted a project steering committee involving executive-level members. The following agreements have been reached: **SAF Marketing** Idemitsu Kosan is considering the import of SAF to establish a sustainable supply system by 2030. Discussions will continue towards an offtake agreement from Petronas' biorefinery. **Cultivation of oilseed plant as an Oil Feedstock** Both companies propose to jointly establish a central platform for research, training, and support of bio-feedstock cultivation. As concrete initial steps, we will advance studies on economic feasibility and develop joint pilot projects.
Planned Demonstration Period	2025 and onwards
Future Plan	Depend on the implications of the demonstration phase
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	Another agreement is expected to be reached in the near future to commence the collaborative demonstration trials of one potential bio-feedstock cultivation.

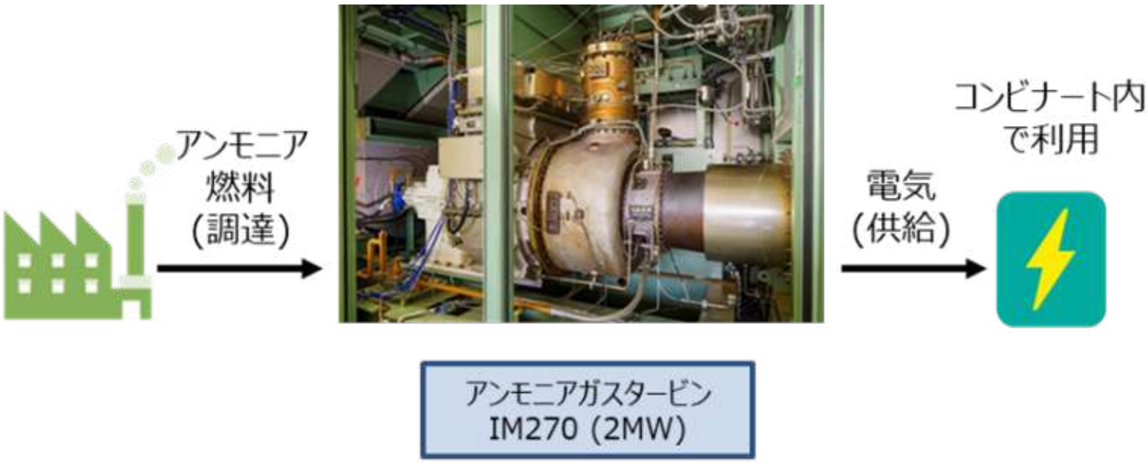
Evaluation and exploration of climate abatement projects within and outside Malaysia

Project Overview	Idemitsu International (Asia) and PETCO Trading Labuan Company Ltd (PTLCL) will collaborate to evaluate and explore climate abatement projects, focusing on carbon credits and sustainable products, to address sectorial emissions within and outside Malaysia.
Responsible Entity	Idemitsu International Asia Pte. Ltd. PETCO Trading Labuan Company Ltd
Project Goals/KPI	The collaboration aims to address sectorial emissions including power generation, transportation, agriculture, waste, and others. By combining the strength and expertise of both companies, the collaboration also aims to assess the viability of the projects through issuance of environmental certificates including carbon credits.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Idemitsu International (Asia) and PTLCL are collaborating to evaluate and explore climate abatement projects and have identified a landfill rehabilitation & development project in Malaysia to potentially harness landfill gas and generate carbon credits and biogas while contributing to the reduction of greenhouse gas emissions.
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	Singed Memorandum of Collaboration in relation to the landfill rehabilitation & development project between Idemitsu International (Asia), PTLCL, Saxon Renewable Energy Sdn Bhd and AE Carbon Capital Sdn Bhd in Feb 2025.
Other Milestones	Continue to collaborate aiming to address sectorial emissions including power generation, transportation, agriculture, waste, and others within and outside Malaysia.

- The project aims to extract methane from the landfill and recover it for either power generation or upgrading to Bio-CNG (Compressed Natural Gas), while simultaneously generating carbon credits from GHG emission reduction.

Basic agreement on the commercial use of the world's first dedicated ammonia gas turbine

Project Overview	IHI and Gentari Hydrogen (a subsidiary of PETRONAS) is to install 100% ammonia-fired gas turbine 'IM270' at a PETONAS's ammonia production plant in Malaysia. This will be the world's first project to generate electricity by 100% ammonia fuel and to supply the electricity to the plant as a comemrcial operation.
Responsible Entity	IHI Corporation Gentari Hydrogen Sdn. Bhd.



Ammonia-Fired Gas Turbine IM270

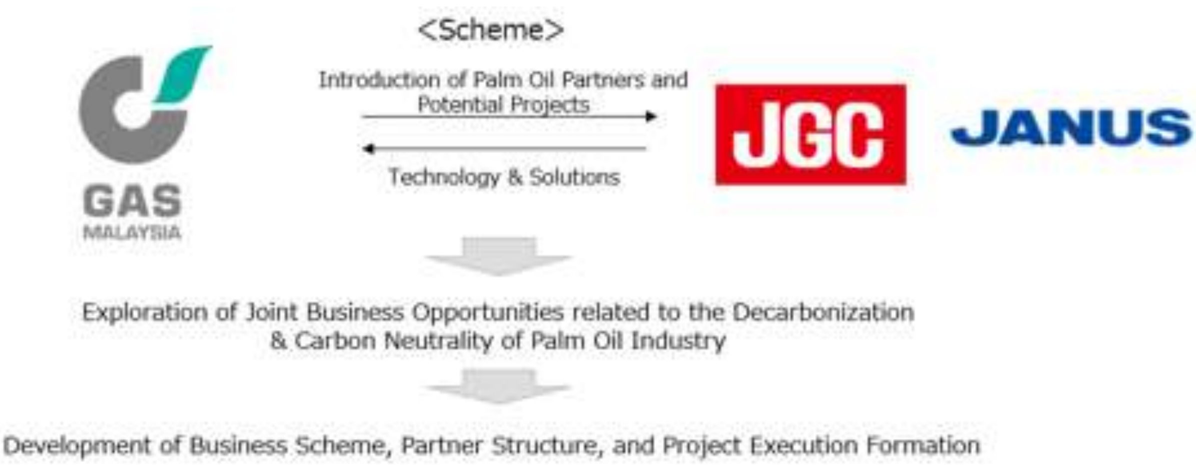
MoU between IHI and TNB Power Generation Sdn Bhd regarding basic design for small scale ammonia and/or biomass mix-firing

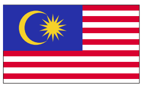
Project Overview	Conduct a study and plan a decarbonisation roadmap including CO_2 reduction plan through ammonia/biomass combustion at the coal-fired power plant owned by TNB Power Generation Sdn Bhd (TNB GENCO)
Responsible Entity	IHI Corporation TNB Power Generation Sdn Bhd (TNB GENCO)
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	As a result of the study, TNB Genco has decided to consider ammonia fuel as a future initiative, and for now, they intend to proceed with biomass co-firing, which is relatively more economically feasible. Currently, they are conducting a study on biomass co-firing.

Manjung Coal-Fired Power Plant, which is the subject of the study.

Memorandum of Understanding on the Promotion of Carbon Neutrality through the Effective Utilisation of Palm Oil Derived Waste

Project Overview	In order to promote decarbonisation in Malaysia, the JGC Group and Gas Malaysia Sdn. Bhd, a leading gas company in Malaysia, have agreed to conduct a feasibility study on the production and sales of biofuels and biochemicals through effective utilisation of unused waste materials (POME, EFB, wood waste, etc.) generated by the palm oil industry.
Responsible Entity	JGC Holdings Japan NUS Co LTD. Gas Malaysia Sdn. Bhd
Production Scale	Biomethane 5,000 tonnes per year
Project Goals/KPI	JGC Group, which has a wide range of solutions for effective utilisation of waste including palm residue, and Gas Malaysia, which has a solid energy distribution network and connections with the palm oil industry in Malaysia, will collaborate to explore joint business opportunities and conduct joint studies with a view to future commercialisation. JGC Group and Gas Malaysia, a major gas company in Malaysia, will collaborate to explore joint business opportunities and conduct joint studies with a view to future commercialisation, in order to promote the sustainability of the palm oil industry and decarbonisation in Malaysia, which will contribute to the country's carbon neutrality. JGC Group and Gas Malaysia, a major gas company in Malaysia, have agreed to conduct a feasibility study on the production and sales of biofuels and biochemicals through the effective utilisation of unused waste materials (POME, EFB, waste wood, etc.) from the palm oil industry.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The joint study described in the objectives has been completed. Discussions are ongoing for joint implementation of agreed upon ideas within the study.





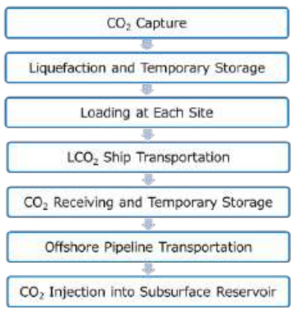
Southern Offshore Peninsular Malaysia CCS project

Project Overview	The Southern Offshore Peninsular Malaysia CCS project involves capturing CO_2 from diverse industrial emission sources across Western Japan, liquefying it, transporting it via liquefied CO_2 carriers, and storing it in depleted gas field offshore Peninsular Malaysia.
Responsible Entity	Mitsui & Co., Ltd. PETRONAS CCS Solutions Sdn Bhd TotalEnergies Carbon Neutrality Ventures Kansai Electric Power Co., Inc. Cosmo Oil Co., Ltd. Chugoku Electric Power Co., Inc. Electric Power Development Co., Ltd. Kyushu Electric Power Co., Inc. Crasus Chemical Inc. UBE Mitsubishi Cement Corporation PETRONAS CCS Solutions Sdn Bhd
Production Scale	Storage of approximately 5 million tonnes of CO_2 per year
Project Goals/KPI	Contribution to the creation of an eco-friendly society
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	Progress is being made in designing the entire CCS value chain and evaluating the potential storage capacity
Planned Commercial Operation Start Period	Aiming to commence operations by the early 2030s
URL	https://www.mitsui.com/jp/en/topics/2023/1246779_13949.html

Project Overview

Business Entity	Mitsui & Co., Ltd. PETRONAS TotalEnergies Kansai Electric Power Co., Inc. Cosmo Oil Co., Ltd. Chugoku Electric Power Co., Inc. Electric Power Development Co., Ltd. Kyushu Electric Power Co., Inc. Crasus Chemical Inc. UBE Mitsubishi Cement Corporation
Storage	Offshore Peninsular Malaysia Depleted Gas Field
Scale	5 million tons of CO2 per year
COD	by the early 2030s

Value Chain Image



(provided by PETRONAS)

e-methane Production in Malaysia using Biomass

Project Overview	Osaka Gas and IHI and PETRONAS Global Technical Solutions signed MOU for joint feasibility study on a project to produce e-methane using biomass in Malaysia. In this project, e-methane is planned to be synthesised from hydrogen and CO produced by the gasification of biomass such as unutilised forest resources and agricultural residues. It is also noteworthy that biomass-derived CO_2 is obtained as a by-product, and negative emissions through CCS of this CO_2 will be studied in the future.
Responsible Entity	Osaka Gas Co., Ltd.(Daigas Group) IHI Corporation PETRONAS Global Technical Solutions Sdn. Bhd.(PETRONAS Group)
Production Scale	Amount of e-methane production: 60,000 tonnes/year
Project Goals/KPI	Production cost of e-methane, Construction Lead Time of the production plant (specific value is not disclosed.)
Progress Status as of March 2025	The MOU project is completed (or expected to be completed), but there are no plans for subsequent phases
Progress Overview	The feasibility study based on the MOU was completed on schedule with the cooperation of each company. Since the timing of commercialisation needs to be carefully determined in light of various external factors, when to proceed to the next step (or scrap the business plan) is still under consideration.
Progress Status as of March 2025	The MOU project is completed and has progressed to the next phase (e.g., demonstration)
URL	https://www.osakagas.co.jp/en/whatsnew/__icsFiles/afieldfile/2023/04/10/230410.pdf

MOU for hydrogen and ammonia and other utilisation projects in Johor, Malaysia

Project Overview	(i) Development of ammonia receiving terminal and ammonia-fired gas turbine thermal power plant. (ii) Supply of ammonia for marine fuel. (iii) Carbon-neutral ports that utilises hydrogen from existing ports.
Responsible Entity	Sojitz Corporation Mitsubishi Heavy Industries Ltd JLand Group Sdn Bhd
Project Goals/KPI	(i) Commencement of operations of the ammonia receiving terminal and the ammonia-fired gas turbine power plant. (ii) Start of supply of ammonia for marine fuel. (iii) Completion of the development of a carbon-neutral port utilising hydrogen from existing ports.
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	We are actively working on resolving issues such as the value of carbon-neutral electricity in the country where the business is being implemented and the procurement of traditional fuels.
URL	https://www.sojitz.com/en/news/article/20220927.html

e-methane production project in Sarawak, Malaysia

TOKYO GAS Sumitomo Corporation Enriching lives and the world PETRONAS

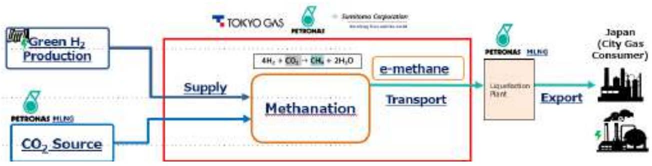
Project Overview	Production of e-methane (methanation) in Sarawak, Malaysia. Utilising CO_2 emitted by Malaysia's national oil and gas company PETRONAS to produce e-methane for export to Japan.
Responsible Entity	Tokyo Gas Sumitomo Corporation PETRONAS
Project Goals/KPI	Building a supply chain to produce e-methane from green hydrogen in Malaysia and export it to Japan which can contribute to Japan's decarbonisation society by utilising existing infrastructure.
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	The MOU project (Feasibility Study) has been completed, and an additional study is currently being conducted to reduce the production cost of e-methane in preparation for FEED.
Planned Commercial Operation Start Period	Early 2030s

- Description

This project is an innovative initiative jointly promoted by Tokyo Gas and Sumitomo Corporation in collaboration with PETRONAS. The project aims to utilise Sarawak's hydroelectric power to produce green hydrogen using renewable energy-derived electricity. This green hydrogen is then synthesised with CO_2 supplied from Petronas' MLNG plant to produce e-methane. e-methane can be utilised without significant capital investment by leveraging existing LNG transportation, receiving facilities, and pipeline networks. The realisation of this project represents an important step towards achieving a decarbonised society.

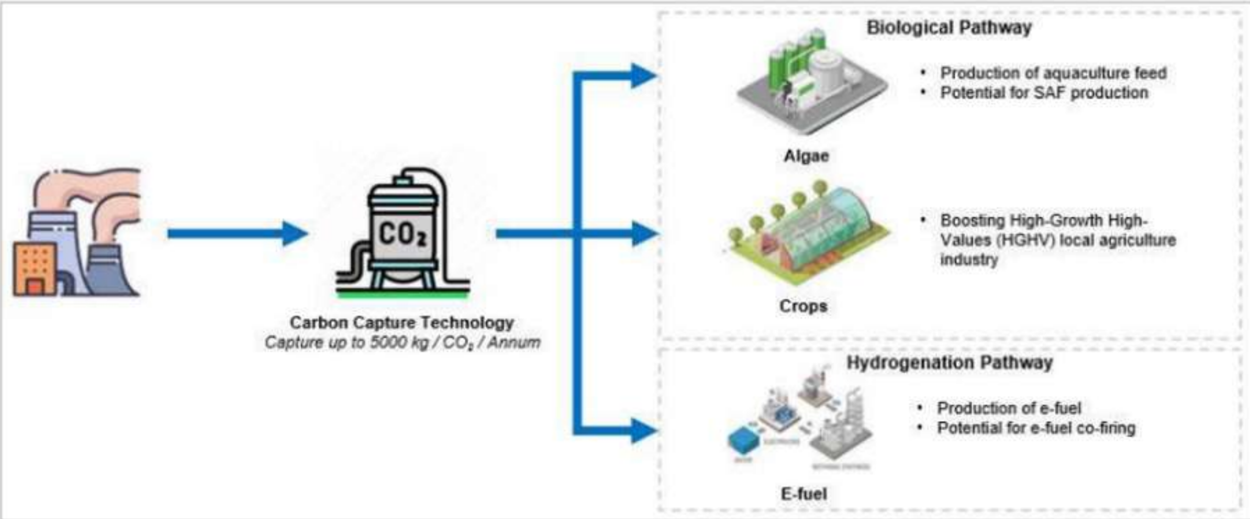
- Project site

- Project scheme



Memorandum of Understanding in relation to the proposed collaboration on Strategic Technology Partnership for TNB Genco CCUS pilot Plant Facility

Project Overview	TNB is targeting to achieve Net Zero by 2050. Towards this target, TNB GENCO is seeking the opportunity to introduce CCUS technology to its's facilities by utilising TESS's Carbon Capture related knowledge and technology. This MOU is to establish the framework of the strategic technology partnership for future introduction of CCUS facility between TNB GENCO and TESS.
Responsible Entity	Toshiba Energy Systems & Solutions Corporation TNB Power Generation Sdn. Bhd. (MOU) TNB Research (Project)
Production Scale	Pilot Project = 5 tonnes/year (15kg/day)
Project Goals/KPI	TNB Target of 5t per year from the project.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Based on this MOU, TESS conducted the training for the CCUS Technology to TNB GENCO. TNB is changing the direction with TNB internally doing business feasibility study by doing a pilot project using R&D arm TNB Research to see the value chain in Carbon Capture and Utilization (CCU). Tender has been issued for pilot project and TOSHIBA has been awarded as one of the technology providers. This project is using TNB own Research budget. Scale up by TNB depending on the outcome of the pilot project and business consideration.
Future Plan	For TNB Research Pilot Project. 3 years from 2025 until 2027.
Planned Construction Period	December 2025-June 2026
Planned Commercial Operation Start Period	It is a research project. Start Operation for TOSHIBA scope is from February 2026
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	LOA has been issued to TOSEM (TOSHIBA subsidiary) in January 2025.



Link below on the project explanation from TNB website.
The project is under point number 2. Carbon Capture Emission.

https://www.tnb.com.my/sustainability/esg-stories-urgency-of-carbon-emission-management

MOU with Invest Sarawak to advance Sarawak's energy transition agenda

TOYO ENGINEERING InvestSarawak

Project Overview	Toyo Engineering Corporation, Toyo Engineering & Construction Sdn Bhd (Toyo Malaysia), and Invest Sarawak signed an MOU to advance an energy transition agenda of Sarawak state in Malaysia, which aims to help Toyo Group explore and facilitate potential investment projects in the state in alignment with the state's energy transition strategies
Responsible Entity	Toyo Engineering Corporation Invest Sarawak
Project Goals/KPI	Toyo undertakes feasibility studies, FEED jobs, or any engineering works for potential investors in Sarawak.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Toyo Malaysia and Invest Sarawak formed a working group for exchanging information of potential investors and their aiming projects. Toyo Malaysia indicated areas they focus on, which are SAF, CCU (g-Methanol TM), and ammonia & urea.
URL	https://investsarawak.gov.my/investsarawak-toyo-ink-mou-to-advance-state-govts-energy-transition-agenda/

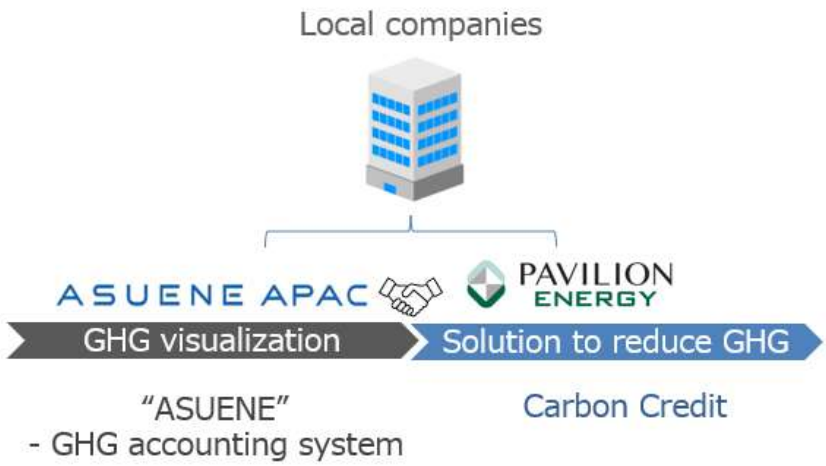
Mizuho Bank and Ayala Group: Financial / Non-financial Assistance to De-carbonisation

MIZUHO Ayala

Project Overview	Mizuho is providing financial and non-financial services to Ayala Group, one of Philippines' leading conglomerates, to assist Ayala in advancing its group-wide net zero greenhouse gas initiatives.
Responsible Entity	Mizuho Bank Ayala Group
Progress Overview	Bank of the Philippine Islands: Renewal of business cooperation agreement including ESG.
URL	https://www.mizuhogroup.com/bank/news/2024/01/20240123release_eng.html

MOU Signed to Achieve Net Zero

Project Overview	Joint sales of partner carbon credits and Asuene's CO_2 calculation software
Responsible Entity	Asuene APAC
Partner Company in the Counterparty Country	Pavilion Energy Trading & Supply Pte. Ltd.



Business cooperation agreement on ESG management support for SMEs

Project Overview	Signing agreements to co-operate with Singapore Manufacturing Federation for GHG accounting support.
Responsible Entity	Asuene APAC Singapore Manufacturing Federation

Tri-parties' MOU to study retrofitting with ammonia combustion by Sembcorp, IHI and GE in Singapore

Project Overview	Sembcorp, GE Vernova and IHI collaboratively study retrofittability of Sembcorp's Sakra Power Station for ammonia combustion, and aim to contribute decarbonisation of Singapore power sector.
Responsible Entity	IHI Corporation Sembcorp Industries GE Vernova
URL	https://www.ihi.co.jp/all_news/2023/resources_energy_environment/1200364_3538.html

Sembcorp Cogeneration Power Plant, Jurong Island, Singapore

Retrofitting GE Gas Turbine

Mizuho and Climate Impact X join forces to scale carbon credit market in Asia

Project Overview	Mizuho Financial Group agreed to invest in Climate Impact X (CIX), a Singaporean entity that operates a marketplace, auctions house and exchange for trusted carbon credits.
Responsible Entity	Mizuho Financial Group Climate Impact X
URL	https://www.climateimpactx.com/the-board

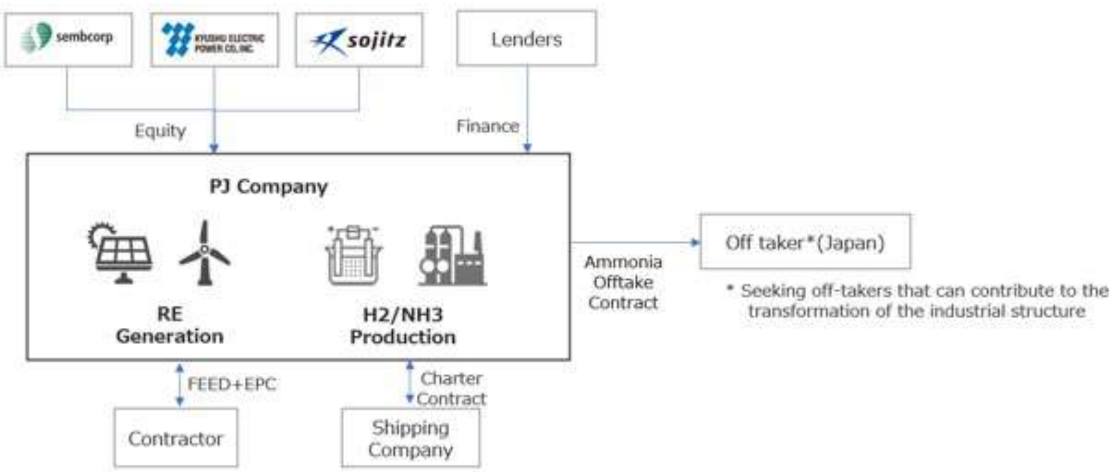
MOU between Maritime and Port Authority of Singapore and NYK Line to advance maritime sustainability

Project Overview	The purpose of this MOU is to define three areas of potential collaboration which is decarbonisation, digitalisation and manpower development. Especially for some scopes in decarbonisation area, MPA/NYK aim to have concrete milestones and deliverables. MPA and NYK had signing ceremony on 2 July 2024 and have set working groups for each scope to deepen collaboration.
Responsible Entity	Nippon Yusen Kabushiki Kaisha (NYK Line) Maritime and Port Authority of Singapore (MPA)
Project Goals/KPI	1.Decarbonisation • Promoting safe use of fuel ammonia through initiatives on ammonia fueled vessels (including bunkering vessels) • Training for seafarers on ammonia fueled vessels • Use of other alternative fuels such as methanol and bio-fuels • Methodology to accelerate decarbonisation investments 2.Digitalisation • Digitalisation to improve efficiency of shipping operations 3.Manpower Development • Discuss on initiatives such as leadership programs for maritime talents
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	November 2024, the two parties visited the A-Tug (Ammonia Fuelled Tugboat) developed under the GI Fund, a framework supported by the Japanese government. Regular dialogue has also been held at the Chief Executive levels to explore how Singapore and Japan can work together from a business perspective to realise decarbonisation, digitalisation and manpower development.
URL	https://www.nyk.com/english/news/2024/20241126.html https://www.mpa.gov.sg/media-centre/details/mpa-and-nyk-forge-partnership-to-advance-maritime-sustainability--digitalisation-and-manpower-development https://www.nyk.com/english/news/2024/20240709.html

India green ammonia production project -Project Jasmine-

Project Overview	Producing the green ammonia in Tuticorin, India with cost competitive renewable energy to supply green ammonia to industrial offtakers in Kitakyushu, Japan.
Responsible Entity	Sojitz Corporation Kyushu Electric Power Co., Inc. Sembcorp Green Hydrogen India Private Limited ('Sembcorp', wholly owned subsidiary of Sembcorp Industries Limited.)
Production Scale	200,000 tonnes/NH_3 per year
Project Goals/KPI	(1) To contribute to the decarbonisation plan of Japan by producing low-cost green ammonia in India with highly cost competitive renewable energy. (2) To contribute to Japan's energy security by producing green ammonia which will not be affected by fluctuations in gas prices and establishing new supply chain from India, a non-traditional energy supplier for Japan.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	FEED work is ongoing.
Planned Business Consideration/FID Period	2026
Planned Construction Period	2027-2030
Planned Commercial Operation Start Period	2030

Sojitz Corporation, Kyushu Electric Power Co., and Sembcorp had signed a term sheet on June 2024, for the supply of green ammonia produced in India to Japanese off-taker.
Sojitz and Kyushu Electric will undertake the 200,000 metric tonnes of green ammonia per year from 2030 for the Japanese market and will supply it to various industrial off-takers mainly in the Kyushu region.
For the ammonia transportation, we also signed a term sheet for charter contract with NYK on August 2024.

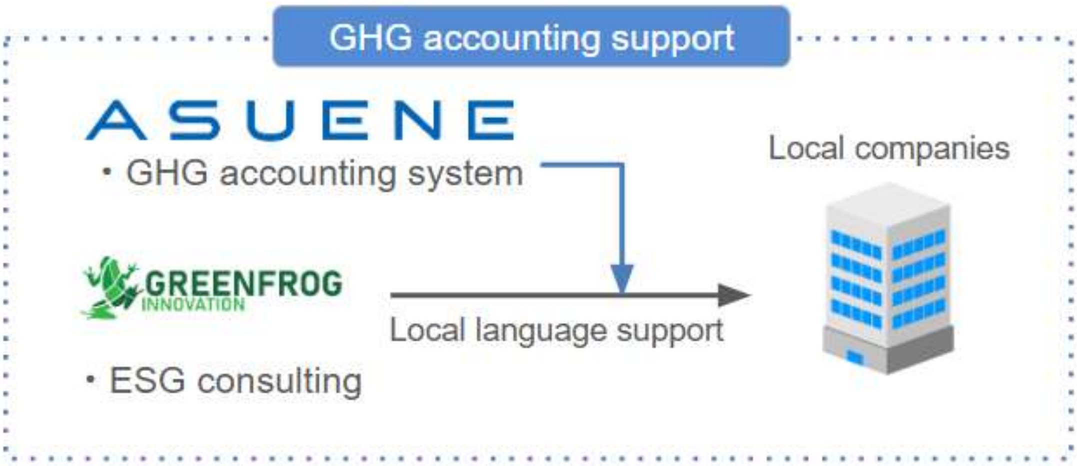


Zeroboard (Japan)/RIMM (Singapore) MoU

Project Overview	Project Overview: Zeroboard, provider of a cloud service for calculating and visualising GHG emissions, has formed a business alliance with RIMM, a provider of ESG scoring services, to build an advanced ESG management support service. Aim of MoU: RIMM will integrate with and leverage Zeroboard's carbon calculating function to provide an advanced ESG scoring service, aimed at promoting ESG management in Asia.
Responsible Entity	Zeroboard Inc. (e.g.) RIMM
Project Goals/KPI	Support decarbonisation efforts of Zeroboard/RIMM customers.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Zeroboard/RIMM has implemented 'customer referral scheme' and has begun sending referrals to other company.
URL	https://www.zeroboard.jp/news/1572

Agreement to collaborate on promoting GHG accounting for local companies

Project Overview	Signed a collaboration agreement with Green Frog Innovation, a local company in Thailand, for GHG calculation of ASUENE.
Responsible Entity	Asuene Green Frog Innovation

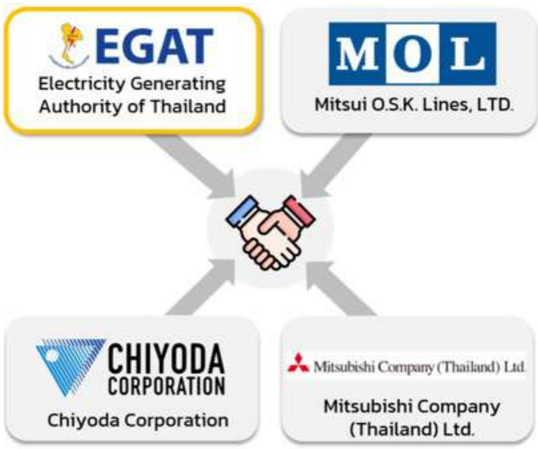


The Development of Clean Hydrogen/ Ammonia Value Chain

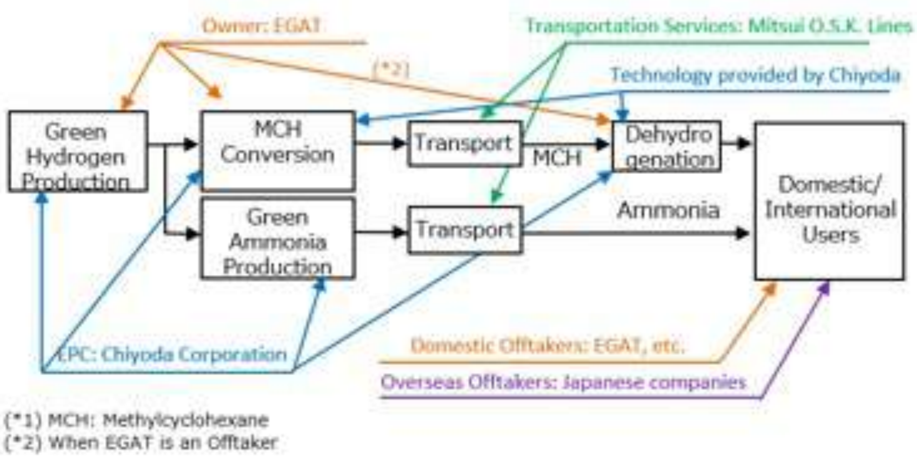
Project Overview	**Project Overview:** Development of project focusing on producing clean hydrogen/ clean ammonia from renewable energy in southern provinces of Thailand in order to trade it to domestic and/or international industries for the utilisation throughout the value chain. **Purpose of MOU:** • Toward the realisation of decarbonisation target in Thailand, Chiyoda Corporation, Mitsui O.S.K. Lines, and Mitsubishi Company (Thailand) Limited aims to study and provide expertise to Electricity Generating Authority of Thailand (EGAT), the Thailand's leading state-owned enterprise, to cooperate and exchange the ideas relating the supply chain of clean hydrogen/ clean ammonia in southern provinces of Thailand, including the production, storage, transportation and utilisation.
Responsible Entity	Chiyoda Corporation Mitsui O.S.K. Lines Mitsubishi Company (Thailand) Limited Electricity Generating Authority of Thailand (EGAT)
Project Goals/KPI	To build a value chain that uses renewable energy in Thailand to produce green hydrogen and green ammonia and supply them to domestic and overseas markets, including power generation.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	• Feasibility study has been performed for clean Hydrogen value chain development by considering Methylcyclohexane (MCH) as Hydrogen carrier under METI's Subsidy Program in FY2023. Based on the findings of the FY2023 study, we have determined that under the current assumptions, the project lacks sufficient competitiveness. Further optimisation and improvements in economic viability are therefore required. Further discussions and verifications are ongoing amongst EGAT, Chiyoda Corporation, Mitsui O.S.K. Lines and Mitsubishi Corporation (Thailand).In particular, hydrogen production capacity, the price of renewable energy, and the internal rate of return (IRR) are considered to be key factors that can significantly contribute to reducing the hydrogen sales price. EGAT is currently leading the re-evaluation of these elements to explore further optimisation. • A review of the value chain structure and brainstorming sessions are also being conducted jointly by all partners. • Once measures that contribute to economic improvement are identified, a further feasibility study (FS) can be performed.

	• At that time, we would also like to consider utilising available subsidy programs from the Government of Japan. In addition, we would highly appreciate it if the Government of Japan could also provide information on the hydrogen demand outlook, market growth prospects, and the activities of competing companies in the Thai market, particularly from studies or insights led by the Government of Japan.
Planned Demonstration Period	After 2030
Planned Business Agreement Period	Late 2020s
Planned Business Consideration/FID Period	Late 2020s
Planned Construction Period	Late 2020s
Planned Commercial Operation Start Period	Late 2020s
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	The Memorandum of Understanding on 'The Development of Clean Hydrogen/Ammonia Value Chain' is in the process of being extended for two years as it expires in March 2025.

MOU Relationship Diagram



Potential Project Scheme



MoU for Cooperation on Decarbonisation Projects with EGAT

IHI EGAT Power for Thai Happiness

Project Overview	To conduct a study for decarbonisation and energy transition in Thailand and EGAT using IHI's carbon solutions.
Responsible Entity	IHI Corporation EGAT(Electricity Generating Authority of Thailand)
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	As a result, this MOU was concluded concerning biomass production and co-firing. (> Item 150 'MOU between EGAT and IHI on collaboration for biomass fuel production and utilisation')

Saha Group Industrial Park, which has been selected as the target for the decarbonisation study using batteries.

MOU between EGAT and IHI on collaboration for biomass fuel production and utilisation

Project Overview	To conduct a study for production of biomass and CO_2 reduction plan through biomass combustion at the coal-fired power plant owned by EGAT.
Responsible Entity	IHI Corporation EGAT(Electricity Generating Authority of Thailand)
Progress Status as of March 2025	Continuing the MOU project
URL	https://www.ihi.co.jp/en/all_news/2024/resources_energy_environment/1200865_13691.html

Mae Moh Coal-Fired Power Plant, which is the subject of the biomass co-firing study.

MOU on Gas Turbine Hydrogen Co-firing Technology between EGAT and Mitsubishi Heavy Industries, Ltd.

Project Overview	To accelerate decarbonisation of energy in Thailand, EGAT, state-owned electricity company in Thailand, and Mitsubishi Heavy Industries, Ltd. commence discussions on study for introducing hydrogen co-firing technologies at power plants owned and operated by EGAT.
Responsible Entity	Mitsubishi Heavy Industries, Ltd. EGAT
Progress Status as of March 2025	A feasibility study using Gas Turbine Hydrogen Co-Firing Technology in power plant owned by EGAT has already begun in part, and discussions with EGAT are ongoing for further feasibility studies.
URL	https://www.mhi.com/news/24060502.html

Joint Study on the Development of Next-Generation Automotive Fuels by Mitsubishi Corporation, Tri Petch Isuzu Sales, and PTT

Project Overview	To contribute not only the EVs expansion but also the decarbonisation of domestically produced internal combustion engine (ICE) vehicles—which remain essential to Thailand's economic growth—Mitsubishi Corporation and TIS are actively promoting initiatives for the adoption of next-generation carbon-neutral (CN) fuels in Thailand. In December 2023, Mitsubishi Corporation, TIS, and PTT signed a comprehensive Memorandum of Understanding (MOU) to advance CN goals. Through activities aimed at commercialisation—such as demonstration trials using HVO-blended fuel made from waste oil (a non-edible resource)—the three companies are exploring ways to reduce carbon emissions from ICE vehicles.
Responsible Entity	Mitsubishi Corporation / Tri Petch Isuzu Sales (TIS) PTT Public Company Limited (PTT)
Project Goals/KPI	Through the demonstration trials using alternative fuels: • To assess the impact on the driving performance and functionality of existing ICE vehicles • To verify the contribution to decarbonisation • To identify challenges toward the adoption of alternative fuels
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	A road test was conducted using existing TIS (Isuzu) customer vehicles, fueled with a blend of 30% HVO (derived from waste oil produced in Thailand) and 70% diesel fuel (B7). After approximately 20,000 kilometers of driving, no technical issues were observed, and fuel efficiency was confirmed to be on par with that of 100% B7.
Planned Demonstration Period	2024–2025
URL	https://www.tripetchgroup.com/en/news/hvo

Summary:
In December 2023, Mitsubishi Corporation, TIS, and PTT signed a comprehensive MOU to promote CN initiatives through road trials using HVO-blended fuel derived from waste oil and exploratory activities related to e-fuels, aiming to reduce carbon emissions from ICE vehicles.

Purpose/Goals:
Through the demonstration trials using alternative fuels:
- To assess the impact on the driving performance and functionality of existing ICE vehicles
- To verify the contribution to decarbonisation
- To identify challenges toward the adoption of alternative fuels

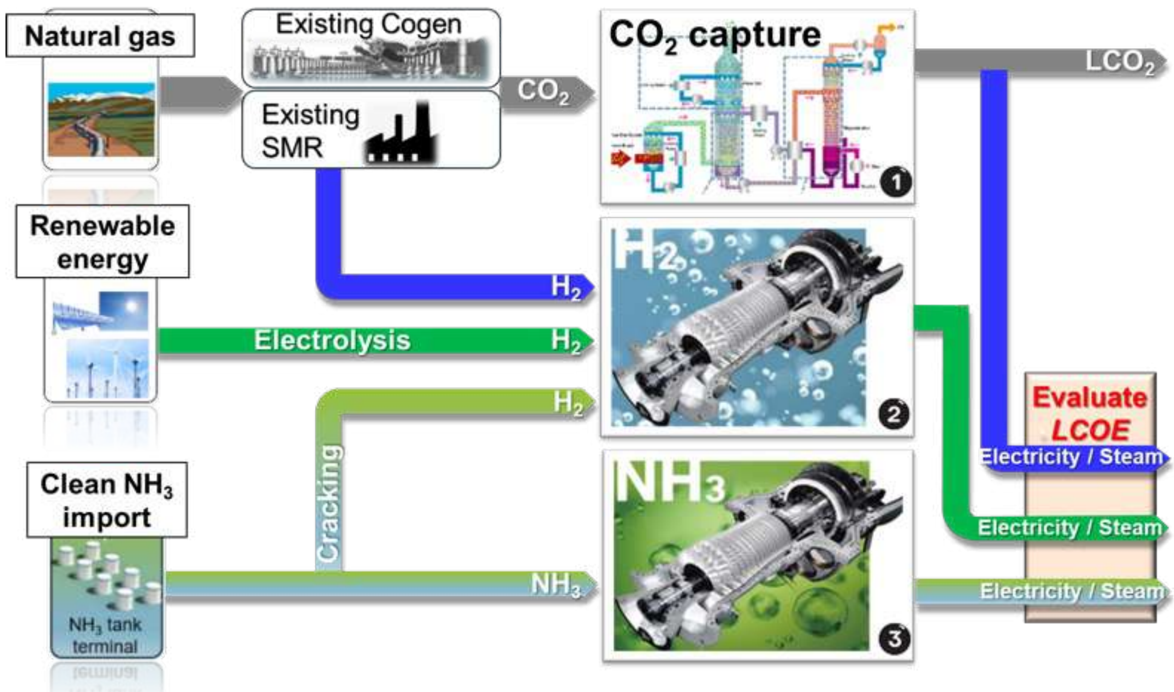

ptt Group
TRI PETCH GROUP
Mitsubishi Corporation


残油活用による
HVO開発
次世代燃料
検討
活用
実車走行

MOU for the utilisation of hydrogen, ammonia and CCS to de-carbonise petrochemical plant in Thailand

Project Overview	PTT Global Chemical(GC) and Mitsubishi Heavy Industries Asia Pacific(MHI-AP) signed MoU to utilise hydrogen, ammonia and CCS to de-carbonise GC's existing petrochemical plant in Thailand. Joint study to compare the economy of using hydrogen and ammonia as fuels for gas turbines, as well as CCS.
Responsible Entity	Mitsubishi Heavy Industries PTT Global Chemical

Comparative study to utilise H_2, NH_3, CCS



Zeroboard /Banpu NEXT MOU

Project Overview	Cooperation outline: Zeroboard, provider of a cloud service for calculating and visualising GHG emissions, has formed a business alliance with Banpu NEXT, a smart energy solutions provider under Banpu group. Purpose or objectives of MOU: The collaboration will involve Banpu NEXT's clients in calculating and visualising their GHG emissions using Zeroboard, and then taking action to further reduce their emissions. The two companies will co-create innovations including GHG emission reduction solutions such as solar projects, and EV charging, EV fleet management with both companies to expand their decarbonisation management services.
Responsible Entity	Zeroboard Inc. (e.g.) Banpu NEXT Co., Ltd.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Collaborated with BanpuNEXT in multiple seminars and engaged with potential customers.
URL	https://zeroboard.jp/ https://banpunext.co.th/th/

Zeroboard / FDI Group MOU

Project Overview	Cooperation outline: Zeroboard, provider of a cloud service for calculating and visualizing GHG emissions, has formed a business alliance with FDI group, which provides ESG consulting service to companies. Purpose or objectives of MOU: Zeroboard will support the calculation, disclosure and reduction of GHG emissions with the cloud service, while FDI will provide decarbonisation consulting services to meet the diverse needs of customers in Thailand.
Responsible Entity	Zeroboard Inc. (e.g.) FDI Group (Thailand)
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	Collaborated with FDI to support multiple customers in Thailand.
URL	https://zeroboard.jp/ https://fdi.co.th/th/

Zeroboard (Japan)/Innopower (Thailand) MoU

Project Overview	Cooperation outline: Zeroboard, provider of a cloud service for calculating and visualising GHG emissions, has formed a business alliance with Innopower, an energy innovation and technology company under EGAT (Electricity Generating Authority of Thailand). Purpose or objectives of MOU: The collaboration will involve INNOPOWER's clients in calculating and visualising their GHG emissions using Zeroboard, and then taking action to further reduce their emissions. The two companies will co-create innovations including GHG emission reduction solutions such as trading of renewable energy certificates (I-RECs), solar projects, and electric vehicle (EV) fleets with both companies to expand their decarbonisation management services.
Responsible Entity	Zeroboard Inc. (e.g.) INNOPOWER
Project Goals/KPI	Promote and distribute the services of both parties to potential customers in Thailand, ranging from small and medium-sized enterprises (SMEs) to large corporations.
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	Capable of reaching over 100 small and medium-sized enterprises (SMEs), as well as several large corporations.
URL	https://www.zeroboard.jp/news/1889

Zeroboard (Japan)/SENA Development (Thailand) MoU

Project Overview	Cooperation outline: Zeroboard, provider of a cloud service for calculating and visualizing GHG emissions, has formed a business alliance with SENA, a property developer and provider of decarbonisation technologies in Thailand. Purpose or objectives of MOU: SENA implements Zeroboard to calculate the GHG emissions of its own organisation and buildings to promote decarbonisation. In time, SENA will introduce Zeroboard to their supply chain companies. Providing comprehensive decarbonisation support to Thai companies, including actions to reduce emissions.
Responsible Entity	Zeroboard Inc. (e.g.) SENA Development (Thailand)
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	Zeroboard has provided support to SENA in calculating its greenhouse gas (GHG) emissions.
URL	https://zeroboard.jp/ https://www.sena.co.th/en

Zeroboard(Japan) / Summit Auto Body Industry Co., Ltd. (Thailand) MOU

Project Overview	Cooperation outline: Zeroboard has signed an MOU with Summit Group, Thailand's largest auto parts manufacturer, to support decarbonisation management. Through this collaboration, both companies support Summit Group's supply chain partners to calculate and visualise their GHG emissions using cloud services, and then take action to reduce their emissions. Purpose or objectives of MOU: As a leading manufacturing company in Thailand, Summit Group will maximise Zeroboard's knowledge and expertise in decarbonisation to provide decarbonisation support to its supply chain partners and help strengthen the international competitiveness of the Thai manufacturing industry.
Responsible Entity	Zeroboard Inc. (e.g.) Summit Group (Thailand)
Progress Status as of March 2025	Continuing the MOU project
URL	https://zeroboard.jp/ http://summitautobody.co.th/

Memorandum of Understanding on Collaboration between Zeroboard (Japan) and TPA (Thailand)

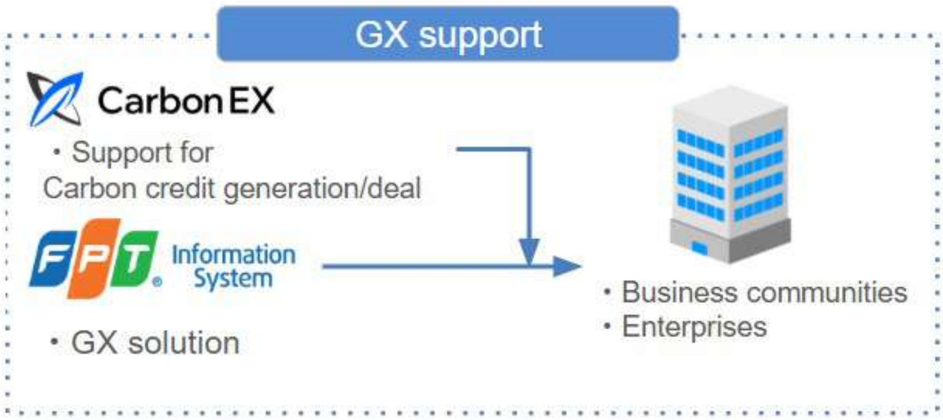
Project Overview	Cooperation outline: Zeroboard Signs MOU with TPA (Technology Promotion Association (Thailand-Japan)) for Decarbonisation in Thailand. With the conclusion of this MOU, the two organisations will expand their support for decarbonisation management by leveraging TPA's member network throughout Thailand, especially in the manufacturing industry. Purpose or objectives of MOU: TPA will hold events and seminars for its member companies and promote the introduction of the Zeroboard service. Through the provision of 'Zeroboard', we support TPA and TPA member companies to calculate and visualise their GHG emissions and support them in taking action to reduce their emissions.
Responsible Entity	Zeroboard Inc. (e.g.) TPA (Thailand)
Progress Status as of March 2025	Continuing the MOU project
URL	https://zeroboard.jp/ https://www.tpa.or.th/

Zeroboard (Japan)/THS Innovations (Thailand) MoU

Project Overview	Cooperation outline: Zeroboard has partnered with THS Innovations, a company that provides energy-saving and decarbonisation solutions for factories and other buildings. Purpose or objectives of MOU: Leveraging the networks and solutions of both companies, both companies will expand their support for decarbonisation management not only to Japanese companies in Thailand, but also to Thai companies. Zeroboard will support the visualisation of GHG emissions, while THS Innovations will provide energy management solutions that lead to decarbonisation, aiming to meet a wide range of customer needs.
Responsible Entity	Zeroboard Inc. (e.g.) THS Innovations (Thailand)
Progress Status as of March 2025	Continuing the MOU project
URL	https://zeroboard.jp/ https://www.teohong.com/

MOU on Partnership for Carbon Credit Business Development in Viet Nam

Project Overview	Memorandum of Understanding between FPT Vietnam and Carbon EX for partnership in the supply and sale of carbon credits.
Responsible Entity	Carbon EX FPT



MOU amongst erex Co., Ltd., Tuyen Quang Province for Cooperation in Biomass Fuel Developments MOU amongst erex Co., Ltd., Tuyen Quang Province for Cooperation in Biomass Fuel Developments

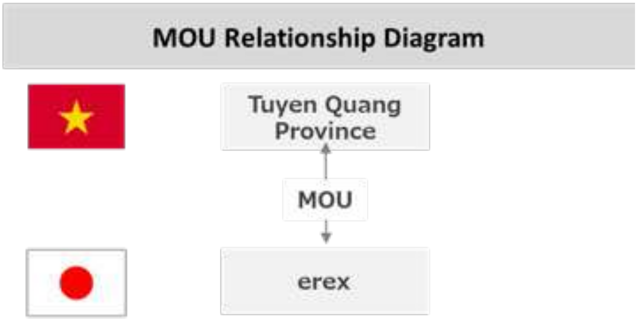
Project Overview	The MOU confirms mutual cooperation to develop biomass fuels in existing in Tuyen Quang provinces in Viet Nam and to realise projects to utilise unused resources from agriculture and forestry
Responsible Entity	erex Co.,Ltd Tuyen Quang Province,Viet nam
Progress Status as of March 2025	The MOU project is completed and has progressed to the next phase (e.g., demonstration)
Progress Overview	Pellet plant completed and production of FSC-certified wood pellets begins.

The following surveys and researches will be conducted by Tuyen Quang province and erex

(1) Surveys to attract investments in the biomass sector

(2) Research on sustainable supply of biomass resources in Tuyen Quang province

(3) Survey on wood pellet plant investment feasibility in Tuyen Quang province



*Surveys and researches listed on the left will be conducted with Tuyen Quang Province

MOU amongst erex Co., Ltd., Tuyen Quang Province, and Yen Bai Province for Cooperation in Biomass Fuel Developments

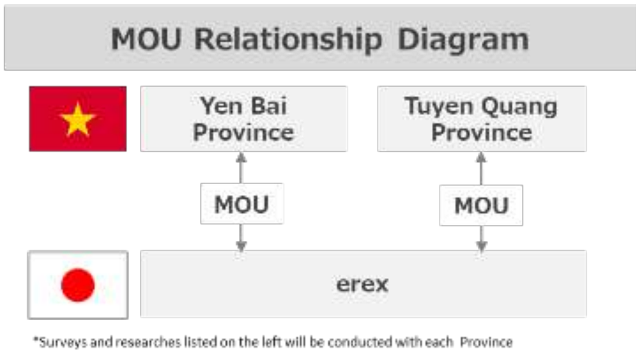
Project Overview	The MOU confirms mutual cooperation to develop biomass fuels in existing in Tuyen Quang and Yen Bai provinces in Viet Nam and to realise projects to utilise unused resources from agriculture and forestry
Responsible Entity	erex Co.,Ltd
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Tuyen Quang province: Pellet plant completed and production of FSC-certified wood pellets begins. Yen Bai Province: In conjunction with the development of biomass fuels, the company is considering where to sell the products from the wood pellet mill.

The following surveys and researches will be conducted by Tuyen Quang province and erex

(1) Surveys to attract investments in the biomass sector

(2) Research on sustainable supply of biomass resources in each province

(3) Survey on wood pellet plant investment feasibility in each province

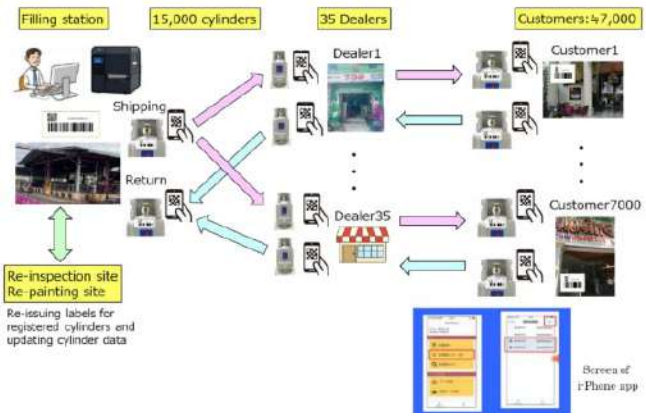


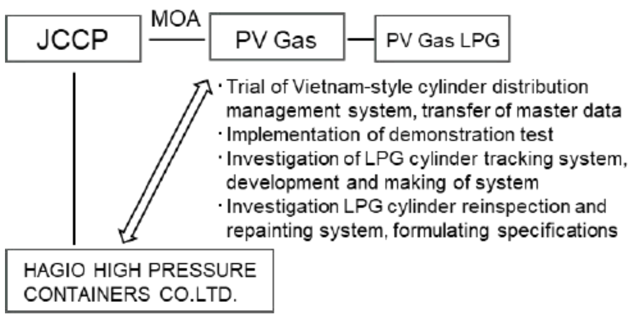
Improving the Capacity of LPG Cylinder Distribution Management in Viet Nam by using barcode labels

Project Overview	This project considers the applicability of Japanese-style barcode-based individual LPG cylinder management and distribution management system and develops it. We verify its effectiveness in preventing loss/theft of LPG cylinders, safety and asset management.
Responsible Entity	HAGIO HIGH PRESSURE CONTAINERS CO.LTD. PetroVietnam Gas Joint Stock Corporation (PV Gas) PetroVietnam LPG Joint Stock Company (PV Gas LPG)
Project Scale (US$)	Japan's contribution from FY2023 to FY2025: US$391,200 (Exchange Rate 154 yen/US$)
Production Scale	2.5 million tonnes (Year 2023) 2.6 million tonnes (Year 2024)
Project Goals/KPI	Carrying out a research of the current status of LPG cylinder distribution in Viet Nam, development of system environment for the introduction and popularisation of a Vietnamese-style cylinder distribution management system using barcodes, implementation of demonstration tests, and improvement of the effectiveness of the LPG cylinder distribution management system through technology transfer etc, verification of the effectiveness of the system and consideration of full-scale introduction in the future.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	• After implementing and trial testing of the Vietnamese-style cylinder distribution management system, demonstration test was implemented at three dealers and their customers to confirm the system's effectiveness. • Conducting research, formulating specification, system development and production, and trial testing on a cylinder tracking system that detects cylinders with abnormal activities as fraudulent cylinders. • While researching and implementing 'the cylinder reinspection and repainting system', the actual situation regarding cylinder reinspection and repainting was grasped, and the sorting and transportation of LPG cylinders at filling stations and the actual situation from receipt of LPG cylinders at reinspection and repainting stations to shipment were also assessed.
Planned Demonstration Period	July 2024 ~ February 2026

Planned Period for Signing MOU or Similar Agreements (until around October 2025)	Concluded August 8, 2024
URL	https://www.jccp.or.jp/country/docs/T12%28VN%29PVGasMOA_20230830_jp.pdf

The delivery of LPG cylinders to customers can be optimised by scanning the barcode on LPG cylinder between the LPG filling stations, dealers, and customers, by understanding the inventory period and cylinder turnover.
Theft or loss of LPG cylinders at the distribution stage can be detected from barcode management and expected cycles during the distribution route.
This project conducts a research of the current status of LPG cylinder distribution in Viet Nam, preparation and implementation of demonstration tests for the introduction and dissemination of a Vietnam-style LPG cylinder distribution management system using barcodes, and verification of effectiveness through technology transfer of LPG cylinder distribution management system.
Therefore, full-scale introduction will be considered in the future after the verification.





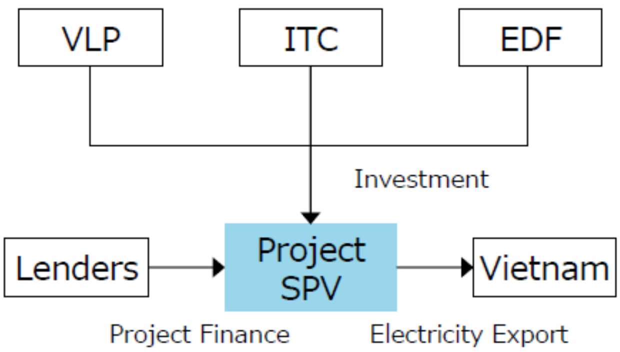
Three Parties' Joint Feasibility Study for FPV Project in Lao PDR

Project Overview	**MOU outline:** Viet Lao Power JSC (VLP), ITOCHU Corporation (ITC), and Electricite De France SA (EDF) to conduct a feasibility study for a floating solar PV (FPV) project on the reservoir of existing Xekaman 1 Hydro Power Plant that VLP owns and operates in Lao PDR. **Objectives:** Viet Nam to expand electricity import from Lao PDR according to the national power development plan (PDP8). By installing the FPV, three parties to contribute to energy transition and electricity stability for Viet Nam.
Responsible Entity	ITOCHU Corporation Viet Lao Power JSC (VLP) Electricite De France SA (EDF)
Project Goals/KPI	To achieve FID based on the result of the feasibility study, and eventually construct the power plant in Lao PDR to export the electricity generated to Viet Nam.
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	Based on the result of the feasibility study, the parties are currently discussing how to proceed with the project, given that there is no existing legal framework between Viet Nam and Lao PDR for the import electricity price of solar power.

<Project Site>

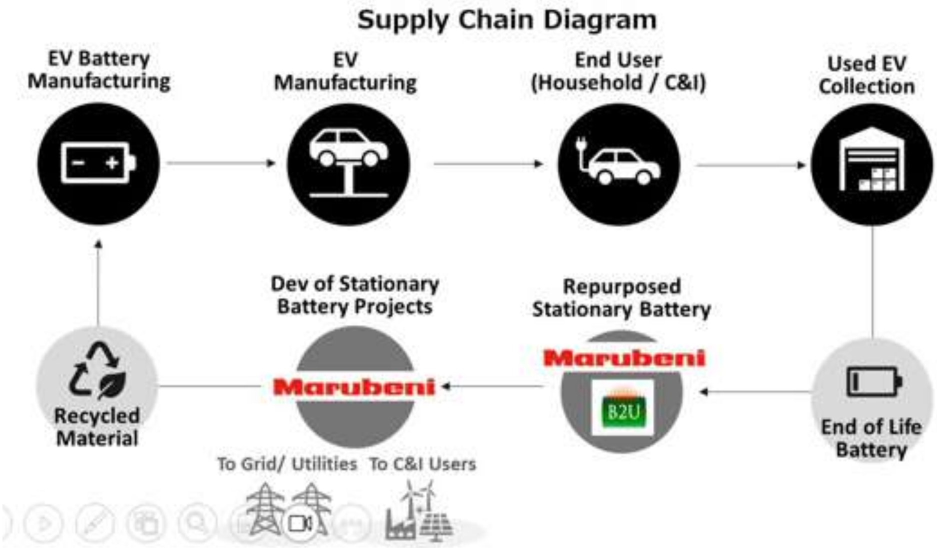
Xekaman 1 HPP (290MW)

<Expected Project Scheme>



Marubeni-Vin Fast Collaboration to Repurpose Used EV Batterzes in Circular Economy

Project Overview	Collaborate in Viet Nam on a demonstration project to repurpose used batteries from VINFAT EVs as stationary battery energy storage systems (BESS), creating businesses that promote circular economy model building. For BESS conversion, technology from B2U (USA), a company Marubeni has invested in, will be utilised.
Responsible Entity	Marubeni Corporation VINFAST
Project Scale (US$)	US$ 2-5 million (demonstration phase)
Project Goals/KPI	Manufacture BESS from reused EV batteries Safe and stable operation of BESS Development of business plans based on circular economy when the time comes
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	- Marubeni and VINFAST are developing critical information for business planning, such as forecasts for used EV battery collection and costing. - After formulating economically reasonable business plans, it will proceed to technical verification of used EV batteries and demonstration project.
Other Milestones	NA
Planned Demonstration Period	Year 2026 ~ 2027
Planned Business Agreement Period	Year 2027
Planned Business Consideration/FID Period	Year 2027
Planned Construction Period	Six months
URL	https://www.marubeni.com/en/news/2023/release/00123.html


Supply Chain Diagram
EV Battery Manufacturing
EV Manufacturing
End User (Household / C&I)
Used EV Collection
Dev of Stationary Battery Projects
Repurposed Stationary Battery
Marubeni
Marubeni
B2U
Recycled Material
End of Life Battery
To Grid/ Utilities
To C&I Users

Corporation for LNG to Power Project

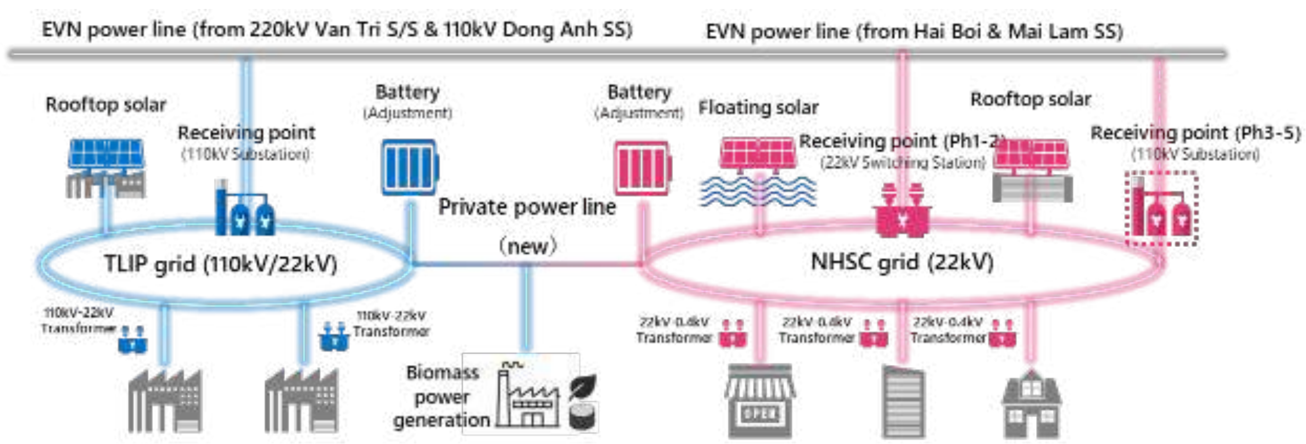
Project Overview	In order to develop new power projects that contribute to the achievement of energy transition of Viet Nam, PV Gas and Sumitomo Corporation will jointly study the feasibility of a potential LNG to Power Project in Khanh Hoa Province under the framework of the MOU.
Responsible Entity	Sumitomo Corporation Petro Vietnam Gas Joint Stock Corporation (PV GAS)
Project Scale (US$)	Up to US$ 2 billion
Production Scale	TBD
Project Goals/KPI	The registration of the LNG to Power Project covered by this MOU, which can contribute to the achievement of energy transition of Viet Nam, in the National Power Development Plan (PDP) and implementation of this Project.
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	This Project was listed the stand-by list of the LNG to Power Project of the updated PDP 8 plus published in April 2025, which was the updated version of PDP 8 and its implementation plan published in May 2023 and in April 2024 respectively. While SC continues the lobbying activity to promote the Project to the active list, Partner's motivation of the development of this Project gets less than the one when entering the MOU. Practically SC continues -also based on the MOU with Khanh Hoa Province listed as No.167 in this list- the lobbying activity solely by SC. The subjected MOU will be terminated in December 2025.
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	As listed as No. 167 in this list, SC have entered the MOU with Khanh Hoa Province in December 2025 which states that, through developing the subjected LNG to Power Project (Van Phong 2 Project), SC and Khanh Hoa Province collaborate to promote the energy security/transition in the Khanh Hoa province, and accordingly to promote the foreign investment activities in the province. Under this collaboration, SC are pursuing the opportunity of the development of LNG to Power Project in Khanh Hoa Province.


Project Site


Existing Power
Expected
LNG to Power Plant

Cooperation project for decarbonisation through Energy Management between Thang Long Industrial Park and North Hanoi Smart City

Project Overview	To promote decarbonisation in industrial parks & townships through various measures: (a) by expanding renewable energy supply in TLIP, where Japanese manufacturers are concentrated and in NHSC, which is being developed as a Japan-Viet Nam flagship project; (b) by implementing broad energy management between the two projects and (c) by introducing energy-saving solutions.
Responsible Entity	Sumitomo Corporation Thang Long Industrial Park Corporation (TLIP) North Hanoi Smart City Development Investment Joint Stock Company (NHSC) BRG Group
Project Goals/KPI	1. To expand and introduce renewable energy such as rooftop solar, floating solar and biomass power plant 2. To connect TLIP and NHSC with private line to conduct mutual energy management 3. To promote energy-saving by utilising highly energy-efficient equipment (heat-pump water heater/air conditioning etc.) and green construction material
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	TLIP has installed 33MWp of rooftop solar as of April 2025. For further expansion of other renewable energy, with the support from the Japanese government, the discussion with the Vietnamese authorities for clarification of relevant regulations is ongoing.



Corporation for promotion of foreign investment in Khanh Hoa Province including LNG to Power Project

Project Overview	Khanh Hoa People's Committee and Sumitomo Corporation will collaborate to expand investment activities in Khanh Hoa Province especially from Japan. The investment activities include energy sector (Van Phong 2 LNG to Power Project) to accelerate energy transition in Viet Nam
Responsible Entity	Sumitomo Corporation Khanh Hoa People's Committee, Viet Nam
Project Scale (US$)	Up to US$ 2 billion
Project Goals/KPI	The registration of the LNG to Power Project covered by this MOU, which can contribute to the achievement of energy transition of Viet Nam, in the National Power Development Plan (PDP) and implementation of this Project.
Progress Status as of March 2025	Implementing the MOU project but facing challenges, causing delays compared to the initial plan
Progress Overview	This Project was listed the stand-by list of the LNG to Power Project of the updated PDP 8 plus published in April 2025, which was the updated version of PDP 8 and its implementation plan published in May 2023 and in April 2024 respectively. SC continues the lobbying activity to promote the Project to the active list.

<Site Location>

<Project Site>

MOU for business development to realise a Carbon Neutral Society

TEPCO EVN

Project Overview	TEPCO and Vietnam Electricity ('EVN') signed the MOU, which intends to foster better business operations, with a view to future joint business development. Specifically, both parties will cooperate in a wide range of areas, including carbon neutrality initiatives and power system optimisation, such as improving the efficiency of power transmission and distribution networks.
Responsible Entity	Tokyo Electric Power Company Holdings (TEPCO) Vietnam Electricity
Project Goals/KPI	TEPCO and EVN have been sharing information through mutual exchanges for years, and now want to go beyond the conventional framework and consider joint business development. With this MOU, both parties will strengthen their cooperation, aim to cooperate with each other in anticipation of future system reforms such as electricity deregulation and contribute to the realisation of a carbon neutral society in Viet Nam.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Since March 2024, multiple discussions have been held with the International Relation Department, Development Strategy Department, Business Department, and Technical & Operational Department to identify specific areas of interest with a view toward future joint business development. As distributed energy sources such as solar power and storage batteries continue to spread in Viet Nam, discussions have also taken place on concrete measures within the power system, including the design of systems like electricity tariffs system and DPPA. We continue to engage in two-way communication through workshops/seminars with management-level participants.
Other Milestones	By continuing two-way communication throughout this year, we aim to identify areas of interest that contribute to the realisation of a carbon-neutral society, and to further specify and elaborate on potential themes and projects for collaboration.

MOU on Development of Nearshore Wind Power Project in Vinh Long Province by TTVN,TTP and Tokyo Gas

Project Overview	The nearshore wind power project in Vinh Long Province, with a total capacity of 48MW, which is registered under Power Development Plan 8.
Responsible Entity	Tokyo Gas Co.,Ltd. Truong Thanh Viet Nam Group (TTVN) Truong Thanh Energy (TTP)
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Under the investor selection process in Vinh Long Province.

Zeroboard (Japan) / New Land Vietnam Japan Long An (Vietnam) MOU

Project Overview	Cooperation outline: Zeroboard and NLVJLA (New Land Vietnam Japan Long An), a group company of Sojitz Corporation, have entered into a partnership to provide decarbonisation management support to their suppliers in the company's suppler chain. Purpose or objectives of MOU: By combining NLVJLA and Sojitz's network in Viet Nam with Zeroboard's expertise in GHG emissions calculation and reduction support, we aim to establish a model case for decarbonised management in the logistics industry by calculating and visualising not only NLVJLA's own GHG emissions but also those of the entire supply chain.
Responsible Entity	Zeroboard Inc. Sojitz Kokubu Logistics Solution LLC (SKLS)
Progress Status as of March 2025	Continuing the MOU project
URL	https://www.zeroboard.jp/news/4160

Projects supported by the Government of Japan (GoJ)

Among the projects supported by the Japanese government, approximately 100 projects will be introduced individually.

JBIC

The following are the projects supported by for which JBIC through provides financial tools support, such as loans, to contribute to aiming to promote decarbonization in the energy sector within across the AZEC region.

A Protocol of Cooperation (POC) supporting Collaboration with PT PLN in Clean Energy Sectors, between JBIC and National Power Company of Indonesia, PT PLN (Persero).

Project Overview	On August 19, 2024, JBIC signed the POC with PT PLN (Persero), a state-owned power company in Indonesia, to strengthen the partnership between the two organisations, on the sidelines of the AZEC Ministerial Meeting held in Jakarta, Indonesia.
Responsible Entity	Japan Bank for International Cooperation (JBIC) PLN

- The POC supplements the MOU signed between JBIC and PLN on November 15, 2022. It aims to strengthen collaboration between the two parties to realise projects that contribute toward reducing greenhouse gas emissions, including ones related to the development of renewable energy and electricity grids, energy efficient technologies, and green transportation. Under this POC, JBIC is expected to support the Indonesian power sector, thereby helping the decarbonisation of power sources procured by Japanese companies operating in the country.

Loan for Renewable energy projects in Indonesia (implemented by PT Pertamina (Persero))

Project Overview	Loan for Renewable energy projects in Indonesia (implemented by PT Pertamina (Persero)) (December 2022)
Responsible Entity	JBIC PT Pertamina (Persero)
Scale of Support (US$)	US$30 million
URL	https://www.jbic.go.jp/en/information/press/press-2022/1215-017136.html

Project Financing for Rantau Dedap Geothermal Power Project in Indonesia (implemented by PT Supreme Energy Rantau Dedap (SERD))

Project Overview	Project Financing for Rantau Dedap Geothermal Power Project in Indonesia (implemented by PT Supreme Energy Rantau Dedap (SERD)) (March 2018)
Responsible Entity	JBIC PT Supreme Energy Rantau Dedap (SERD)
Scale of Support (US$)	Approx. US$188 million
URL	https://www.jbic.go.jp/en/information/press/press-2017/0328-010746.html

Project Financing for Muara Laboh Geothermal Power Expansion Project in Indonesia (implemented by PT. Supreme Energy Muara Laboh (SEML))

Project Overview	Project Financing for Muara Laboh Geothermal Power Expansion Project in Indonesia (implemented by PT. Supreme Energy Muara Laboh (SEML)) (January 2025)
Responsible Entity	JBIC PT. Supreme Energy Muara Laboh
Scale of Support (US$)	US$138million
URL	https://www.jbic.go.jp/en/information/press/press-2024/press_00118.html

Project Financing for Rajamandala Hydro Power Plant Project in Indonesia (implemented by PT. Rajamandala Electric Power (REP))

Project Overview	Project Financing for Rajamandala Hydro Power Plant Project in Indonesia (implemented by PT. Rajamandala Electric Power (REP)) (June 2014)
Responsible Entity	JBIC PT. Rajamandala Electric Power (REP)
Scale of Support (US$)	Approx. US$66 million
URL	https://www.jbic.go.jp/en/information/press/press-2014/0625-22435.html

Project Financing and Political Risk Guarantee for Sarulla Geothermal Power Plant Project in Indonesia (implemented by Sarulla Operations LTD (SOL))

Project Overview	Project Financing and Political Risk Guarantee for Sarulla Geothermal Power Plant Project in Indonesia (implemented by Sarulla Operations LTD (SOL)) (March 2014)
Responsible Entity	JBIC Sarulla Operations LTD (SOL)
Scale of Support (US$)	Approx. US$492 million
URL	https://www.jbic.go.jp/en/information/press/press-2013/0331-19526.html

Loan for Production and Sale of Recycled Asphalt Mixture Carried Out by PT. SUGAWARA KOGYO in Indonesia

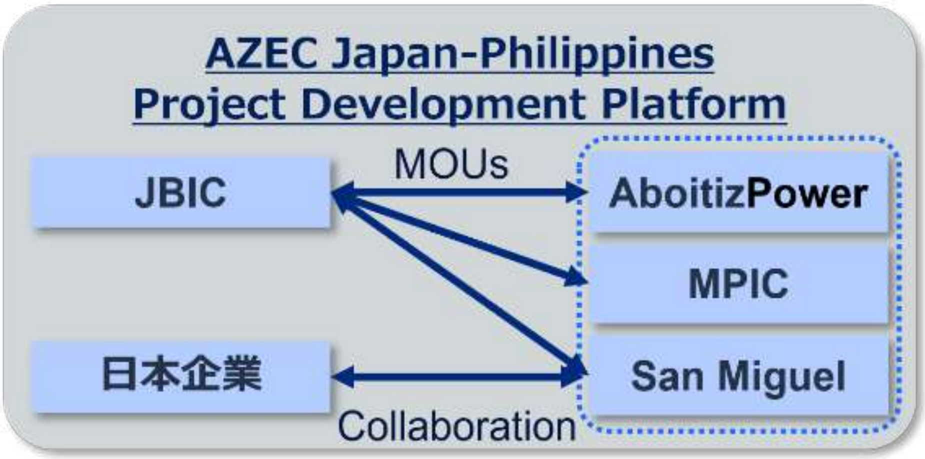
Project Overview	Loan for production and sale of recycled asphalt mixture carried out by PT. SUGAWARA KOGYO in Indonesia (December 2021)
Responsible Entity	JBIC PT. SUGAWARA KOGYO INDONESIA
Scale of Support	Rp13 billion
URL	https://www.jbic.go.jp/ja/information/press/press-2021/1213-015590.html

Loan and Project Financing for Nam Ngiep 1 Hydro Power Plant Project

Project Overview	Loan and Project Financing for Hydro Power Plant Project in Lao People's Democratic Republic (Lao PDR) (implemented by Nam Ngiep 1 Power Company Limited (NNP1)) (August 2014, September 2014) * NNP1 is a Laotian company invested in by The Kansai Electric Power Co., Inc., and other sponsors
Responsible Entity	JBIC MINISTRY OF FINANCE OF LAO P.D.R, Nam Ngiep 1 Power Company Limited
Scale of Support (US$)	US$234.5 million

AZEC Japan-Philippines Project Development Platform (PDP)

Project Overview	To promote AZEC in the Philippines, JBIC signed MOUs with Aboitiz Power, MPIC and San Miguel, major players in the power sector, to support collaboration between Japanese companies and the local conglomerates of the Philippines.
Responsible Entity	JBIC Aboitiz Power Corporation Metro Pacific Investments Corporation San Miguel Corporation
URL	https://www.jbic.go.jp/en/information/press/press-2023/press_00117.html https://www.jbic.go.jp/en/information/press/press-2023/press_00118.html https://www.jbic.go.jp/en/information/press/press-2023/press_00199.html



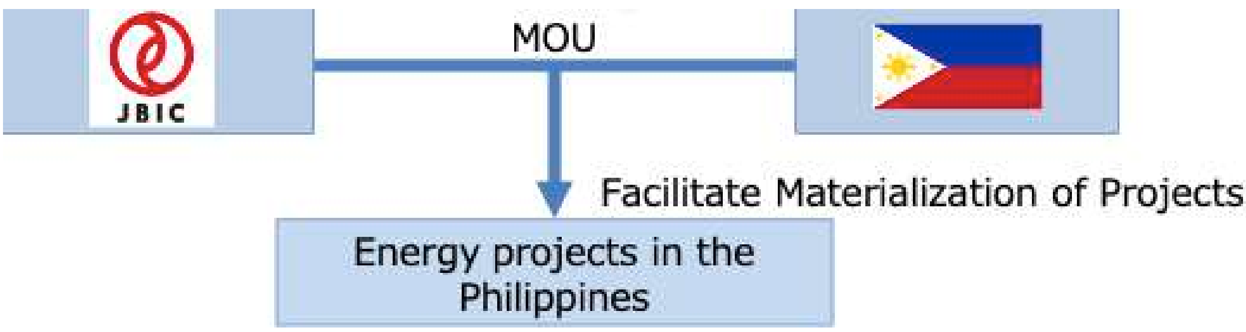
Loan for Share Acquisition of Aboitiz Power Corporation (JERA Co., Inc.)

Project Overview	Loan for Share Acquisition of Philippine Company Aboitiz Power Corporation by JERA Co., Inc. (December 2021)
Responsible Entity	JBIC Aboitiz Power Corporation
Scale of Support (US$)	US$ 630 million
URL	https://www.jbic.go.jp/en/information/press/press-2021/1227-015711.html

MOU with Government of the Philippines

Project Overview	JBIC will sign MOU with the Government of the Philippines, to enhance projects that involves Japanese business that helps the Philippines achieve just transition.
Responsible Entity	JBIC
Partner Company in the Counterparty Country	Government of the Philippines

Attainment of just transition requires significant financial resources. Through the MOU, JBIC aims to facilitate the materialisation of projects by Japanese companies in these areas through cooperation in actualisation of JBIC finance in the Philippines.



Loan for ESCO (Energy Service Company) Business (West Holdings Corporation)

Project Overview	Loan for ESCO (Energy Service Company) Business in Thailand by West Holdings Corporation (March 2020, June 2022)
Responsible Entity	JBIC WEST International (Thailand) Co., Ltd.
Scale of Support	THB 360 million
Progress Overview	Please refer to the URL.
URL	https://www.jbic.go.jp/en/information/press/press-2022/0621-016448.html https://www.jbic.go.jp/en/information/press/press-2019/0331-013328.html

GREEN Two Step Loan for VietinBank

Project Overview	Support for renewable energy projects through a two-step loan via VietinBank
Responsible Entity	JBIC Vietnam Joint Stock Commercial Bank for Industry and Trade
URL	https://www.jbic.go.jp/en/information/press/press-2023/press_00150.html

JBIC GREEN Two Step Loan to VPBank

Project Overview	JBIC established the credit line with Vietnam Prosperity Joint Stock Commercial Bank (VPBank) for supporting the development of the power transmission network being carried out by Vietnam National Grid Corporation (NPT), a subsidiary of Vietnam Electricity Company (EVN), state-owned power company.
Responsible Entity	Japan Bank for International Cooperation Vietnam Prosperity Joint Stock Commercial Bank
Project Scale (US$)	US$ 150 million

Loan for Biomass Fuel Manufacturing and Sales (erex Co., Ltd.)

Project Overview	Loan for Biomass Fuel Manufacturing and Sales Business in Viet Nam by erex Co., Ltd. (September 2023, October 2023)
Responsible Entity	JBIC erex Co., Ltd.
Scale of Support (US$)	US$ 16.6 million
Progress Overview	Please refer to the URL.
URL	https://www.jbic.go.jp/en/information/press/press-2023/press_00119.html https://www.jbic.go.jp/en/information/press/press-2023/press_00104.html

MOU for Vietcombank to finance renewable energy projects

Project Overview	MOU for Vietcombank to finance renewable energy projects in Viet Nam (June 2019, March 2023)
Responsible Entity	JBIC Joint Stock Commercial Bank for Foreign Trade of Vietnam
Scale of Support (US$)	US$ 265 million
Progress Overview	Please refer to the URL.
URL	https://www.jbic.go.jp/en/information/press/press-2022/0329-017547.html https://www.jbic.go.jp/en/information/press/press-2019/0626-012288.html

Loan for Rooftop Solar Power Generation Project at Thang Long Industrial Park II (Sumitomo Corporation)

Project Overview	Loan for Rooftop Solar Power Generation Project in Viet Nam by Sumitomo Corporation (March 2022)
Responsible Entity	JBIC Thang Long Industrial Park II Corporation
Scale of Support (US$)	US$ 8 million
Progress Overview	Please refer to the URL.
URL	https://www.jbic.go.jp/en/information/press/press-2021/0331-016132.html

Loan for Manufacturing and Sales of Solar Panel Sheet Glasses (Nippon Sheet Glass Company, Ltd.)

Project Overview	Loan for Manufacturing and Sales of Solar Panel Sheet Glasses in Viet Nam by Nippon Sheet Glass Company, Ltd. (August 2019)
Responsible Entity	JBIC NSG Vietnam Glass Industries, Ltd.
Scale of Support (US$)	US$ 54 million
Progress Overview	Please refer to the URL.
URL	https://www.jbic.go.jp/en/information/press/press-2019/0829-012484.html

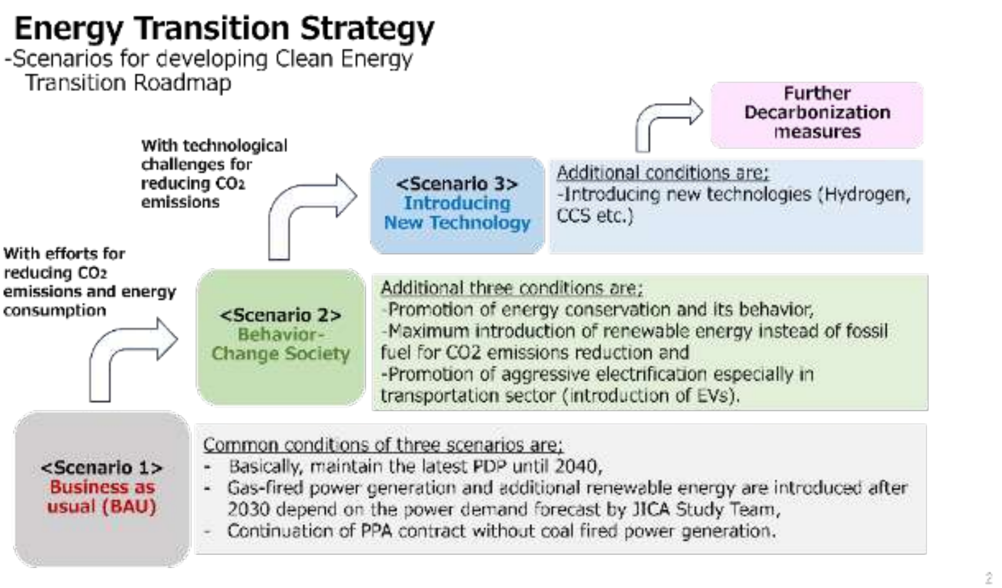
JICA

The followings are the projects for which JICA provides support in formulating decarbonization roadmaps and financing to contribute to decarbonization in the energy sector within the AZEC region.

Project for Development of Clean Energy Transition Roadmap towards Carbon Neutral Society

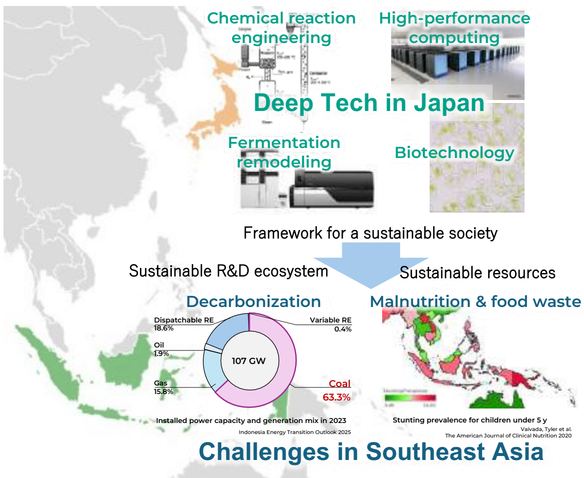
Project Overview	This project aims to develop an energy transition roadmap in Cambodia through the development of a medium- to long-term primary energy supply plan. This project will also support the capacity development required for identifying the policy measures, institutional framework, and investments needed to implement the roadmap, as well as the operationalisation of the necessary technologies. This project aims to achieve a clean, reliable, and economical energy transition toward a carbon-neutral society. Conducted multiple scenario analyses, including scenarios towards achieving carbon neutrality by the middle of the 21st century. Based on the scenarios obtained, we are currently considering a roadmap for achieving carbon neutrality.
Responsible Entity	JICA Ministry of Mines and Energy
Project Scale	¥220 million
Project Goals/KPI	Development of Clean Energy Transition Roadmap towards Carbon Neutral Society. Capacity development of those who implements the master plan.

The project is a bilateral technical cooperation.
Conceptual diagram for scenario study



The project for integrated sustainable energy and food production from microalgae-based carbon capture and utilisation

Project Overview	This project aims to establish a CCU infrastructure based on green fermentation technology and green hydrogen technology, and propose economically viable carbon cycle policies by implementing the following activities in Indonesia: (1) introduction of algae bioreactors, (2) establishment of green fermentation technology and expansion of green tempe business, (3) establishment of basic technology for hydrogen production using chemical looping technology, and (4) development of a co-firing model for biomass and hydrogen-based fuels at coal-fired power plants. thereby contributing to the realisation of a sustainable society in Indonesia and Southeast Asia from the perspectives of energy and food resources.
Responsible Entity	RIKEN Padjajaran University
Project Scale (US$)	US$3.5 million
Scale of Support (US$)	US$2.5 million
Project Goals/KPI	A technology integrating and developing the use of microalgae to capture carbon dioxide as a sustainable resource in Indonesia has been developed, providing a profitable scenario toward a carbon-neutral society. Indicators and target values: 1. At least 10 research papers will be published. 2. At least one review paper explaining the effectiveness of integrated algae-based CCU technology toward achieving a carbon-neutral society will be published. 3. CCU scenarios, policy briefs (recommendations) on health and agriculture, a roadmap for a hydrogen society based on green hydrogen technology, and policy briefs (recommendations) on low-carbon coal-fired power plants will be submitted to relevant authorities and stakeholders.
Progress Status as of March 2025	Over 15 papers, reviews and a policy work on Indonesia's hydrogen strategy, have been published. Continuing the MOU project
Progress Overview	Research is continuing in collaboration with RIKEN, Padjadjaran University, and other related institutions and companies.



MOU between JICA and PT PLN (Persero) for Capacity Building to promote Energy Transition in Indonesia

Project Overview	Both JICA and PLN confirm the importance of collaborative efforts on energy transition to achieve net zero target by 2060 in Indonesia. Particularly capacity building of PLN staffs is the key to enhance energy transition.
Responsible Entity	JICA PLN
Project Goals/KPI	To promote decarbonisation through the development of inter-island transmission lines using various business schemes, to achieve carbon neutrality in Indonesia
Progress Status as of March 2025	Continuing the MOU Project
Progress Overview	In close collaboration with PLN and BBSP, a pilot project has been selected. Feasibility studies are currently ongoing to explore the potential for project implementation.

Master Plan for Energy Management Project in Indonesia (PT PLN (Persero) and JICA)

Project Overview	It aims to strengthen the capacity of PLN to plan associated with energy transition toward carbon neutrality by 2060 in Indonesia, contributing to socio-economic development by providing stable, affordable and sustainable power supply.
Responsible Entity	JICA PLN

Memorandum of Cooperation between MEMR, BRIN, IFHE, and JICA for partnership towards promoting Hydrogen and Ammonia Development

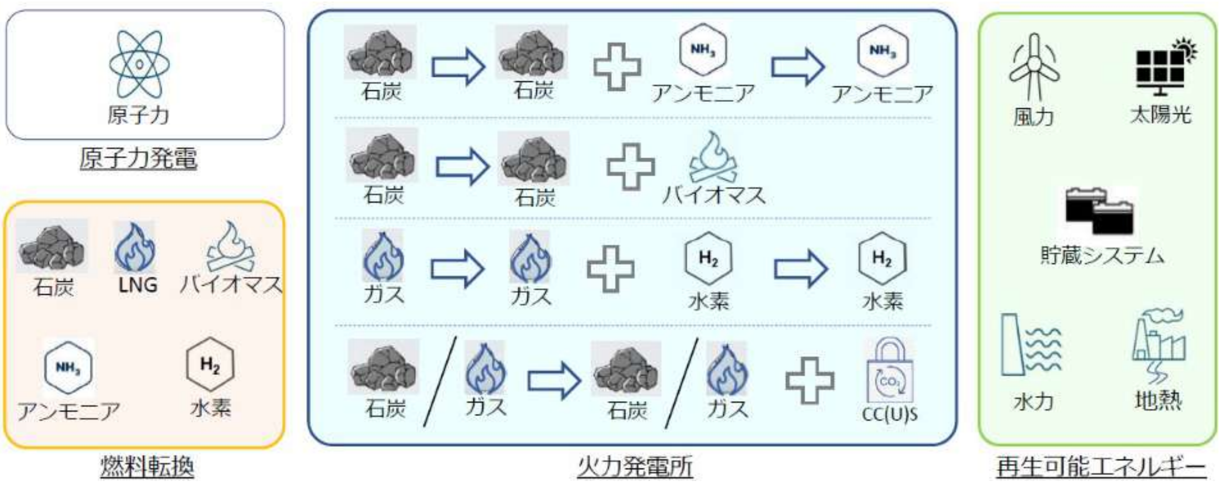
Project Overview	The Parties will strengthen their comprehensive cooperation. e.g. (i) Research and development of policies, regulatory framework and standards on new energy (hydrogen and ammonia), (ii) Public and private stakeholder engagements for both Indonesia and Japan, (iii) Knowledge and capacity development for the latest technologies and policies, (iv) Formulation of new program/project for financing necessary infrastructures to accelerate the market creation for new energy (hydrogen & ammonia).
Responsible Entity	JICA MEMR, BRIN, IFHE

Letter of Intent between Pertamina and JICA for partnership towards promoting energy transition in Indonesia

Project Overview	Through this collaboration, which plays an essential role in the energy transition, PERTAMINA and JICA contribute to Indonesia's goal of achieving net zero emissions by 2060. The partnership is expected to pave the way for numerous joint initiatives, driving forward the transition to renewable energy and enhancing the overall efficiency of energy projects.
Responsible Entity	JICA PT Pertamina

Master Plan for Energy Transition Management Project

Project Overview	To decarbonise existing and new thermal power plants in Indonesia while utilising multiple options according to the progress of technical development, site characteristics and grid system characteristics. This project also organise the basic concept as a master plan and proceed with the facility development along with the master plan.
Responsible Entity	JICA Perusahaan Listrik Negara Persero (PLN)
Project Scale (US$)	US$1.8 milion
Project Goals/KPI	Overall Goal To realise stable, reliable, affordable and sustainable power supply with achievement of the de-carbonisation by 2060 in Indonesia. Project Purpose To formulate the master plan especially for thermal power plants to achieve stable, reliable, affordable and sustainable power supply toward 2060.
Progress Status as of March 2025	Continuing the MOU Project
Progress Overview	Implementing research about energy demand forecasts, roadmaps for carbon neutrality, and making action plans in this project, and are in discussions with implementing agencies (PLN) toward the completion of the project in 2025.



Peusangan Hydroelectric Power Plant Construction Project (Phase II)

Project Overview	The objective of this project is to improve the power balance and stability in Aceh and North Sumatra by increasing the power-supply capacity of these areas. It will do so through the construction of a hydroelectric power plant and related transmission and distribution lines, thereby contributing to the economic development of the Northern Sumatra region, as well as to the rehabilitation and reconstruction of Aceh province. The project will also contribute to the reduction of the environmental burden by utilising renewable energy, and to the achievement of SDGs Goals 7 (Affordable and clean energy) and 13.
Responsible Entity	Japan International Cooperation Agency (JICA) PT PLN

Hululais Geothermal Power Plant Project

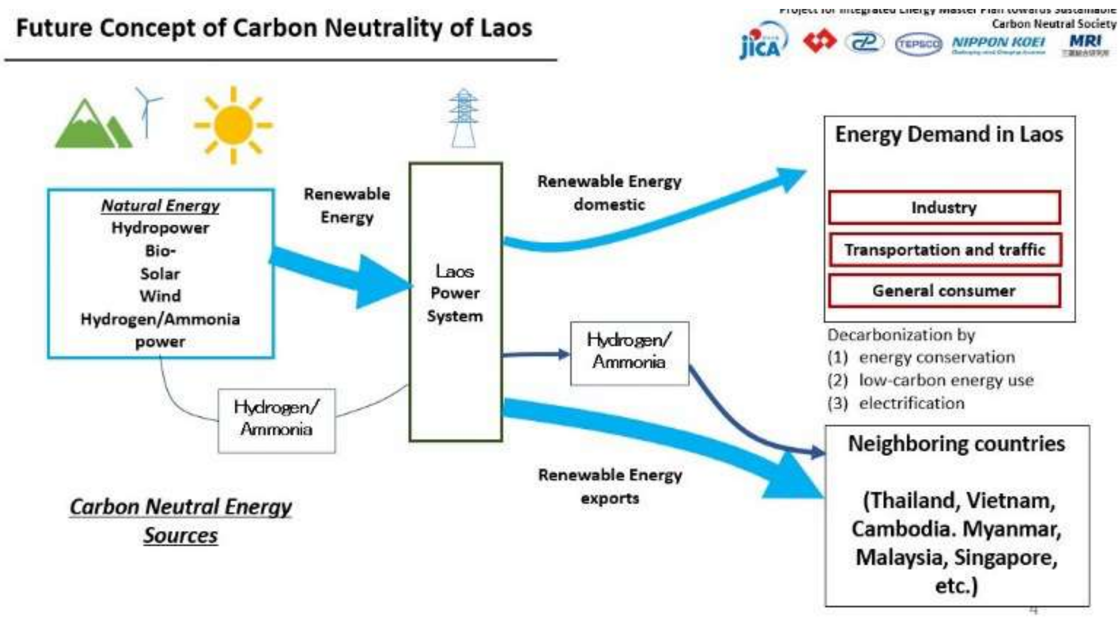
Project Overview	The objective of the project is to construct Hululais Geothermal Power Plant in Lebong District, Bengkulu Province, and connect it to the Sumatra grid to increase the power supply and improve the stability of the Sumatra grid. Through improving the living standards and investment environment in the Sumatra region, this project contributes to economic development and climate change mitigation.
Responsible Entity	JICA PLN

出典：Feasibility Study Report 2018 年 11 月

Project for Integrated Energy Master Plan towards Sustainable Carbon Neutral Society

Project Overview	A long-term energy transition masterplan for achieving a carbon-neutral society will be formulated, and the governmental institutions concerned will cooperate toward the same development goals.
Responsible Entity	JICA Ministry of Energy and Mines
Scale of Support	¥320 million
Project Goals/KPI	Outcome: A long-term energy transition master plan for achieving a carbon-neutral society is approved in Lao PDR and reflected in policy. Output: The master plan is formulated, and relevant agencies share goals to enable coordinated action.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Implementing research about energy demand forecasts and energy transition scenarios aimed at carbon neutrality and are currently in discussions with implementing agencies (MEM) toward the completion of the project in December 2025.

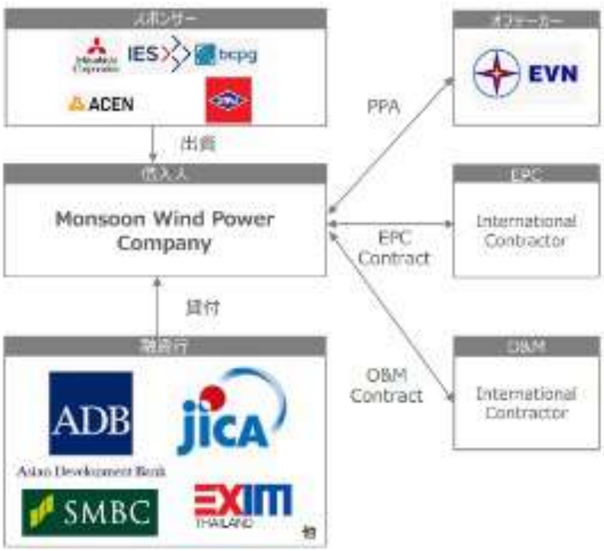
The project is a bilateral technical cooperation.



Monsoon Wind Farm Project

Project Overview	The Monsoon Project is a wind farm to be constructed in the south-east of Lao PDR that will dispatch power into Viet Nam. The Project capacity will be 600MW. The power is exported to Viet Nam.
Responsible Entity	Monsoon Wind Power Company Viet Nam Electricity
Project Scale (US$)	US$988.4 million
Scale of Support (US$)	US$120 million
Project Goals/KPI	Outcomes(operation and effects indicators) • Capacity factor(%) 29.2 % • Total maximum output (MW) 600 MW • Net electric energy production (GWh/year) 1,536 GWh/year • CO_2 emissions reductions (t/year) 757,741 t/year
Progress Status as of March 2025	Continuing the MOU project
Planned Construction Period	Start of construction: March 2023
Planned Commercial Operation Start Period	July 2025

Project scheme

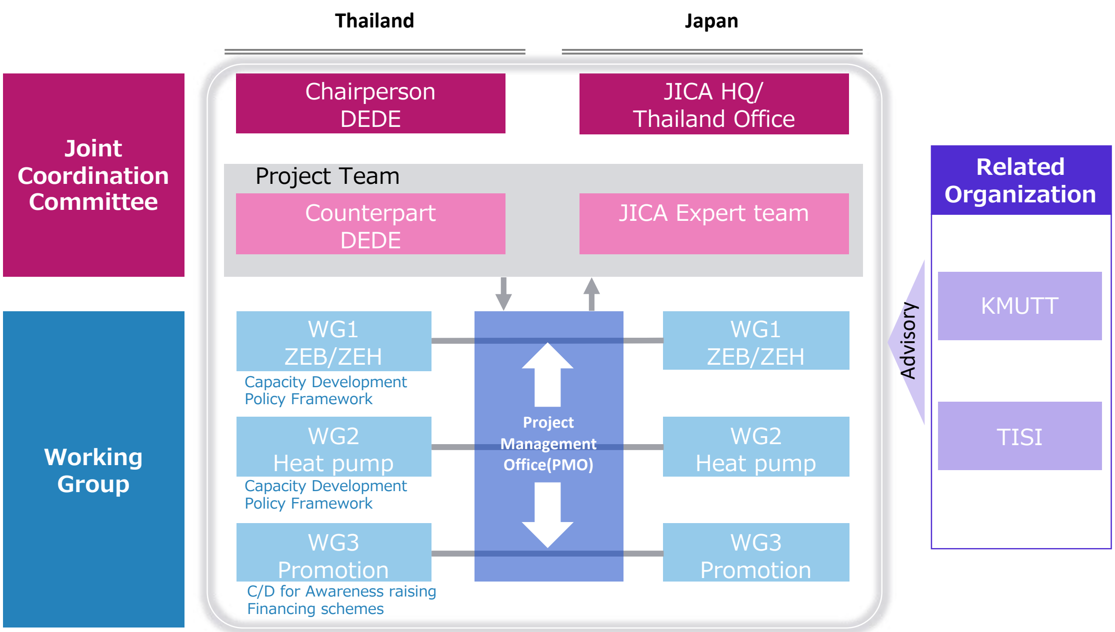


Photos

The Project for Promotion of Energy Efficiency by Introducing Zero Energy Building (ZEB) / Zero Energy House (ZEH) and Heat Pumps in Thailand

Pacific Consultants
กระทรวงพลังงาน MINISTRY OF ENERGY

Project Overview	This project aims to strengthen DEDE's implementation capacity for energy conservation promotion in Thailand through knowledge and technology transfer related to ZEB/ZEH and heat pump dissemination, as well as support for the examination of measures to promote these new measures. This will contribute to improving energy efficiency in the industrial, commercial, and residential sectors.
Responsible Entity	PACIFIC CONSULTANTS CO., LTD. DEDE (Department of Alternative Energy Development and Efficiency, Ministry of Energy)
Project Scale (US$)	Approximately ¥160 million (approximately US$1.1 million)
Project Goals/KPI	Project Objective: To enhance the capacity to implement and encourage energy conservation measures for the promotion of ZEB/ZEH and heat pumps. Indicators and Target Values: 1. A roadmap and guidelines for promotion of ZEB/ZEH will be made. 2. Basic knowledge and benefits of heat pump adoption will be recognised in the industrial and commercial sectors. 3. Energy efficiency standards for selecting efficient heat pumps will be established. 4. Mechanisms for the dissemination and funding of ZEB/ZEH and heat pumps will be proposed and drafted.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The first JCC meeting was held on 1 April. Projects are steadily progressing, including on-site training, training in Japan, and several workshops and seminars.



Ninh Thuan Province onshore wind power project

Project Overview	The onshore wind farm project in Ninh Thuan Province developed by BIM Wind Power Joint Stock Company, with a total capacity of 88 MW, being expected to help Viet Nam reach its clean energy and climate action targets.
Responsible Entity	BIM Wind Power Joint Stock Company BIM Group
Project Scale (US$)	US$ 100 million (Total debt finance package)
Scale of Support (US$)	US$ 25 million (JICA debt finance)
Production Scale	88 MW
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	commercial operation

Waste to Energy and Waste Treatment Project in Binh Duong Province

Project Overview	The objective of the project is to promote waste treatment helpful to the circular economy in Binh Duong Province, Viet Nam, through the construction and operation of a composting plant and a waste-to-energy incinerator, thereby contributing to improvement of urban environmental hygiene in the province and the southern region and their sustainable economic growth.
Responsible Entity	Binh Duong Water Environment Cooperation-Joint Stock Company
Scale of Support (USD)	US$ 7 million

Project site

JOGMEG

JOGMEC engages in cooperation and provides assistance for the following projects and activities, which contribute to decarbonization in the energy sector within the AZEC region.

MOU to contribute to Japanese investments towards projects on hydrogen, ammonia and CCS in the State of New South Wales, Australia

Project Overview	Cooperation to promote investment in New South Wales in oil and natural gas, hydrogen and ammonia, CCS, metals and coal, including the exchange of information and the formation of joint ventures related to resource development.
Responsible Entity	Japan Organization for Metals and Energy Security The State of New South Wales
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	JOGMEC held the Coal and Metals Resources Forum with NSW Government in December 2023.
URL	https://www.jogmec.go.jp/news/release/news_10_00156.html https://www.jogmec.go.jp/news/release/news_08_00035.html

Memorandum of Understanding signed by JOGMEC and Northern Territory Government

Project Overview	Cooperation in not only natural gas, CCS, hydrogen, and ammonia to ensure stable energy supply as well as to contribute to a decarbonised society
Responsible Entity	Japan Organization for Metals and Energy Security Northern Territory Government
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	JOGMEC and INPEX carry out joint research to assess the CO_2 storage potential in the Bonaparte Basin, aiming for GHG emissions reduction from an Australian LNG project.
URL	https://www.jogmec.go.jp/english/news/release/news_10_00071.html

Equity capital and Liability guarantee for Wheatstone LNG Project

JOGMEC

Project Overview	The Wheatstone LNG project is an LNG project in Ashburton North, Western Australia, Australia, operated by Chevron. Production began in 2017, and 5.2 million tonnes of LNG is being supplied to Japane se entities under long-term Sale and Purchase Agreements (SPAs).
Responsible Entity	Mitsubishi Corporation Nippon Yusen Kabushiki Kaisha JERA Co., Inc. Japan Organization for Metals and Energy Security Chevron KUFPEC Kyusyu Electric Woodside (LNG Plant only)
Production Scale	8.9 million tonnes per annum of LNG
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	LNG production is ongoing.
Planned Business Consideration/FID Period	FID was done.
Planned Construction Period	Construction was completed.
Planned Commercial Operation Start Period	Construction was completed.
URL	https://www.jogmec.go.jp/english/news/release/release0093.html https://www.jogmec.go.jp/english/news/release/news_06_000052.html

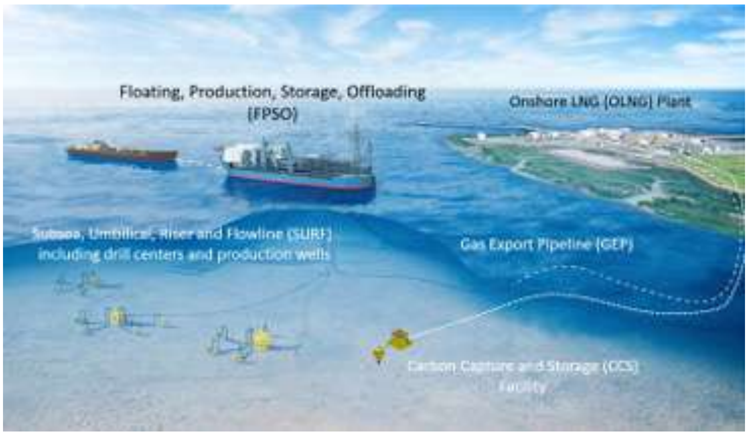
Project location map

MOU between PT Geo Dipa Energi (Persero) and Japan Organization for Metals and Energy Security

Project Overview	Building a cooperative relationship in the technical field of geothermal resource surveys and exploration in Indonesia.
Responsible Entity	Japan Organization for Metals and Energy Security PT Geo Dipa Energi (Persero)
Progress Status as of March 2025	Continuing the MOU Project
URL	https://www.jogmec.go.jp/news/release/news_10_00091.html https://www.jogmec.go.jp/english/news/release/news_08_00043.html

Equity Capital for Abadi LNG Project

Project Overview	Abadi LNG Project is a large-scale LNG project led by INPEX as operator. In this project, INPEX plans to neutralise the CO_2 emitted from natural gas production at the Abadi Gas Field through the introduction of CCS.
Responsible Entity	INPEX CORPORATION Japan Organization for Metals and Energy Security PT Pertamina Hulu Energi Masela PETRONAS Masela Sdn. Bhd.
Production Scale	The project is expected to produce approximately 9.5 million tonnes of LNG per year, up to 35,000 barrels of condensate per day and approximately 150 million cubic feet of natural gas per day.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Preparation work for FEED underway



Project concept image

Methane Emission Measurement and Quantification in Donggi-Matindok field and JOB Tomori field in Indonesia

Project Overview	In December 2023, JOGMEC and Pertamina signed a memorandum of understanding (MOU) to promote the cooperation on methane emission measurement and quantification from natural gas production facilities in Indonesia. Based on discussion under the MOU, Donggi Martindok gas field and JOB Tomori gas field have been selected targe field. JOGMEC, Pertamina, PEP, and JOB Tomori announced the conclusion of a four-party JSA at the side event of the Asia Zero Emission Community (AZEC) Ministerial Meeting held in Jakarta on August 21, 2024. This initiative aims to foster a cooperation of reducing methane emissions and implementing the project. JOGMEC, Pertamina, PEP and JOB Tomori develop the methane emission management plan and calculate the carbon intensity for the upstream of natural gas production.
Responsible Entity	JOGMEC Pertamina Pertamina EP JOB Tomori Indonesia
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	1st Measurement and Quantification activities are completed in 2024 and 2nd measurement and quantification is planning to arrange 2025. During Measurement and Quantification activities in 2024 , It is arranged as the Methane Leadership Program (MLP) 2.0 Workshop and site visits, bringing together industry experts to discuss and enhance methane emission measurement techniques. It is reinforced all ASEAN MLP members dedication to reducing methane emissions and adopting best practices in environmental stewardship. https://ascope.org/News/Detail/1184 https://ascope.org/Home/Detail/1121
Planned Demonstration Period	July–October 2025 (estimated)
URL	https://www.jogmec.go.jp/english/news/release/news_08_00016.html https://www.jogmec.go.jp/english/news/release/news_08_00009.html https://ascope.org/News/Detail/1184 https://ascope.org/Home/Detail/1121

Map of Donggi Martindok gas field and JOB Tomori gas field

Joint Study Agreement towards Implementing CO_2 Injection Field Test in Sukowati Field in Indonesia

Project Overview	This project aims to commercialise enhanced oil recovery (EOR) technology using carbon dioxide (CO_2) in the Sukowati oil field in East Java, Indonesia. The joint study includes a preliminary study for the implementation of a CO_2 injection field test.
Responsible Entity	Japan Organization for Metals and Energy Security Japan Petroleum Exploration Co., Ltd. PT Pertamina (Persero) PT Pertamina EP
Progress Status as of March 2025	The MOU project is completed and has progressed to the next phase (e.g., demonstration)
Progress Overview	The preliminary study, which included a feasibility study of the commercial implementation of CO_2-EOR as well as the implementation of a small-scale injection test, has been successfully completed. The project has advanced to the next phase: a larger-scale CO_2 injection field test.
Planned Demonstration Period	FY2024 (completed)
URL	https://www.jogmec.go.jp/english/news/release/news_10_00043.html https://www.jogmec.go.jp/english/news/release/news_10_00054.html

Joint Study Agreement on Inter-Well CO_2 Injection Field Test in Sukowati Field, Indonesia

JOGMEC JAPEX PERTAMINA

Project Overview	This project aims to commercialise enhanced oil recovery (EOR) technology using carbon dioxide (CO_2) in the Sukowati oil field in East Java, Indonesia. The joint study includes the implementation of an inter-well CO_2 injection field test in the field.
Responsible Entity	Japan Organization for Metals and Energy Security Japan Petroleum Exploration Co., Ltd. PT Pertamina (Persero) PT Pertamina EP
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The inter-well CO_2 injection field test has been successfully completed, and its post-evaluation and further study for commercialisation are undergoing.
Planned Demonstration Period	FY2024 (completed)
URL	https://www.jogmec.go.jp/english/news/release/news_10_00074.html https://www.jogmec.go.jp/english/news/release/news_10_00077.html

Equity capital and liability guarantee for Tangguh LNG Project

JOGMEC

Project Overview	Tangguh LNG, which currently has an annual LNG production capacity of 11.4 million tonnes, is located in Bintuni Bay in Indonesia's Papua Barat Province. The Tangguh LNG Project is operated by a consortium led by bp under a production-sharing contract with SKK Migas, Indonesia's upstream oil and gas regulator. In 2009, the first cargo of LNG has been lifted from the Tangguh LNG project. In 2023, the new liquefaction train (Train 3) of the Tangguh Expansion Project started commercial operation and first shipment of LNG produced by Train 3 safely sailed from the Tangguh site.
Responsible Entity	Mitsubishi Corporation INPEX CORPORATION ENEOS Xplora Inc. MITSUI & CO., LTD. LNG JAPAN CORPORATION Japan Organization for Metals and Energy Security BP Berau Ltd CNOOC Muturi Limited
Production Scale	An annual LNG production capacity of 11.4 million tonnes
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	In 2024, the joint venture partners of the Tangguh LNG Project reached a Final Investment Decision (FID) on the Tangguh Ubadari, CCUS, Compression (UCC) Project. The project features Indonesia's first at-scale Enhanced-Gas-Recovery (EGR) through CCUS, which will contribute to the deployment of CCUS technology in the country.
Other Milestones	The Tangguh Ubadari, CCUS, Compression (UCC) Project is expected to begin operation and production in stages from 2028.
URL	https://www.jogmec.go.jp/english/news/release/release0026.html https://www.jogmec.go.jp/english/news/release/news_10_00049.html https://www.jogmec.go.jp/english/news/release/news_08_00027.html

Project picture (Source: bp Indonesia)

Project location map

Memorandum of Cooperation (MOC) between Petroliam Nasional Berhad and Japan Organization for Metals and Energy Security

Project Overview	Discussion and joint study to formulate and promote projects related to hydrogen/fuel ammonia, CCS, and GHG emissions management.
Responsible Entity	Japan Organization for Metals and Energy Security PETRONAS
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Some projects are ongoing in the areas of carbon capture and storage as well as GHG emissions management in energy supply chain.
URL	https://www.jogmec.go.jp/english/news/release/news_10_00027.html

MOC on Cross Border Transportation of Carbon Dioxide between PETRONAS, METI, and JOGMEC

Project Overview	The Memorandum of Cooperation (MOC) was signed between PETRONAS, METI, and JOGMEC in September 2023 to promote discussions on the cross-border CO_2 transportation and storage between Malaysia and Japan, which would contribute to the reduction of greenhouse gas emissions.
Responsible Entity	Ministry of Economy, Trade and Industry (METI) Japan Organization for Metals and Energy Security (JOGMEC) Petroliam Nasional Berhad (PETRONAS)
Progress Status as of March 2025	Continuing the MOU project
URL	https://www.jogmec.go.jp/english/news/release/news_10_00048.html

Collaborative activities on CCS under the MOU between PETROVIETNAM and Japan Organization for Metals and Energy Security

Project Overview	This project aims to support the launch of Viet Nam's first CCS project in the 2030s by conducting studies, including identifying suitable CO_2 storage sites, investigating CO_2 emission sources, and providing related information for promoting the CCS business environment in Viet Nam.
Responsible Entity	Japan Organization for Metals and Energy Security (JOGMEC) PETROVIETNAM
Project Scale (USD)	5 million
Project Goals/KPI	• Identification of suitable CO_2 storage sites for CCS project • Design of the CCS value chain model • Holding at least one CCS-related workshop per year
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	With the addition of ENEOS Xplora Inc. as a partner in the joint study on CCS, JOGMEC and PETROVIETNAM have derived suitable CO_2 storage sites for CCS project and designed the model for the entire CCS value chain, from CO_2 capture to storage. Additionally, JOGMEC and PETROVIETNAM have jointly held a workshop in Viet Nam to promote the establishment of CCS business environment.
Other Milestones	By the end of 2025, the current agreement of joint study between PETROVIETNAM and JOGMEC under the MOU will terminate, and a decision should be made on whether to proceed to the next study.
URL	https://www.jogmec.go.jp/english/news/release/news_08_00023.html

Target Area: The study is being conducted targeting offshore Hanoi within Song Hong Basin as a CO_2 storage site.

Project Milestones: In 2022, JOGMEC renewed the existing comprehensive MOU with PETROVIETNAM, adding CCS/CCUS as a collaborative project and started a joint study on CCS (Phase-1). After identifying promising basins, JOGMEC and PETROVIETNAM signed an individual MOU in 2023 to begin a detailed CCS study (Phase-2). Through the efforts under this MOU and joint study, we expect to lead to the launch of CCS projects by private sectors in the 2030s.

CCS Business Environment Workshop: Under the MOU, a workshop aimed at promoting the CCS business environment in Viet Nam was held on October 30, 2024, in Da Nang, Viet Nam. Approximately 150 participants, including government officials, attended the workshop. Through the workshop, JOGMEC and PETROVIETNAM confirmed the necessity to accelerate the establishment of a business environment for CCS in Viet Nam and deepen cooperation between the two countries to launch a CCS project. Additionally, the intention to strengthen future cooperation on CCS was reaffirmed.

METI

The followings are the projects in which METI provides support for demonstrations and feasibility studies in the energy sector contributing to decarbonization within the AZEC region.

Feasibility Study of Digital Business Model for Water Resources Development

Project Overview	We are undertaking the production of ultrapure water—essential for hydrogen and ammonia synthesis—by reusing and purifying treated wastewater. In anticipation of future developments in the hydrogen and ammonia sectors, we are committed to designing modular, highly scalable water treatment systems. Furthermore, we aim to incorporate advanced digital technologies to enhance operational efficiency and reduce associated costs.
Responsible Entity	Yokogawa Electric Corporation coNEXA
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	MoU signed on Feb. 2025 between Yokogawa Australia and coNEXA

Two leaders in the Australian water sector are joining forces in the development, delivery and operation of an Advanced Recycled Water Pilot (AWT Pilot) in Mayfield, NSW. Yokogawa Australia & New Zealand and coNEXA Infrastructure Partners will collaborate on the AWP Pilot, which will be potable reuse ready, and in an Australian first trial an AI engine for process optimisation together with an innovative online instrument to determine virus removal for membrane technology. The new AWT Pilot will sit alongside coNEXA's existing 10.5MLD recycled water plant, which provides an opportunity to apply learnings from the AWP Pilot directly to the full scale. Yokogawa Australia and coNEXA look forward to reporting on progress and findings from the AWT Pilot, with operation to commence in early 2026.

Effective utilisation of oil palm trunk project

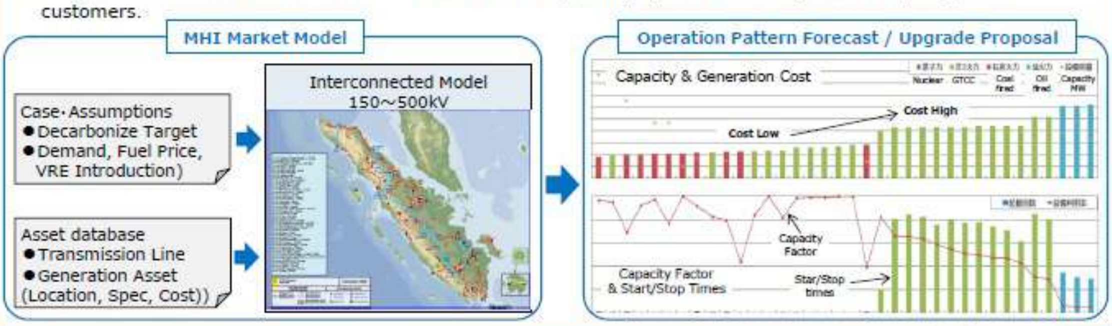
Project Overview	We are creating a comprehensive business model that utilises oil palm trunks (OPT), which are generated in large quantities annually due to replanting efforts aimed at maintaining yield in palm plantations. The sap extracted from OPT is used as a fermentation feedstock for bioethanol production, while the residual fibers after sap extraction are processed into biomass fuel products such as fuel pellets. This integrated approach contributes to sustainable resource utilisation in the palm industry.
Responsible Entity	Green Earth Institute Co.,Ltd.
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	In the 2023 Feasibility Study Project for Overseas Development of High-Quality Energy Infrastructure, the following studies were conducted: (1) Identification of regions in Indonesia where OPT can be obtained and the amount of OPT available, (2) Identification of current OPT processing methods, (3) Identification of the quality of OPT juice-derived bioethanol material (compositional analysis), (4) Identification of bioethanol production cost, (5) Identification of OPT-derived pellet quality (compositional analysis), (6) Estimation of the amount of reduction in energy-derived CO_2 emissions. Then, we made several visits to palm plantations in Indonesia, where OPTs were cut down and the OPT sap was squeezed for lab-level fermentation testing and ethanol sample production. Based on the field search and lab-testing, the feasibility study has been completed. Currently, preparations are underway for a pilot demonstration test in Indonesia.
Planned Demonstration Period	Scheduled to be implemented after January 2026.
URL	https://gei.co.jp/ja/

Feasibility study of power planning and operation optimisation proposal service

Project Overview	In order to contribute to the achievement of the decarbonisation goal, the feasibility of a power supply planning and operation optimisation proposal service for Indonesia and other target countries utilising power market simulation technology and knowledge will be investigated.
Responsible Entity	Mitsubishi Heavy Industries, Ltd. Institute of Technology in Bandung for Indonesia (Indonesia) University of Philippine (Philippine)
Project Goals/KPI	Receive order for power planning and operation optimisation service
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	As for Indonesia, MHI and ITB jointly create capacity planning which complies revised NDC by Indonesia government and made discussion with stakeholders in Indonesia including government agencies and state-owned utility company. Based on that communication, MHI and ITB plans to offer more detailed analysis for supplementing current power development plan in Indonesia. As for Philippine, MHI and UP signed the agreement to carry out the review of current energy plan in Philippine and will discuss that result with stakeholders there including Department of Energy. The program will be finished within this year.
Planned Business Agreement Period	December 2025 (potentially continued beyond that)
Planned Business Consideration/FID Period	NA (Searching opportunity for providing intended service is ongoing in parallel with above mentioned project.)
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	Renewed MOU with each partner
URL	https://www.jetro.go.jp/newsletter/jkt/2025/250428_Business_Catalog_ver13_English_set.pdf

Product and Service Outline

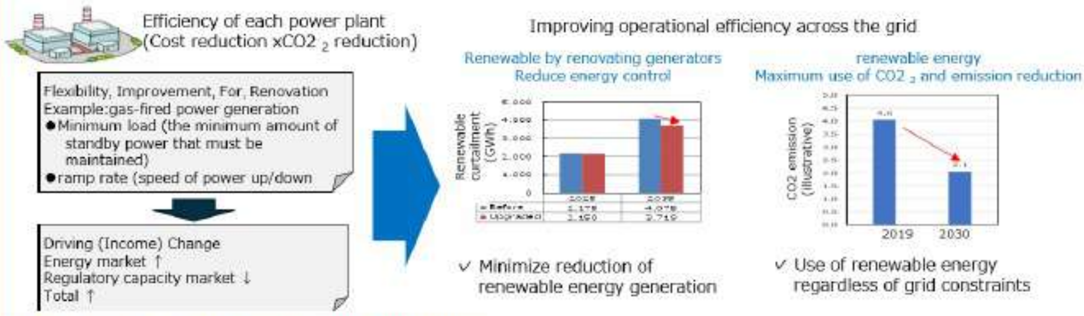
- Countries are required to economically optimize the introduction of renewable energy and the stability of the power system while achieving carbon neutrality targets.
- MHI uses an analytical model of the electricity and energy markets to provide businesses and related organizations with asset evaluation and technology implementation optimization services that address the balance between decarbonization and economic efficiency.
- Based on its broad range of products and technical expertise related to Energy Transition, and the results of analysis conducted in various countries around the world, MHI propose an asset optimization policy for our customers.



Experience and Example

1. Strategy to utilize existing asset

Expect the future utilization of facilities and propose measures to improve profit by modifying it using the best suitable technology for the business environment in future.

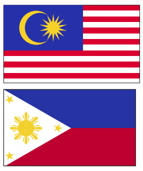


2. Future Asset portfolio with decarbonatization

By showing the most economical power supply configuration in the future, we will propose the necessary technology and schedule capital investment, quantify the impact of the business environment, such as change in power demand, and policy options, such as the CO_2 target and use it to assess risks and provide data for policy discussions. MHI has been conducting a joint study with the Bandung Institute of Technology about the decarbonization strategy in Indonesia to propose several suggestions to make it economical and practical.

3. Optimizing facility specification for decarbonatization project

For hydrogen or ammonia project for production or storage, the economy should be estimated based on future generation patterns, equipment specifications, and collection prices. Based on case studies of equipment specifications, MHI propose an optimal equipment configuration based on the fluctuation of prerequisites.



IVSG project: for huge deployment of renewable energy in Pacific islands and ASEAN countries while keeping the grid stable

Kawasaki
Powering your potential

Project Overview	Pacific islands and ASEAN countries are trying to deploy more renewable energy for the purpose of their decarbonisation while maintaining economic growth but little as yet known about the fact about renewable energies which are connected to their power grid through inverters cause serious disturbances. This will be one major obstacle to decarbonisation, and immediate solutions are required. Kawasaki's GFM method 'iVSG' provides a way to stop engine operation by mimicking the behavior of engines and realise the maximum use of renewable energy.
Responsible Entity	Kawasaki Heavy Industries,Ltd
Scale of Support (US$)	50% of the project cost
Project Goals/KPI	Decrease an operation time of engines in the daytime when the excess power is generated by renewable energies.
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	Kawasaki and local partner completed FS for iVSG project in February 2025. Currently, discussions with partner companies are ongoing towards project implementation.
URL	https://global.kawasaki.com/en/

Feasibility Study for Two Small Hydropower Projects in Negros Island, the Philippines

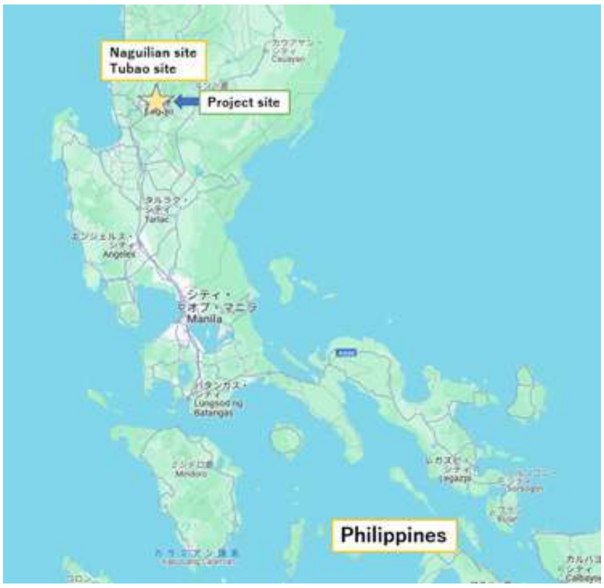
Project Overview	In this project, a small-scale hydropower plant is being developed in the Anulod River basin on Negros Island, the Philippines. Utilising a net head of 100 meters and a flow rate of 8.0 m^3/s, the plant is expected to generate 7,300 kW of electricity, supplying approximately 40 GWh annually. A Special Purpose Company (SPC) formed by Fujita Corporation, Chodai Co., Ltd., and Almana Power Corporation is promoting the project under the Joint Crediting Mechanism (JCM), with support from the Philippine government and local stakeholders. This initiative aims to contribute to the country's renewable energy targets and the achievement of carbon neutrality.
Responsible Entity	Fujita Corporation Chodai Co., Ltd. Almana Power Corporation Almana Group of Companies
Project Scale (US$)	Approximately US$25 million (equivalent to about ¥3.6 billion)
Scale of Support (US$)	Approximately US$3.5 million (with a planned subsidy of ¥500 million from the Ministry of Economy, Trade and Industry and the Ministry of the Environment) Note: Equivalent to approximately ¥500 million under the JCM scheme.
Production Scale	Annual power generation: approximately 40 GWh
Project Goals/KPI	(see table below)

Item	Description
Annual Power Generation	Stable supply of approximately 40 GWh
CO_2 Reduction	Annual reduction effect equivalent to 25,900 tonnes of CO_2
Plant Utilisation Rate	Maintained at over 62.6%
Power Sales Price	Secured contract at approximately PHP 6/kWh or higher
Project Profitability	Achieve PIRR of 11% or higher, and EIRR of 15% or higher
Construction Period	Approximately 38 months (September 2026 – October 2029)
Operation Start Date	Scheduled to start in or after November 2029
Local Employment	Around 20 local staffs expected for operation and maintenance

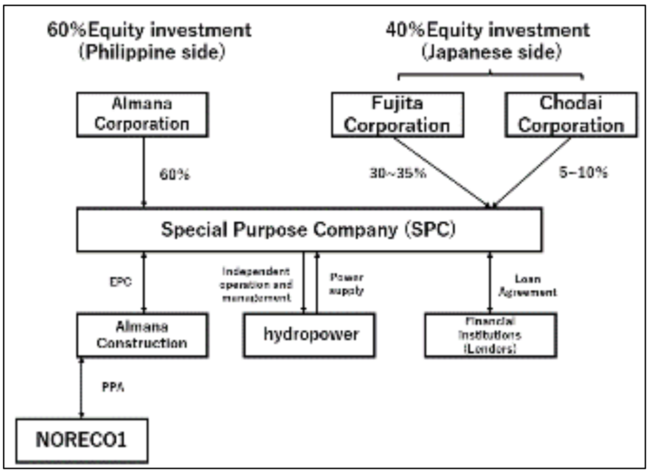
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)

Progress Overview	As of March 2025, the initial feasibility study (FS), as well as additional topographic and geotechnical surveys, have been completed. A basic design review meeting with Fujita, Almana, and Chodai was held at the end of 2024. The project is currently in the preparation phase for detailed design and commercial agreements, with the signing of the Joint Venture Agreement (JVA) scheduled for the end of 2025.
Planned Demonstration Period	• Construction Period: September 2026 – October 2029 (approximately 38 months) • Commissioning and Start of Power Generation (i.e., Start of Demonstration Operation): From November 2029
Planned Business Agreement Period	In May 2025, a Letter of Intent (LOI) was signed to continue discussions with Almana Power Corporation and Alama Group of Companies (Almana Corporation) toward the execution of the JVA, which is scheduled to be signed for the end of 2025.
Planned Business Consideration/FID Period	Beginning in Q1 2025
Planned Construction Period	From September 2026 to October 2029
Planned Commercial Operation Start Period	November 2029
Planned Period for Signing MOU or Similar Agreements (until around October 2025)	• April 2023: Memorandum of Understanding (MOU) signed amongst Almana Corporation, Chodai Co., Ltd., and Fujita Corporation. • May 2025: Letter of Intent (LOI) signed with Almana Corporation to continue discussions toward signing of JVA.
Other Milestones	• October 2025: Sign Term Sheet • December 2025: Sign JVA • Early 2026: Commencement of detailed design following the establishment of the SPC • August 2026: Completion of detailed design • September 2026: Equipment procurement and construction commencement • November 2029: Start of operation

Map and Project site



Project Scheme



Project Schedule

- October 2025: Sign Term Sheet
- December 2025: Sign JVA
- 2026: Completion of detailed design, and equipment procurement
- September 2026- October 2029: construction period
- November 2029: Start of operation

Photos

Site visit to the Anulod River project site

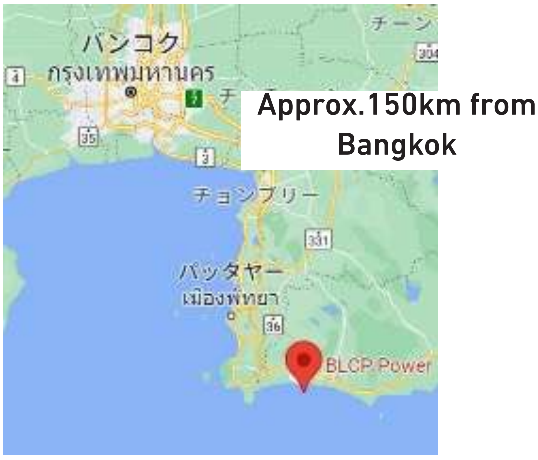
The Feasibility Study on Technology Application, Economic Evaluation and CO_2 Reduction Plan for Ammonia Substitution at BLCP Coal-fired Power Plant in Thailand

Project Overview	1. Feasibility study including Ammonia 20% substitution at BLCP Power Plant 2. Establishment of supply chain for ammonia procurement Economics and carbon reduction benefits of the entire ammonia value chain
Responsible Entity	JERA Co., Ltd. Mitsubishi Corporation Machinery, Inc. Mitsubishi Heavy Industries, Ltd. Nippon Koei Co., Ltd. Electricity Generating Public Company Limited (EGCO) Banpu Power Public Company Limited (BPP) BLCP Power Limited (BLCP)
Project Scale (US$)	Study cost: Approx. ¥84,320,000
Production Scale	20% ammonia conversion (Higher Heating Value basis) at a 700 MW coal-fired power plant
Project Goals/KPI	1. Net zero emissions in Thailand by 2065 2. Decarbonisation of coal-fired power generation 3. Conduct field surveys and feasibility studies for the development of a fuel ammonia value chain.Additionally, export Japanese infrastructure technology through these studies.
Progress Status as of March 2025	After completing survey in February 2024, we have been appealing to the Thailand government regarding the importance of ammonia substitution.
Progress Overview	While the Thailand Power Development Plan (PDP), which is currently under preparation, includes the remarks about hydrogen, there are no plans to introduce ammonia into power sector at this stage. It is necessary for the Thailand government to understand the importance of ammonia utilisation for the transition from coal. The project members plan to engage in discussions with the Energy Policy and Planning Office (EPPO), a key agency involved in policy formulation related to decarbonisation together with BLCP Co., Ltd.
Planned Demonstration Period	FY2025-2027
Planned Business Agreement Period	FY2027
Planned Business Consideration/FID Period	FY2027
Planned Construction Period	FY2028-FY2030

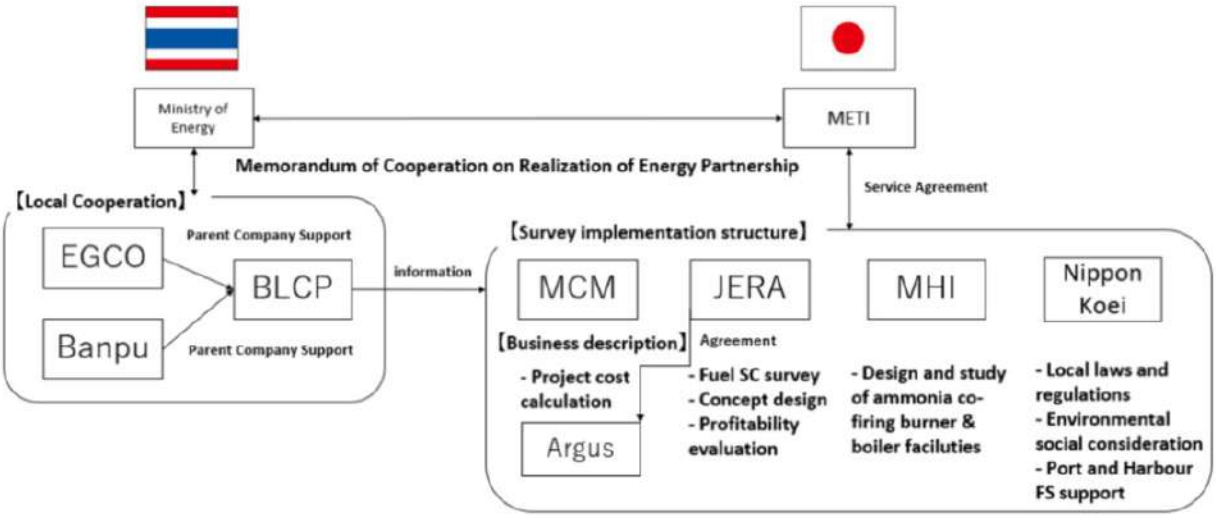
Planned Commercial Operation Start Period	FY2031-FY2032
URL	https://www.jera.co.jp/news/notice/20230427_1432

Project site (BLCP Power Plant)

Location



Organisation chart



Feasibility study for the application of CO_2 separation, capture and utilisation technology that utilises Japanese technology at the BLCP coal-fired power plant, an economic evaluation, and CO_2 reduction plan

Project Overview	This study examines commercialisation possibility of the project where 1 million tonnes/year of methanol will be produced through some process like treatment of a portion of the flue gas from BLCP's existing coal fired power plant, CO_2 separation and recovery, syngas and methanol production process.
Responsible Entity	Mitsubishi Corporation Machinery, Inc./ Chiyoda Corporation BLCP Power
Project Scale (US$)	Approximately US$ 870 million
Progress Status as of March 2025	The MOU project (including subsequent demonstration and commercialisation) has been terminated
URL	We identified issues for commercialisation as below. ① Although we will conduct CCU in this project, the methanol which will be produced will be classified as gray considering the production process. The required selling price level will be same as conventional methanol in order to sell in the competitive market. ② Although there is a demand for low carbon methanol even with a high price only in the shipping industry, it is difficult to sell it unless it is green, bio, or e-methanol due to IMO regulations. ③ Thailand's carbon credit market is still under development, and it is difficult to incorporate carbon credit into revenue in this project. ④ CAPEX/OPEX would be higher than originally expected.

NEDO

The followings are the projects for which NEDO conducts research and demonstration activities to contribute to decarbonization within the AZEC region.

Demonstration and research on hybrid power generation for microgrids based on 'EMS' technology to realise 100% renewable energy supply

Project Overview	To stabilise the local power grid and increase the ratio of renewable energy power generation through coordinated control of renewable energy and existing internal combustion power generation on a remote island with a population of tens of thousands of people located in the Malaysian border area of North Kalimantan.
Responsible Entity	KRAFTIA (formerly Kyudenko)
Progress Status as of March 2025	The feasibility study is ongoing.
Progress Overview	Implementing the feasibility study
Planned Demonstration Period	Expected to FY2026

Experimental Study of 'Production Technology of Bio Coke to Realise the Same Effect as Coal Coke'

Project Overview	By focusing on coconut shells (PKS), which is a country of origin for palm plants but has few uses, to developed a fuel using PKS as a raw material (biobriquette coal) to achieve carbon neutrality in cupola melting, and replace existing fuels (coal coke). In order to achieve, to conduct empirical research on producing bio-briquette coal that meets the required quantity and required quality for one cupola.
Responsible Entity	Aisin Takaoka Co., Ltd.
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	The basic study completed
URL	https://www.aisin.com/jp/news/2024/006198.html

MOU between the National Research and Innovation Agency of the Republic of Indonesia and the New Energy and Industrial Technology Development Organization of Japan for Cooperation in Carbon Neutral Contribution Technology

Project Overview	To strengthen the relationship between the Parties and to promote development and dissemination of Carbon Neutral Contribution Technology, including the implementation of related research and development, in Indonesia.
Responsible Entity	New Energy and Industrial Technology Development Organization (NEDO) The National Research and Innovation Agency
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Based on the comprehensive MOU between NEDO and BRIN, the following cooperation was implemented, including events and exchange of information 1. Clean Energy Technology Summer School 2024 (in RD20) 2. Matching event for creating biofuel projects 3. Site visit of several demonstration sites and laboratories developing carbon neutral contribution technology 4. Meetings for exchange of information in various fields

MOU between the ministry of energy and mineral resources of the republic of Indonesia and the new energy and industrial technology development organization of Japan concerning cooperation in the decarbonisation of the energy sector

Project Overview	To enhance cooperation on decarbonisation efforts in the energy sector through utilising available energy sources including renewable energy, clean technologies, energy efficiency, and options that could help enhance energy security while reducing greenhouse gas emissions.
Responsible Entity	New Energy and Industrial Technology Development Organization (NEDO) Ministry of Energy and Mineral Resources (MEMR)

NEDO invited MEMR to a matching seminar hosted by NEDO in Jakarta in December 2024. Both parties gave presentations and encouraged collaboration between Japanese and Indonesian companies toward decarbonisation in the energy sector.

Progress Status as of September 2025	Continuing the MOU Projects
Progress Overview	Based on the comprehensive MOU between NEDO and MEMR, the following cooperation was implemented, including events and exchange of information: 1. Matching event for creating biofuel projects 2. Site visit of several demonstration sites and laboratories developing carbon neutral contribution technology 3. Meeting for exchange of information in various fields.

Demonstration of hydrogen technology that utilises surplus electricity and exhaust heat from geothermal power generation to achieve economically viable hydrogen production and transportation

Project Overview	To demonstrate efficient hydrogen production technology that utilises surplus electricity from geothermal power generation, geothermal steam, and waste heat, and establish a viable green hydrogen production and transportation method in Indonesia with high geothermal potential.
Responsible Entity	TEPCO / YHC
Progress Status as of March 2025	The project is completed.

Demonstration Project on the Smart Energy Technology to Realise Green Energy Supply

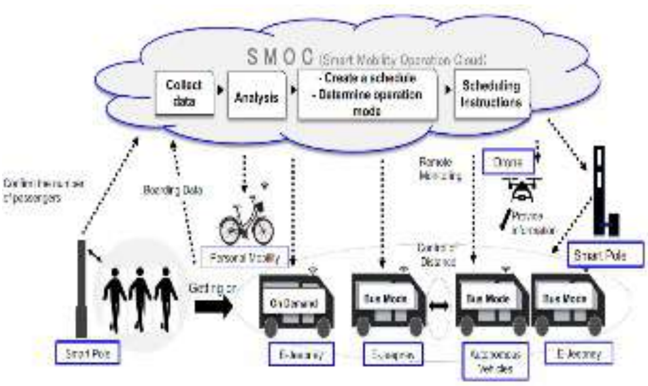
Responsible Entity	Nippon Koei Energy Solutions Co., Ltd., Nippon Koei Co., Ltd. , iFORCOM Co.,Ltd.
Progress Status as of March 2025	The feasibility study is ongoing.
Progress Overview	The basic study completed. Implementing the feasibility study

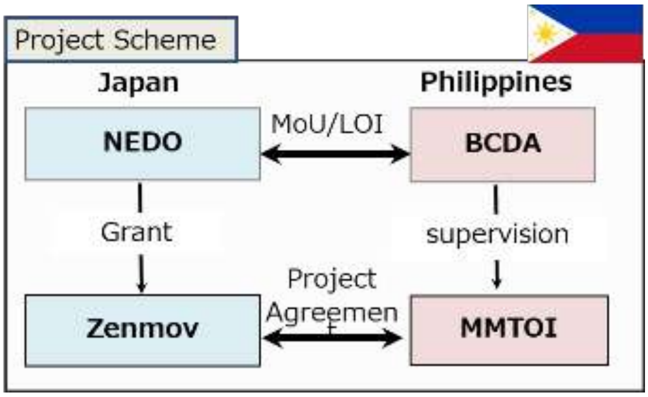
Demonstration project for ZEB to achieve carbon neutrality in the building sector

Project Overview	This project aims to demonstrate a nearly ZEB in hot and humid area for an existing building of SEDA, a Malaysian government agency. The ZEB concept based on ISO/TS23764 will be applied to achieve both energy efficiency and comfort in air conditioning, and is expected to change user behavior by preventing overcooling, etc.
Responsible Entity	Pacific Consultants Mitsubishi Electric AGC AZBIL
Progress Status as of March 2025	Work on concluding agreement documents is progressing toward the start of the demonstration project.
Progress Overview	Passed the external committee evaluation to proceed to the demonstration phase. Preparations are underway to commence the demonstration project.

Smart Mobility Technology using Energy Efficient Transportation Systems in Clark Area, Philippines

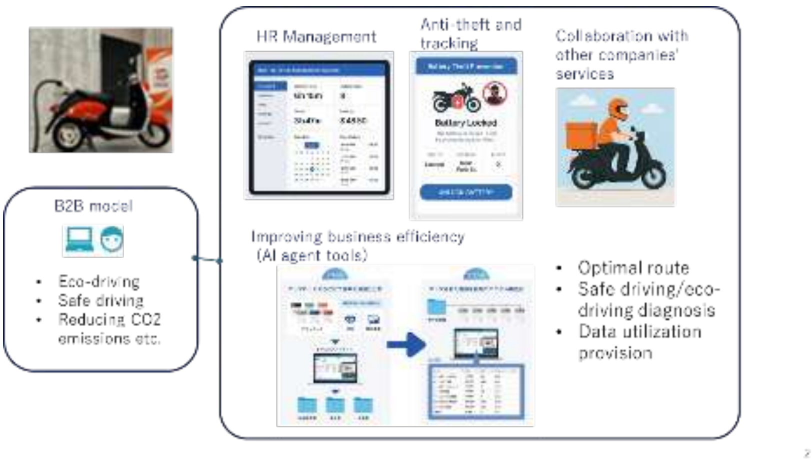
Project Overview	The aim of this project is to contribute to solve issues which are inconvenience, economic losses, air pollution, and wasteful energy consumption through the Smart Mobility Operation Cloud (SMOC) system at Clark Area in Philippines.
Responsible Entity	Zenmov Inc. MMTOI: MC Metro Transport Operation Inc.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Implementing the demonstration phase.
Planned Demonstration Period	October 2022 - June 2025
URL	https://zenmov.com/

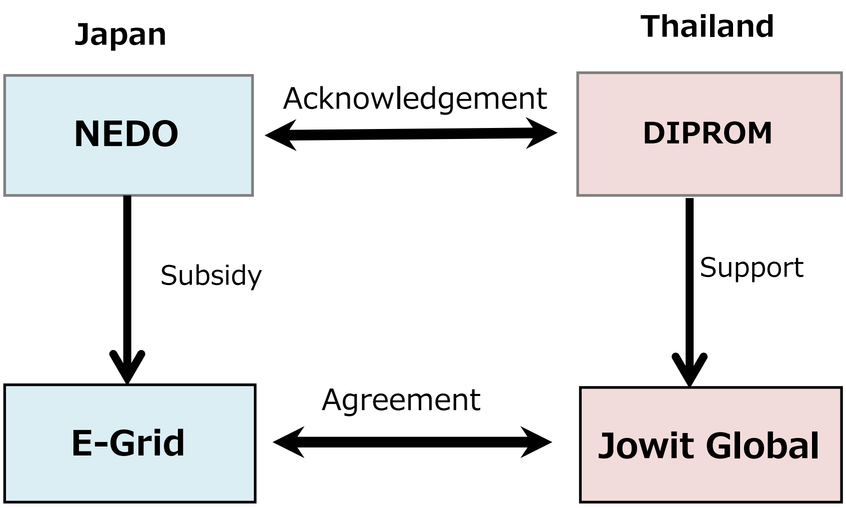




Demonstration research of driver behavior analysis and battery cell condition analysis to realise more efficient energy consumption of EV bikes

Project Overview	Contributing to Efficient Energy Consumption / Demonstration Research for the Compliance Requirements / Driver Behavior Analysis for Efficient Energy Consumption of Electric Motorcycles and Empirical Research on Battery Cell State Analysis.
Responsible Entity	e-Grid Inc. Jowit Global Co.,Ltd.
Progress Status as of March 2025	The feasibility study to be completed to progress to the next phase (e.g., demonstration)
Progress Overview	Completed basic study and feasibility study.
Planned Demonstration Period	July 2025- March 2027
URL	https://www.e-grid.co.jp/



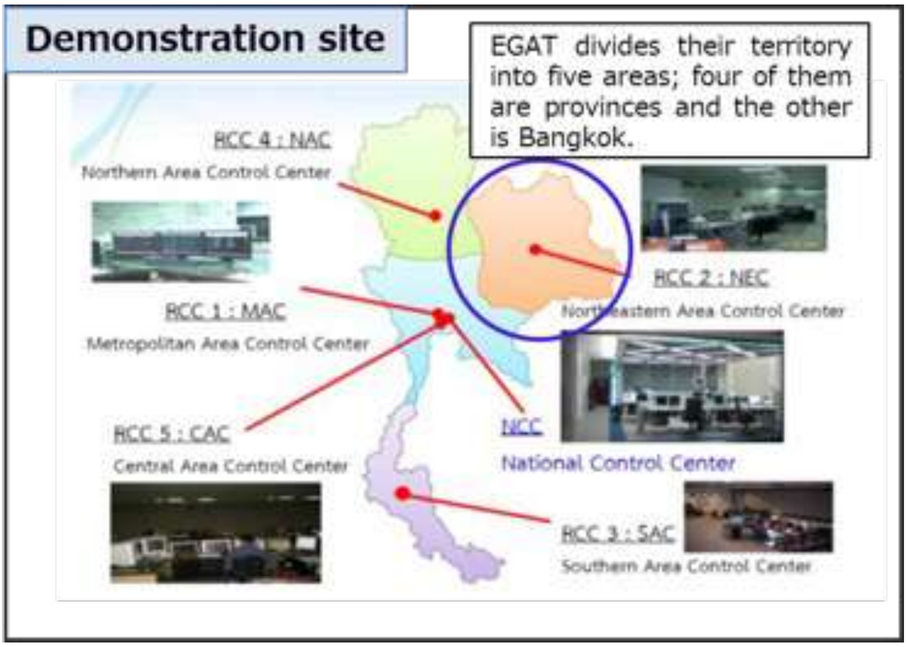


Follow up for quantification project on Low-Carbonised Operation of a Power Grid Utilising Online Voltage-var (Q) Optimal Control 'OPENVQ' with ICT (Thailand)

HITACHI
EGAT

Project Overview	In order to reduce CO_2 emissions, the Project will introduce online optimal control system, named OPENVQ to the transmission system of the Electricity Generating Authority of Thailand (EGAT). OPENVQ can reduce CO_2 emissions by reducing transmission loss and contribute to an increase of renewable energy through increasing transmission capacity.
Responsible Entity	Hitachi, Ltd Electricity Generating Authority of Thailand (EGAT)
Project Scale (US$)	US$7.3 million
Project Goals/KPI	CO_2 credit reduction: 7,700 (tCO_2) per year Transmission loss reduction: 6.0%
Progress Overview	The demonstration project was completed in March 2024, and the quantification follow up project started in February 2025.
Other Milestones	Quantification follow-up project scheduled to end in January 2027.
URL	https://www.hitachi.com/products/it/control_sys/ems/openvq.html

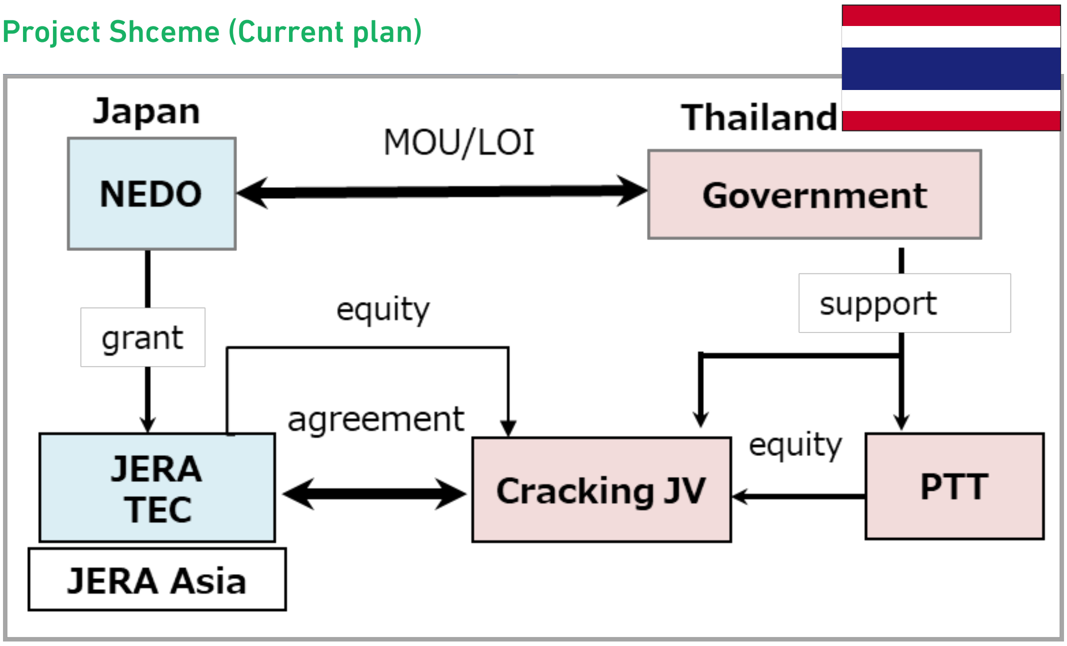
Project period: FY2019 to FY2026



Demonstration Research to realise stable operation of ammonia cracking equipment

Project Overview	An ammonia cracking facility and a hydrogen storage facility to absorb fluctuations in hydrogen demand, thereby ensuring stable operation of the plant and minimising the use of hydrogen storage facilities.
Responsible Entity	JERA Co. Inc. JERA Asia Toyo Engineering Corp.
Progress Status as of March 2025	Completed the project
Progress Overview	Completed the basic study.
Basic Study Period	August 2024- July 2025
URL	https://www.jera.co.jp/en/ https://www.toyo-eng.com/jp/en/

Project Shceme (Current plan)



Manufacturing model project for bio-based nonionic surfactant from non-edible biomass using on-site production system of enzymes optimised for cassava residue

Project Overview	Demonstrate a low LC-CO_2 on-site production system for saccharification enzymes developed with a composition optimised for cassava pulp residue from Thai agricultural waste and demonstrate an integrated production model up to non-edible bio-nonionic surfactant using economical utilisation technology.
Responsible Entity	Kao
Progress Status as of March 2025	The MOU project is completed (or expected to be completed). Subsequent phases are under consideration.
Progress Overview	The feasibility study completed

LOI agreement regarding cooperation in Home IoT demonstration research with DEDE, Ministry of Energy of Thailand

Project Overview	A LOI agreement between NEDO and DEDE (Department of Alternative Energy Development and Efficiency), Ministry of Energy of the Kingdom of Thailand regarding cooperation on 'demonstration for the development of thermal control HomeIoT system and living space design technology for Thai homes'.
Responsible Entity	New Energy and Industrial Technology Development Organization (NEDO) Department of Alternative Energy Development and Efficiency (DEDE)
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Based on the project LOI between NEDO and DEDE, the following cooperation was implemented. • Project Launch Ceremony • Site visit of demonstration project • Project progress report meeting

Letter of Intent for Cooperative Activities

Project Overview	This LoI is for the general framework for cooperation between MOEN and NEDO to promote innovation in applied research and technological development in Thailand in areas of common interest, especially in energy conservation, alternative energy, and related fields.
Responsible Entity	New Energy and Industrial Technology Development Organization (NEDO) Ministry of Energy (MOEN)
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Based on the LoI, MOEN and NEDO agreed and concluded the project LoI to start the project named 'Demonstration project for the thermal control home IoT system and living space design technology that achieves both comfort and energy savings in residential homes in Thailand'

Memorandum of Understanding on Cooperation in Innovation and Technology Research and Development

Project Overview	Memorandum of Understanding between NEDO and NIA (National Innovation Agency) to promote innovation in both countries through information exchange and joint projects in a wide range of fields.
Responsible Entity	New Energy and Industrial Technology Development Organization (NEDO) National Innovation Agency (NIA)
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Based on a MOU between NEDO and NIA, Japanese companies supported by NEDO participated in SITE2025, an event organised by NIA.

Memorandum of Understanding on Cooperation in Development of a Startup Ecosystem between NEDO and NIA

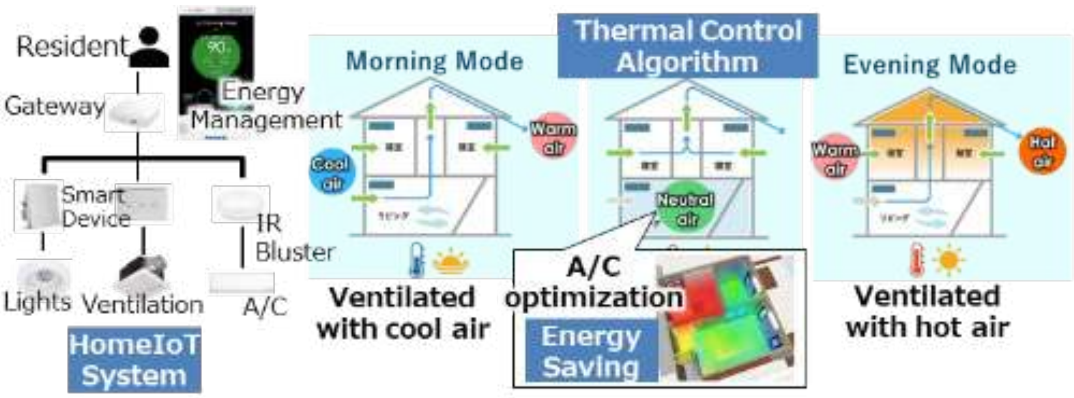
Project Overview	In July 2017, the New Energy and Industrial Technology Development Organization of Japan (NEDO) and the National Innovation Agency of the Ministry of Science and Technology of Thailand (NIA) signed a memorandum of understanding to cooperate in activities to support startups. Based on this MOU, the two organisations are cooperating to exhibit at the exhibition 'Startup x Innovation Thailand Expo (SITE)' held in Thailand.
Responsible Entity	New Energy and Industrial Technology Development Organization (NEDO) National Innovation Agency (NIA)
URL	https://www.nedo.go.jp/ugoki/ZZ_101306.html

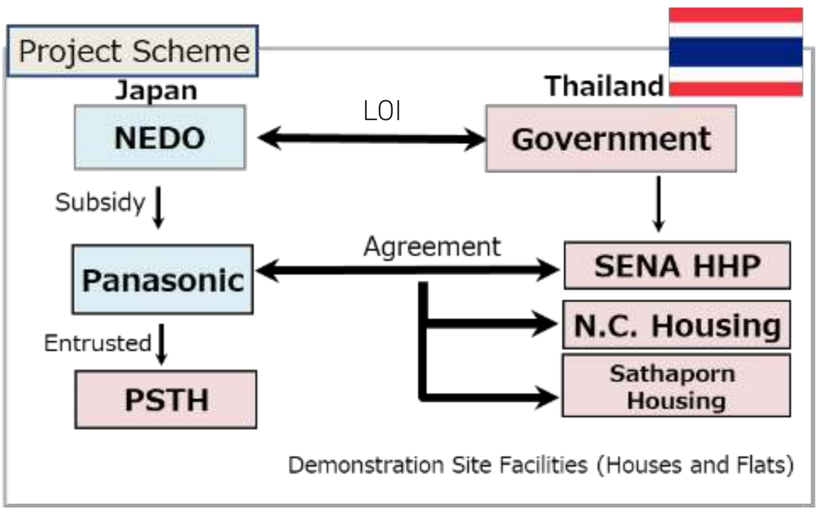
Basic study to demonstrate the carbon capture and utilisation from cement plants exhaust gas in Thailand and Southeast Asia, with the aim of promoting Japanese CCUS technology

Project Overview	In Thailand, we will apply our CO_2 capture and recovery technology to build a CO_2 capture and utilisation (methanation) model that can handle cement plant exhaust gas, as well as a CO_2 capture and utilisation system that effectively uses waste heat from the methanation facility to save energy.
Responsible Entity	Nippon Steel Engineering
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	The basic study completed

Actual proof of thermal control home IoT system and living space design technology that achieves both comfort and energy saving in residential homes in Thailand

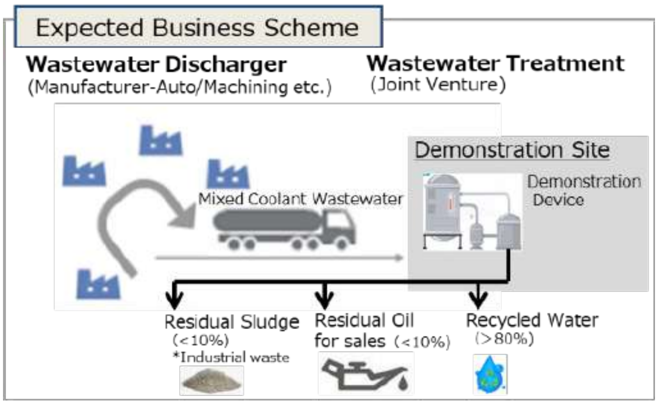
Project Overview	Demonstration experiments with the aim of implementing it in Home IoT and establishing spatial performance design technology.
Responsible Entity	Panasonic Corporation SENA HHP Company Limited, Sathaporn Estate Co., Ltd., and N.C. Housing Public Company Limited
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Passed the external evaluation committee to proceed to the demonstration phase in May 2024. The demonstration project commenced in June 2024.
Planned Demonstration Period	Jun. 2024-Mar. 2026
URL	https://www.panasonic.com/global/about.html

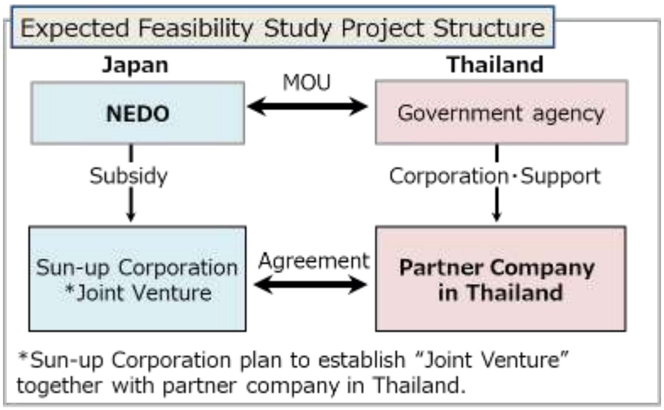




Demonstration research for the distillation and membrane system to improve recycling of wasted oily coolant water

Project Overview	To realise advanced recycling of coolant wastewater (coolant fluid for cutting process needs to be replaced periodically due to deterioration from continuous use) in Thailand. Specifically, a new demonstration system (distillation and membrane treatment) will be used to recycle as much wastewater as possible (recycled water and oil residue), and a small amount of residue (sludge) will be treated as industrial waste. Thai government agencies have high expectations for this system as a solution to the major social problem of improper treatment and illegal dumping of toxic wastewater.
Responsible Entity	Sun-up Corporation
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	To complete basic study in May 2025 and prepare for feasibility study.
Planned Demonstration Period	July 2026–June 2028
URL	https://www.sunup.jp/





Recovery and Purification Technology of Neodymium Magnets from Motor Scrap

Project Overview	Establish a technology to recover and purify neodymium magnets from used motor scraps received from Asia, EU, North America, and Japan in Thailand, and aim to spread the recovery technology to other countries in the world.
Responsible Entity	SUZUKI SHOKAI CO.,LTD
Progress Status as of March 2025	The MOU project is completed and has progressed to the next phase (e.g., demonstration)
Progress Overview	The basic study is completed. Implementing the feasibility study

Verification Survey to improve energy conversion efficiency related to existing methane fermentation

Project Overview	Demonstration study on a service business that allows rental of fermentation accelerators using steam ejectors at existing methane fermentation facilities in Thailand.
Responsible Entity	Tohkemy Corporation (prime), Technoplan Inc. (sub)
Progress Status as of March 2025	Under consideration to proceed to the external committee evaluation
Progress Overview	The basic study is completed.

The Demonstration Project for an Energy-Saving Cellulosic Sugar Production System Using Bagasse

Project Overview	The demonstration project for the production of Cellulosic Sugar and high value-added products (Oligosaccharide and Polyphenol) from bagasse and the independent production of cellulosic sugars derived from cassava pulp as the other raw materials was conducted from FY 2016 to FY 2022. As a follow-up, a survey of Thai raw material companies, a cellulose sugar conversion technology, a cellulose sugar LCA evaluation, and a survey on obtaining external certification had been conducted.
Responsible Entity	TORAY, Mitsui DM Sugar
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Progress Overview	The follow-up survey completed

An empirical study for applying electric motor technology to railroad maintenance vehicle

Project Overview	The introduction of an EV track maintenance vehicles, manufactured and sold in Thailand, could contribute to the development of an environmental conscious society and play a significant role in boosting the local economy.
Responsible Entity	Toyo Machinery Corporation Rail Technology Research and Development Agency
Progress Status as of March 2025	The MOU project is implementing the feasibility study
Progress Overview	The basic study completed. Implementing the feasibility study.
Planned Demonstration Period	February 2026 - December 2028

Feasibility Study on the Optimal Hydrogen Distribution Method in Amata City Chonburi Industrial Estate to Promote the Use of Fuel Cell Forklift (FCFL)

Project Overview	In the Amata City Chonburi Industrial Estate in Thailand, we will (1) study the optimal method of hydrogen distribution to FCFLs and (2) conduct a demonstration study on the feasibility of establishing a hydrogen management system (HMS) that remotely assesses customer hydrogen demand and performs optimal hydrogen distribution.
Responsible Entity	Toyota Tsusho
Progress Status as of March 2025	The project is currently in progress and is scheduled to be completed by December 2025
Progress Overview	The basic study completed. Implementing the feasibility study

Technical Demonstration Project on Smart Bus Systems to Promote Modal Shift in Commuter Transport

Project Overview	In the area centered on AMATA City Chonburi, a technical demonstration to promote modal shift to public transportation using advanced bus operation management system will be conducted to alleviate traffic congestion and to reduce CO_2 emissions in the future.
Responsible Entity	Toyota Tsusho, Odakyu, Pacific Consultants
Progress Status as of March 2025	The MOU project is completed (or expected to be completed), but there are no plans for subsequent phases
Progress Overview	The feasibility study completed

Demonstration study of fuel cell (FC) bus operation system for low-carbon industrial park

TOYOTA TSUSHO CORPORATION
Takasago Thermal Engineering

Project Overview	Construct a series of operation systems (from hydrogen generation and procurement to optimisation of bus operation) for Thailand's first FC bus service at Map Ta Phut New Smart Industrial Estate, and verify performance, safety, and operation through long-term and continuous operation in the Thai environment.
Responsible Entity	Toyota Tsusho Corporation, Takasago Thermal Engineering
Progress Status as of March 2025	The project is expected to be completed
Progress Overview	The basic study completed. Implementing the feasibility study

Demonstration Study on High-Ratio Co-firing of Biomass Fuel with Existing Coal-Fired Power Plants to Achieve Decarbonisation

erex

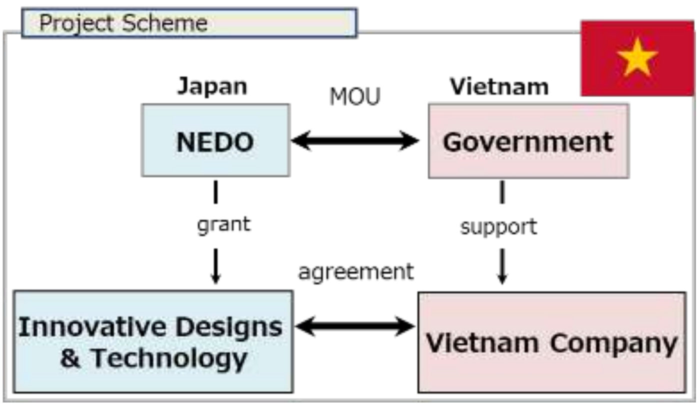
Project Overview	The coal-fired circulating fluidised bed (CFB) boiler-fired power generation facility (Nong Son coal-fired power plant) owned by Viet Nam's Vinacomin Power to be developed using erex's operation control technology and equipment planning optimisation technology.
Responsible Entity	erex Co.,Ltd
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	The basic study completed. Preparing for the Stage Gate review.
URL	https://www.erex.co.jp/en/

Demonstration of Ammonia firing to achieve decarbonisation at anthracite coal fired power plant

Project Overview	Demonstrate ammonia combustion at an anthracite-fired power plant owned by the state-run electricity company Vietnam Electricity (EVN), for the contribution to the decarbonisation of coal-fired power generation as outlined in Viet Nam's National Power Development Plan.
Responsible Entity	IHI corporation
Progress Status as of March 2025	The MOU project is completed and is expected to enter the next phase (e.g., demonstration)
Progress Overview	The basic study completed. Preparing for the Stage Gate review.

Demonstration study of anti-scaling system to achieve energy saving in circulating water facilities

Project Overview	The demonstration maintains high equipment efficiency and achieves energy savings by removing and inhibiting the deposition of scale that deposits in circulating water equipment in buildings and factories in Viet Nam, and to complete commercial production of the equipment.
Responsible Entity	Innovative Designs & Technology Inc.
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Implementing the basic study.
Planned Demonstration Period	Dec.2024 – Sep. 2025
URL	http://www.innovative-dt.com/



An efficient LNG supply chain infrastructure and high-efficiency gas consumption technologies to support low-carbon thermal energy supply in Viet Nam

Project Overview	The research focuses on developing and demonstrating an efficient LNG supply chain infrastructure through multimodal transportation method such as rail and trailers, and high-efficiency gas consumption technologies to support low-carbon thermal energy supply in Viet Nam.
Responsible Entity	Japan Petroleum Exploration Co, Ltd / Japan Freight Railway Company
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	The basic study under implementation

MOU with EVN for Cooperation on Decarbonisation Roadmap

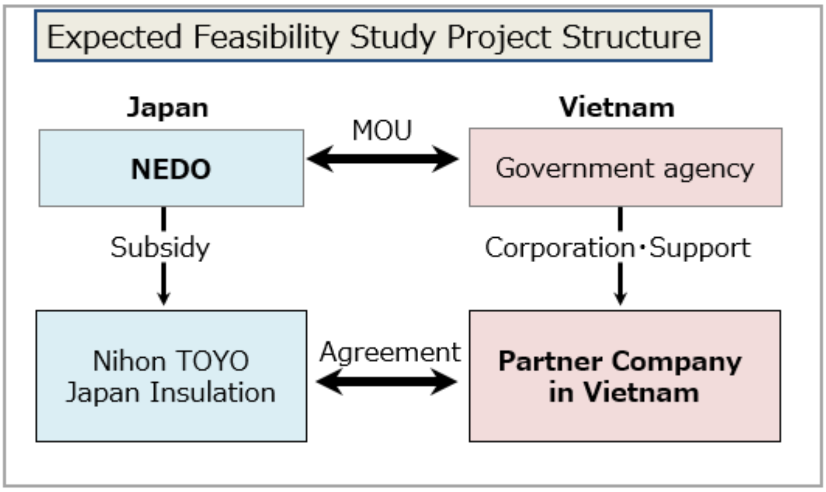
Project Overview	The information sharing and discussions on decarbonising Viet Nam's power sector, including the establishment of a roadmap for decarbonising the entire business of EVN, which starting with the thermal power generation sector, and the initial study for introducing ammonia and hydrogen substitution into EVN's thermal power plants.
Responsible Entity	JERA Co., Inc. EVN
Project Goals/KPI	» Establishment of thermal power decarbonisation roadmap » Initial study for introducing ammonia/hydrogen substitution
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	We are continuing our discussions on the roadmap development for the power sector to achieve carbon neutrality by 2050. At the same time, we are considering a feasibility study on ammonia/hydrogen substitution of thermal power.
URL	https://www.jera.co.jp/en/news/information/20231006_1686

Memorandum of Understanding with NATIF for cooperation in energy, environment-related technologies and industrial technologies

Project Overview	Comprehensive MOU to contribute to bilateral cooperation for decarbonisation and accelerated energy transition in Viet Nam by exchanging information and experts in energy and environment-related technologies and industrial technologies and cooperating in the development and diffusion of technologies that contribute to carbon neutrality in the country.
Responsible Entity	New Energy and Industrial Technology Development Organization (NEDO) National Technology Innovation Foundation
Progress Status as of March 2025	Continuing the MOU project
Progress Overview	Based on the comprehensive MOU between NEDO and NATIF, the following cooperation was implemented. • Site visit of NEDO's demonstration site in Viet Nam • Matching event for Japanese and Vietnamese companies In March this year, the Matching seminar was held in Hanoi (supported by NATIF and co-sponsored by SATI). Four Japanese SMEs (mainly NEDO project graduates) introduced their excellent energy-saving technologies to Vietnamese companies and organisations, and held business talks.

International demonstration study of black pellet production and co-firing with coal (Viet Nam)

Project Overview	Waste and unused biomass resources will be converted into black pellets using hydrolysis technology in Viet Nam, and the reduction of CO_2 emissions will be demonstrated by co-firing them at coal-fired power plants.
Responsible Entity	Nihon TOYO / Japan Insulation Co., Ltd
Progress Status as of March 2025	Proceeding to FEED
Progress Overview	The basic study completed
Planned Demonstration Period	April 2027

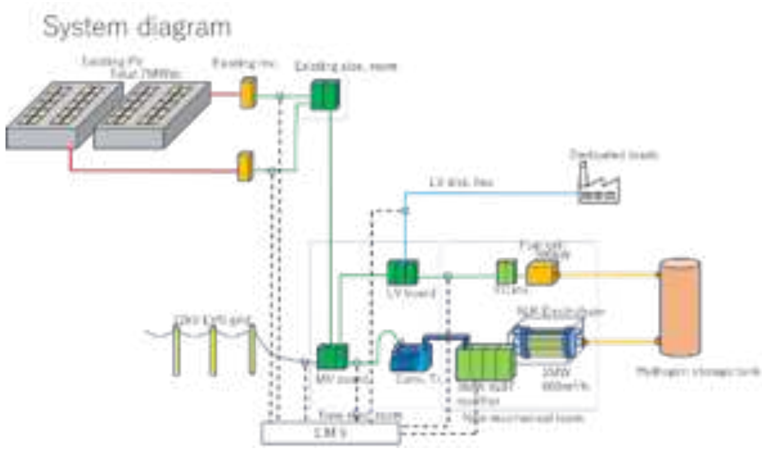


The Demonstration of Producing Green Hydrogen Utilising Surplus Electricity from Renewable Energy and Providing System Solutions in the Socialist Republic of Viet Nam

Project Overview	This project utilises surplus solar power in Viet Nam, where the power grid is underdeveloped, to produce, store, and use green hydrogen at local factories. The aim is to replace fossil fuel-derived energy and achieve a reduction of 1,000 tonnes of CO_2 emissions during the demonstration period.
Responsible Entity	OBAYASHI CORPORATION KIZUNA JV CORPORATION
Project Scale (US$)	Approx. US$10 million
Scale of Support (US$)	Approx. US$7 million
Production Scale	Approx.150t-H_2/year

Kizuna 3 - Ready Serviced Factory (Project site)

Lô K- Khu công nghiêp Tân Kim, Cãn Giuôc, Tỉnh Tây Ninh, Viêt Nam



System Diagram

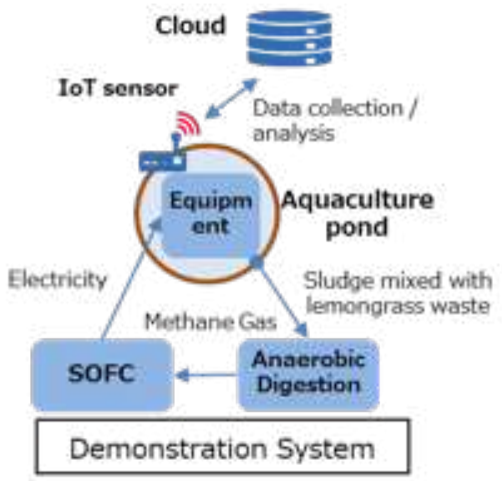
Demonstration study of storage batteries to achieve grid stabilisation in an industrial park

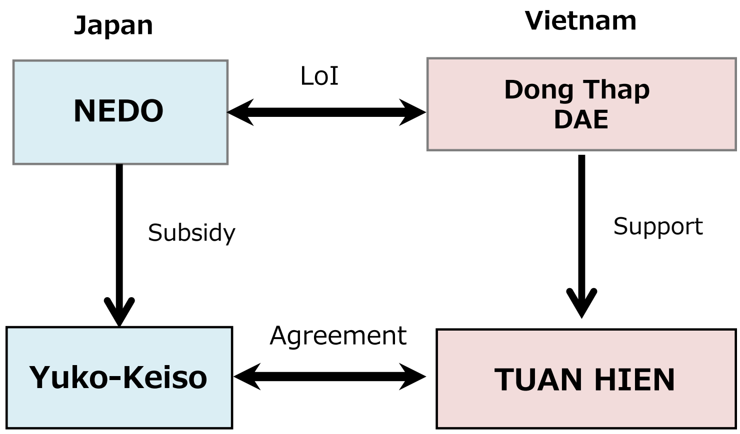
Project Overview	Demonstrate and achieve grid stabilisation, peak shift, adaptation to instantaneous voltage fluctuation, etc., by utilising storage batteries in conjunction with the expansion of roof-mounted solar power generation in Thang Long Industrial Park II.
Responsible Entity	Sumitomo Corporation / Thang Long Industrial Park II Corporation / Nippon Koei Energy Solutions Co., Ltd.
Progress Status as of March 2025	The MOU project is completed (or expected to be completed), but there are no plans for subsequent phases
Progress Overview	The basic study completed

CNA (Carbon Neutral Aquaculture) Project in Mekong (Viet Nam)

Yuko-Keiso

Project Overview	The demonstration examined the technological requirements and economic aspects on a packaged shrimp aquaculture pond system, assuming introduction in the Mekong Delta region of southern Viet Nam.
Responsible Entity	Yuko-Keiso Corporation Limited Tuan Hien
Progress Status as of March 2025	The MOU project is completed and has progressed to the next phase (e.g., demonstration)
Progress Overview	Completed the demonstration.
Planned Demonstration Period	Nov.2022-Mar.2025
URL	http://www.yukokeiso.com/news/3293/





NEXI

The followings are the projects in which NEXI provides insurance support to reduce business risks in the energy sector contributing to decarbonization within the AZEC region.

NEXI signs MOU with Ministry of Mines and Energy (MME)

Responsible Entity	NEXI Ministry of Mines and Energy of Cambodia (MME)
Project Goals/KPI	In line with NEXI's LEAD Initiative launched in December 2020, the MOU aims to build a framework for dialogue between the Ministry of Mines and Energy of Cambodia (MME) and NEXI, to strengthen cooperation primarily to improve the domestic power transmission network in Cambodia, and to support MME in its efforts to achieve a realistic energy transition
URL	https://www.nexi.go.jp/topics/newsrelease/2023030201.html

Tangguh LNG project

Project Overview	The project integrates the Muturi, Berau, and Wiriagar blocks in Indonesia's West Papua Province to develop a large-scale LNG project. According to the expansion and development plan[10] announced in November 2024, new gas fields will be developed, CCUS and compressors will be installed. The plan is expected to begin operation and production in stages from 2028.
Responsible Entity	LNG Japan Corporation Indonesia Natural Gas Resources Muturi, Inc.
Production Scale	11.4 million tonnes per year
Progress Status as of March 2025	The MOU project is completed and has been commercialised

Project site location (Cited from the press release)

Project site overview (cited from LNG Japan website[11])

The joint venture partners (Cited from the press release)

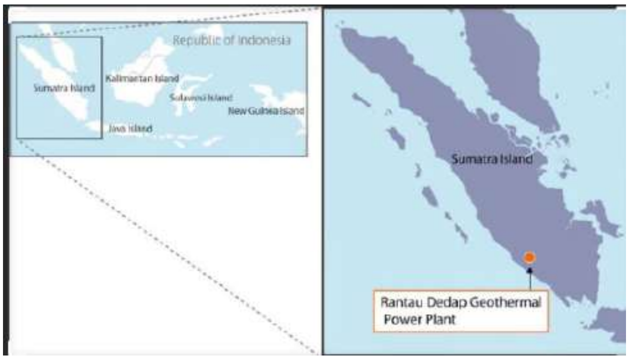
Company/Organization	Participating Interest
bp	40.22%
MI Berau B.V. (Mitsubishi Corporation, INPEX CORPORATION)	16.30%
CNOOC Muturi Limited (China National Offshore Oil Corp - CNOOC)	13.90%
Nippon Oil Exploration (Berau), Ltd. (JX Nippon Oil & Gas Exploration Corporation, Japan Organization for Metals and Energy Security)	12.23%
KG Berau Petroleum Ltd. (Japan Organization for Metals and Energy Security, MITSUI & CO., LTD., JX Nippon Oil & Gas Exploration Corporation, Mitsubishi Corporation, INPEX CORPORATION)	8.56%
Indonesia Natural Gas Resources Muturi Inc.	7.35%
KG Wiriagar Petroleum Ltd.	1.44%

[10] Press release: https://www.lngjapan.com/en/assets/img/pdf/news_241122_en.pdf
[11] https://www.lngjapan.com/en/work/upstream.html

Rantau Dedap geothermal IPP

Project Overview	PT. Supreme Energy Rantau Dedap has constructed a 98.4MW power plant in South Sumatra Province of Indonesia, and all the generated power from the plant will be dispatched to PT. PLN (Persero) under a 30-year power purchase agreement.
Responsible Entity	Marubeni Corporation PT Supreme Energy Rantau Dedap
Production Scale	98.4MW
Progress Status as of March 2025	The project is completed and has been commercialised
Commercial Operation Start Period	December 2021

Project site (Quoted from INPEX website[12])



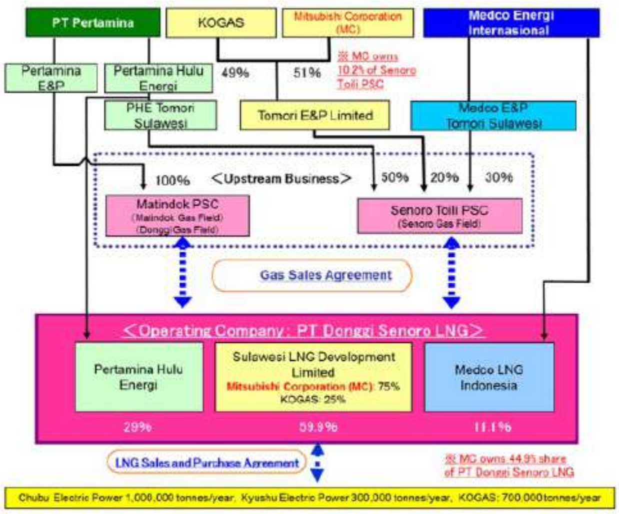
Photos (Quoted from Marubeni Corporation website[13])

[12] https://www.inpex.com/english/news/english/news/assets/pdf/20221025e.pdf
[13] https://www.marubeni.com/jp/news/2022/release/00002.html

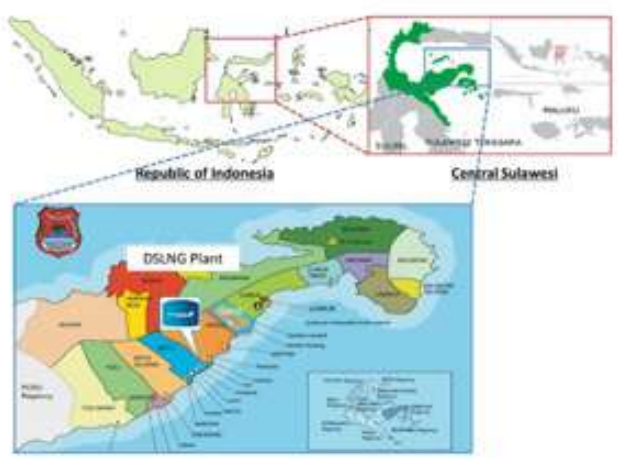
Donggi-Senoro LNG project

Project Overview	This project involves constructing and operating an LNG plant in Central Sulawesi, Indonesia, and producing and selling LNG.
Responsible Entity	Mitsubishi Corporation PT Donggi Senoro LNG
Project Scale (US$)	US$2.9 billion
Production Scale	2 million tonnes per year (LNG production)
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Planned Commercial Operation Start Period	June 2015

Project scheme (Quoted from Mitsubishi Corporation website[14])



Project site (Quoted from Mitsubishi Corporation website)



Location of project site

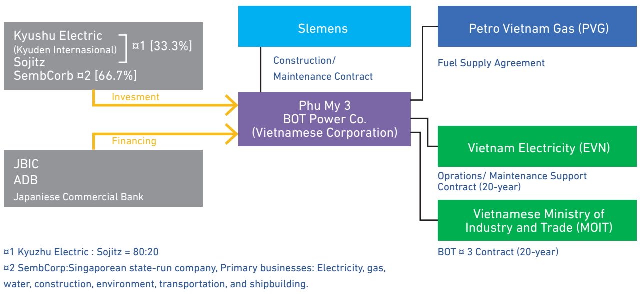
[14] First Shipment of LNG from Donggi-Senoro Project in Indonesia | News Release | News | Mitsubishi Corporation

NEXI signs MOU with PT PLN

Responsible Entity	PT PLN (Persero) (PLN)
Project Goals/KPI	The MOU, which is in line with NEXI's LEAD Initiative, mainly aims to establish a framework for dialogue between NEXI and PLN, to strengthen cooperation in Indonesia's power sector and to support Indonesia's initiatives for decarbonisation.
Progress Overview	In 2022, this MOU was amended. The Amendment will provide financial support of a maximum of US$500 million to PLN from NEXI to facilitate the decarbonisation of Indonesia and aims to provide opportunities in introducing the technologies developed by Japanese companies to PLN. Furthermore, in 2023, this MOU was amended to confirm the loan period and use of funds for US$200 million of the US$500 million.
URL	https://www.nexi.go.jp/topics/newsrelease/2022042206.html

Phu My III Gas Combined Cycle IPP

Project Overview	Domestic natural gas from the Nam Con Son undersea gas field in Vietnam's southeastern ocean is utilised for the generation of electricity via highly fuel-efficient gas combined cycle technology. The generated electricity is then sold to Vietnam Electricity (EVN) under a 20-year power purchase agreement.
Responsible Entity	Sojitz Corporation Phu My 3 BOT Power Company Ltd
Production Scale	744MW
Progress Status as of March 2025	The MOU project is completed and has been commercialised
Planned Commercial Operation Start Period	March, 2004



Project scheme (Quoted from Kyuden website)

Project photo (Quoted from EVN website)

Project scheme

December, 2001	Start of construction
March, 2004	Start of operation

JCM Projects in AZEC partners by MOEJ (The Ministry of the Environment, Japan)
(as of 18 April 2025)

Project Outline	Organisation
Cambodia/Introduction of 1MW Solar Power System and High Efficiency Centrifugal Chiller in Large Shopping Mall	AEON Mall Co., Ltd.
Cambodia/Introduction of 1.1MW Solar Power System at International School	Asian Gateway Corporation
Cambodia/Introduction of Ultra-lightweight Solar Panels for Power Generation at International School	Asian Gateway Corporation
Cambodia/10MW Solar Power and 3MWh Storage Battery Project in Pursat Province	Chugoku Electric Power Co., Inc
Cambodia/Energy Saving by Inverters for Distribution Pumps in Water Treatment Plant	Metawater Co., Ltd.
Cambodia/20MW Solar Power Project in Krakor, Pursat Province	MinebeaMitsumi Inc.
Cambodia/Introduction of High Efficiency LED Lighting Utilising Wireless Network	MinebeaMitsumi Inc.
Indonesia/Energy Saving Project in the Automotive Glass Manufacturing Process	AGC Inc.
Indonesia/Improvement of Combustion Method and Furnace Shapes in Flat Glass Production Melting Furnace	AGC Inc.
Indonesia/4.2MW Rooftop Solar Power Project to Pharmaceutical Factories, Vehicles Dealers, and Timber Factories	Alamport Inc.
Indonesia/Introduction of 3.1MW Rooftop Solar Power System to Fast-Moving Consumer Goods and Printing Factories in Java Island	Alamport Inc.
Indonesia/Introduction of 3MW Rooftop Solar Power System to Paper Factory in Java Island	Alamport Inc.
Indonesia/12MW Biomass Power Plant Project in Aceh Province, Sumatera	AURA-Green Energy Co., Ltd.
Indonesia/2MW Mini Hydro Power Plant Project in East Nusa Tenggara Province	AURA-Green Energy Co., Ltd.
Indonesia/Introduction of Gas Co-generation System and Absorption Chiller to Motor Parts Factory	DENSO CORPORATION

Project Outline	Organisation
Indonesia/Introduction of High-efficiency Once-through Boiler System to Chemical Factory	DIC Corporation
Indonesia/Energy Saving for Air-Conditioni0ng and Process Cooling at Textile Factory (in Batang city)	Ebara Refrigeration Equipment & Systems Co., Ltd
Indonesia/Energy Saving for Air-Conditioning and Process Cooling at Textile Factory	Ebara Refrigeration Equipment & Systems Co., Ltd
Indonesia/Energy Saving for Textile Factory Facility Cooling by High Efficiency Centrifugal Chiller	Ebara Refrigeration Equipment & Systems Co., Ltd
Indonesia/Introduction of LED Lighting to Sales Stores	Fast Retailing Co., Ltd.
Indonesia/Introduction of High-Efficiency Thermal Oil Heater System in Chemical Factory	FUMAKILLA LIMITED
Indonesia/Energy Saving in Industrial Wastewater Treatment System for Rubber Industry	General Incorporated Foundation of Japan Kansai Environmental Management Technology Center
Indonesia/Introduction of CNG-Diesel Hybrid Equipment to Public Bus in Semarang	Hokusan Co., Ltd.
Indonesia/Installation of Solar Power System and Storage Battery to Commercial Facility	ITOCHU Corporation
Indonesia/Introduction of High Efficiency Boiler System to Carton Box Factory	Japan Pulp and Paper Company Limited
Indonesia/Power Generation by Waste Heat Recovery in Cement Industry	JFE Engineering Corporation
Indonesia/①REDD+ project in Boalemo District through controlling slush-and-burn ②REDD+ project in Boalemo District	Kanematsu Corporation
Indonesia/Introduction of high efficient Old Corrugated Cartons Process at Paper Factory	Kanematsu Corporation
Indonesia/Introduction of 0.8MW Rooftop Solar Power System to Automotive Parts Factory	Kansai Electric Power Company, Incorporate
Indonesia/Introduction of 1.5MW Rooftop Solar Power System to Food and Automotive Parts Factories	Kansai Electric Power Company, Incorporate
Indonesia/Energy Savings at Convenience Stores	Lawson, Inc.
Indonesia/Energy Efficient Refrigerants to Cold Chain Industry	Mayekawa Manufacturing Co., Ltd.
Indonesia/Introduction of High Efficiency Once-through Boiler System in Film Factory	Mitsubishi Chemical Corporation

Project Outline	Organisation
Indonesia/Introduction of 0.5MW Solar Power System to Aroma and Food Ingredients Factory	Next Energy & Resources Co., Ltd.
Indonesia/Introduction of High Efficiency Looms in Weaving Mill	Nisshinbo Textile Inc.
Indonesia/6MW Mini Hydro Power Plant Project in West Pasaman, West Sumatra	NiX JAPAN Co., Ltd.
Indonesia/Energy Saving for Air-Conditioning at Shopping Mall with High Efficiency Centrifugal Chiller	NTT Facilities, Inc.
Indonesia/Energy Saving for Industrial Park with Smart LED Street Lighting System	NTT Facilities, Inc.
Indonesia/Energy Saving by Introducing High Efficiency Autoclave to Infusion Manufacturing Factory	Otsuka Pharmaceutical Factory, Inc.
Indonesia/Energy Saving by Introducing High Efficiency Autoclave to Infusion Manufacturing Factory 2	Otsuka Pharmaceutical Factory, Inc.
Indonesia/Patuha Unit-2 55MW Geothermal Power Generation Project	PT Geo Dipa Energi
Indonesia/3.5MW Mini Hydro Power Plant at Pungga River in North Sumatra	SDG Impact Japan Inc.
Indonesia/1.6MW Solar PV Power Plant Project in Jakabaring Sport City	Sharp Energy Solutions Corporation
Indonesia/Introduction of 2.1MW Rooftop Solar Power System in Woodworking Factories	Sumitomo Forestry Co., Ltd.
Indonesia/Introduction of High Efficiency Once-through Boiler in Golf Ball Factory	Sumitomo Rubber Industries, Ltd.
Indonesia/Introduction of 2.1MW Solar Power System to Steel Wire Products and Aluminum Factories	Tokyo Century Corporation
Indonesia/Introduction of Absorption Chiller to Chemical Factory	Tokyo Century Corporation
Indonesia/Introduction of High Efficiency Injection Molding Machine to Plastic Parts Factory	Tokyo Century Corporation
Indonesia/Reducing GHG emission at textile factories by upgrading to air-saving loom	Toray Industries, Inc.
Indonesia/10MW Mini Hydro Power Plant Project in North Sumatra	Toyo Energy Farm Co., Ltd.
Indonesia/Introduction of 5MW Solar Power System to Vehicle and Engine Plants	Toyota Motor Corporation

Project Outline	Organisation
Indonesia/Energy Saving by Double Bundle-Type Heat Pump at Beverage Plant	Toyota Tsusho Corporation
Indonesia/Installation of Gas Co-generation System for Automobile Manufacturing Plant	Toyota Tsusho Corporation
Indonesia/Energy Saving through Introduction of Regenerative Burners to the Aluminum Holding Furnace of the Automotive Components Manufacturer	Toyotsu Machinery Co., Ltd.
Indonesia/10MW Hydro Power Project in Bengkulu Province	Voith Fuji Hydro K.K.
Indonesia/5MW Hydro Power Project in Bengkulu Province	Voith Fuji Hydro K.K.
Indonesia/6MW Hydro Power Project in West Sumatera Province	Voith Fuji Hydro K.K.
Indonesia/Rehabilitation Project of Power Generation System at Karai 7 Mini Hydro Power Plant	Voith Fuji Hydro K.K.
Indonesia/2.3 MW Mini Hydro Power Plant Project in Melesom River, Lampung Province	WWS-Japan Co.
Indonesia/6MW Mini Hydro Power Plant Project in Besay River, Lampung Province	WWS-Japan Co.
Indonesia/Installation of Energy Saving Equipment and Solar Power System to Complex Building in Jakarta	Yuko Keiso Co., Ltd.
Lao PDR/7MW Solar Power Project in Vientiane Province	Liberal Solutions Co.,Ltd.
Lao PDR/11MW Solar Power Project in Savannakhet Province	Sharp Energy Solutions Corporation
Lao PDR/Introduction of 14MW floating solar power system in Vientiane	TSB Co., Ltd.
Lao PDR/①②③REDD+ project in Luang Prabang Province through controlling slush-and-burn ④REDD+ project in Luang Prabang Province through controlling shifting cultivation	①②③Waseda University ④ Waseda University, Marubeni Corporation
Lao PDR/Introduction of Amorphous High Efficiency Transformers in Power Grid	Yuko Keiso Co., Ltd.
Lao PDR/Introduction of Amorphous High Efficiency Transformers in Power Grid II	Yuko Keiso Co., Ltd.
Philippines/Introduction of 6MW Power Generation System by Waste Heat Recovery for Cement Plant	Global Engineering Co., Ltd.

Project Outline	Organisation
Philippines/Biogas Power Generation and Fuel Conversion Project in Pineapple Canneries	ITOCHU Corporation
Philippines/28MW Binary Power Generation Project at Mahanagdong Geothermal Power Plant	JGC Corporation
Philippines/5.6MW Geothermal Binary Power Generation Project in Northern Negros	JGC Corporation
Philippines/11.3MW Mini Hydro Power Plant in Tumauini	Kanematsu Corporation
Philippines/10MW Solar Power Project in San Jose, Luzon Island	Kyuden International Corporation
Philippines/27MW Solar Power Project in Dagohoy, Bohol Island	Kyuden International Corporation
Philippines/Development of a Fluorocarbon Collection and Destruction Model Project in Metro Manila, Philippines Utilising Mixed Combustion Technologies	Marubeni Corporation
Philippines/Energy Supply Project by 4.4MW Solar Power System to Ceramic Factory and Cement Plant	Marubeni Corporation
Philippines/29MW Binary Power Generation Project at Palayan Geothermal Power Plant	Mitsubishi Heavy Industries, Ltd.
Philippines/Tanawon 20MW Flash Geothermal Power Plant Project	Mizuho-Toshiba Leasing Company Ltd.
Philippines/Introduction of 4MW Rooftop Solar Power System in Tire Factory	Sharp Energy Solutions Corporation
Philippines/4.5MW Mini Hydro Power Plant in Piapi River, Luzon	TOKAI CORPORATION
Philippines/7MW Solar Power Project in Collaboration with Power-supply Company	Tokyo Century Corporation
Philippines/9.6MW Solar Power Project in Collaboration with Power-supply Company	Tokyo Century Corporation
Philippines/Installation of 1.2MW Rooftop Solar Power System in Refrigerating Warehouse	Tokyo Century Corporation
Philippines/Introduction of 0.8MW Solar Power System to Aluminum Products, Packaging Materials and Automotive Parts Factories (JCM Eco Lease Scheme)	Tokyo Century Corporation
Philippines/Introduction of 1.2MW Rooftop Solar Power System to Electronic Equipment Assembly Factory (JCM Eco Lease Scheme)	Tokyo Century Corporation

Project Outline	Organisation
Philippines/Introduction of 1.53MW Rooftop Solar Power System in Auto Parts Factories	Tokyo Century Corporation
Philippines/Introduction of 1MW Rooftop Solar Power System in Vehicle Assembly Factory	Toyota Motor Corporation
Philippines/14.5MW Mini Hydro Power Plant Project in Siguil River in Mindanao	Toyota Tsusho Corporation
Thailand/Introduction of High Efficiency Ion Exchange Membrane Electrolyzer in Caustic Soda Production Plant	AGC Inc.
Thailand/Introduction of ORC Waste Heat Recovery Power Generation System to Flat Glass Factory	AGC Inc.
Thailand/Introduction of Energy Efficient Refrigeration System in Logistics Center	Bando Chemical Industries, Ltd.
Thailand/Introduction of Heat Recovery Heat Pumps to Food Processing Factory	CPF JAPAN Co., Ltd.
Thailand/Productivity Improvement of Aluminium Ingots Using High Efficiency Furnace System	Daiki Aluminium Industry Co., Ltd.
Thailand/Introduction of Co-generation System to Motor Parts Factory	DENSO Corporation
Thailand/Project on Introduction of Scheme for Fluorocarbons Recovery and Destruction with Utilisation of Existing Waste Incineration Plant	DOWA ECO-SYSTEM CO., LTD.
Thailand/Energy Saving at Convenience Stores with High Efficiency Air-Conditioning and Refrigerated Showcase	FamilyMart Co., Ltd.
Thailand/Introduction of LED Lighting to Sales Stores	Fast Retailing Co., Ltd.
Thailand/Introduction of 2MW Rooftop Solar Power System for Power Supply in Factory	Finetech Co., Ltd.
Thailand/Introduction of Biomass Co-Generation System to Food Factory	Fuji-Foods Corporation
Thailand/2.7MW Solar Power Project with Blockchain Technology in Chiang Mai University Town Community	Inabata & Co., Ltd.
Thailand/Energy Saving for Air-Conditioning in Tire Manufacturing Factory with High Efficiency Centrifugal Chiller	Inabata & Co., Ltd.
Thailand/Introduction of Energy Efficiency Refrigeration System in Industrial Cold Storage	Kanematsu Corporation

Project Outline	Organisation
Thailand/Introduction of 0.8MW Solar Power System and High Efficiency Refrigerator to Food Factory	Kanematsu KGK Corp.
Thailand/Energy Supply Project by 4.0MW Rooftop Solar Power System to Parts and Tools Factories	Kansai Electric Power Company, Incorporate
Thailand/Introduction of 2.6MW Rooftop Solar Power System to Semiconductor Factory	Kansai Electric Power Company, Incorporate
Thailand/Introduction of 2MW Rooftop Solar Power System to Non-ferrous Metal Factory	Kansai Electric Power Company, Incorporate
Thailand/Introduction of 8.1MW Rooftop Solar Power System in Motorcycle Factory and Fiber Factory	Kansai Electric Power Company, Incorporate
Thailand/Introduction of Energy Saving Centrifugal Chillers to Machinery Factory	Kansai Electric Power Company, Incorporate
Thailand/Introduction of Gas Co-generation System and 22MW Rooftop Solar Power System to Tire Factory	Kansai Electric Power Company, Incorporate
Thailand/Introduction of High Efficiency Boiler, High Efficiency Chiller, and Solar PV System to Textile Factory and Food Factory	Kansai Electric Power Company, Incorporate
Thailand/Introduction of Energy Saving Refrigerator and Evaporator with Mechanical Vapor Recompression in Amino Acid Producing Plant	Kyowa Hakko Bio Co., Ltd.
Thailand/Demonstration Project of Perovskite Solar Cell System in Subtropical Region	Macnica, Inc.
Thailand/Energy Supply Project by 0.9MW Rooftop Solar Power System to Metal Recycling and Automotive Parts Factories	Marubeni Corporation
Thailand/104MW Solar Power and 129MWh Storage Battery Project in Bang Pa-in, Ayutthaya Province	MinebeaMitsumi Inc.
Thailand/48MW Solar Power and 60MWh Storage Battery Project in Lopburi Province	MinebeaMitsumi Inc.
Thailand/Installation of Co-Generation Plant for On-Site Energy Supply in Motorcycle Factory	Nippon Steel & Sumikin Engineering Co., Ltd
Thailand/Efficiency Improvement of Co-generation System by Installation of Heat Exchanger in Fiber Factory	NIPPON STEEL ENGINEERING CO., LTD.
Thailand/Introduction of Biomass Co-generation System to Chemical Factory	NIPPON STEEL ENGINEERING CO., LTD.

Project Outline	Organisation
Thailand/Introduction of 12MW Power Generation System by Waste Heat Recovery for Cement Plant	NTT DATA Institute of Management Consulting, Inc.
Thailand/Energy Supply Project by 2.9MW Rooftop Solar Power System to Metal Factories and Refrigerating Warehouse	Osaka Gas Co., Ltd.
Thailand/Introduction of High Efficiency Once Through Boiler to Garment Factory	Osaka Gas Co., Ltd.
Thailand/Introduction of Solar PV System on Factory Rooftop	Pacific Consultants Co., Ltd.
Thailand/Introduction of 3.4MW Rooftop Solar Power System to Air-conditioning Parts Factories	Sharp Energy Solutions Corporation
Thailand/Introduction of 30MW Rooftop Solar Power System to Large Supermarkets	Sharp Energy Solutions Corporation
Thailand/Introduction of 18.9MW Rooftop and Floating Solar Power System to Factories	Shizen Energy Inc.
Thailand/Introduction of 2MW Rooftop Solar Power System to University	SHIZUOKA GAS CO., LTD.
Thailand/Energy Saving for Semiconductor Factory with High Efficiency Centrifugal Chiller and Compressor	Sony Semiconductor Solutions Corporation
Thailand/Installation of High Efficiency Air Conditioning System and Chillers in Semiconductor Factory	Sony Semiconductor Solutions Corporation
Thailand/Introduction of 5MW Rooftop Solar Power System to Aluminum Building Materials Factory	Sumitomo Mitsui Finance and Leasing Company, Limited
Thailand/Introduction of Biomass Boiler to Cooking Oil Factory	TEPIA Corporation Japan Co.,Ltd
Thailand/Introduction of High Efficiency Chilled Water Supply System in Milk Factory	TEPIA Corporation Japan Co.,Ltd
Thailand/17.8MW Rooftop and Floating Solar Power Project in Industrial Park	Tokyo Century Corporation
Thailand/Introduction of 0.13MW Solar Power System to Auto Parts Factory (JCM Eco Lease Scheme)	Tokyo Century Corporation
Thailand/Introduction of 1.3MW Solar Power System to Food Factories (JCM Eco Lease Scheme)	Tokyo Century Corporation

Project Outline	Organisation
Thailand/Introduction of 1.6MW Solar Power System to Plastic Bottles and Cosmetics Factories (JCM Eco Lease Scheme)	Tokyo Century Corporation
Thailand/Introduction of Solar Power and Heat Battery to Packaging Factory	Tokyo Century Corporation
Thailand/Reducing GHG Emission at Textile Factory by Upgrading to Air-saving Loom (Samutprakarn)	Toray Industries, Inc.
Thailand/Introduction of 3.4 MW Rooftop Solar Power System in Technical Center and Office Buildings	Toyota Motor Corporation
Thailand/Introduction of 37 MW Solar Power System and High Efficiency Melting Furnace in Vehicle & Engine Factory	Toyota Motor Corporation
Thailand/Introduction of 5MW Floating Solar Power System on Industrial Water Reservoir	TSB Co., Ltd.
Thailand/Energy Saving by Air-Conditioning Control System in Precision Parts Factories	Yuasa Trading Co., Ltd.
Viet Nam/ Introduction of High Efficiency Boiler System to Food Factory	Acecook Co., Ltd,
Viet Nam/Introduction of Solar PV System at Shopping Mall in Ho Chi Minh City	AEON Retail Co., Ltd.
Viet Nam/Introduction of Biomass Boiler to Chemical Factory	DAIICHI JITSUGYO CO., LTD.
Viet Nam/Introduction of High Efficiency LED Lighting with Dimming and Tunable Function to Office Building in Ho Chi Minh City	ENDO Lighting Corporation
Viet Nam/20MW Biomass Power Plant Project in Hau Giang Province	erex Co.,Ltd.
Viet Nam/50MW Biomass Power Project in Tuyen Quang Province	erex Co.,Ltd.
Viet Nam/50MW Biomass Power Project in Yen Bai Province	erex Co.,Ltd.
Viet Nam/Introduction of Air Cooled Chiller to Office Building	Hitachi-Johnson Controls Air Conditioning, Inc.
Viet Nam/Introduction of High Efficiency Air-conditioning System to Hotel in Ho Chi Minh City	Hitachi-Johnson Controls Air Conditioning, Inc.
Viet Nam/Installation of Energy Saving Equipment in Lens Factory	HOYA Corporation
Viet Nam/Waste to Energy project in Bac Ninh Province	JFE Engineering Corporation

Project Outline	Organisation
Viet Nam/16MW Mini Hydro Power Plant Project in Binh Thuan Province	Kanematsu KGK Corp.
Viet Nam/49MW Solar Power Project in An Giang Province	Kanematsu KGK Corp.
Viet Nam/57MW Solar Power Project in An Giang Province	Kanematsu KGK Corp.
Viet Nam/Energy Supply Project by 0.8MW Rooftop Solar Power System to Chemical Factory	Kansai Electric Power Company, Incorporate
Viet Nam/Energy Supply Project by 1.25MW Rooftop Solar Power System to Plastics Factory	Kansai Electric Power Company, Incorporate
Viet Nam/Energy Supply Project by 1.8MW Rooftop Solar Power System to Automotive Parts Factory and Construction Materials Factory	Kansai Electric Power Company, Incorporate
Viet Nam/Energy Supply Project by 15MW Rooftop Solar Power System to Factories	Kansai Electric Power Company, Incorporate
Viet Nam/Energy Supply Project by 7.9MW Rooftop Solar Power System to Automotive and Garment Factories	Kansai Electric Power Company, Incorporate
Viet Nam/Introduction of 2.5MW Rooftop Solar Power System to Food Factory and Garment Factory	Kansai Electric Power Company, Incorporate
Viet Nam/Development of Collection Scheme and Introduction of Dedicated System for Destruction of Used Fluorocarbons in Viet Nam	Marubeni Corporation
Viet Nam/Development of Fluorocarbons collection scheme and installation of mixed combustion decomposition facility in Viet Nam	Marubeni Corporation
Viet Nam/Introduction of 12MW Rooftop Solar Power System to Commercial and Industrial Customers	Marubeni Corporation
Viet Nam/Introduction of 4.1MW Rooftop Solar Power System to Medical Equipment, Food, and Automobile Parts Factories	Marubeni Corporation
Viet Nam/Introduction of 5.8MW Rooftop Solar Power System to Fastener Factories	Marubeni Corporation
Viet Nam/Introduction of Biomass Boiler to Soluble Coffee Manufacturing Plant	Marubeni Corporation
Viet Nam/Modal Shift from Truck to Cargo Ship with Freshness Preservation Reefer Container	Nihon Crant Co. Ltd

Project Outline	Organisation
Viet Nam/Eco-Driving with the Use of Digital Tachographs	Nippon Express Co., Ltd.
Viet Nam/Introduction of High Efficiency Air-conditioning in Hotel	NTT DATA Institute of Management Consulting, Inc.
Viet Nam/Introduction of 6.5 MW Rooftop Solar Power System in Industrial Park	Osaka Gas Co., Ltd.
Viet Nam/Energy Saving in Acid Lead Battery Factory with Container Formation Facilit	Resonac Corporation
Viet Nam/Energy Saving in Lens Factory with Energy Efficient Air-Conditioners	Ricoh Company, Ltd.
Viet Nam/Introduction of Energy Saving Equipment to Brewery	Sapporo International Inc.
Viet Nam/Introduction of 3.7MW Rooftop Solar Power System to Factories	Sharp Energy Solutions Corporation
Viet Nam/40MW Onshore Wind Power Generation Project in Huong Hoa District, Quang Tri Province	Shizen Energy Inc.
Viet Nam/Introduction of 0.4MW Rooftop Solar Power System to Aluminum Wheel Manufacturing Factory (JCM Eco Lease Scheme)	Sumitomo Mitsui Trust Panasonic Finance Co., Ltd.
Viet Nam/Introduction of 1.9MW Rooftop Solar Power System to Textile and Chemical Products Factories	Tokyo Century Corporation
Viet Nam/Introduction of High Efficiency Chiller and High Efficiency LED Lighting with Dimming Function to Shopping Center	Tokyu Corporation
Viet Nam/Installation of High Efficiency Kiln in Sanitary Ware Manufacturing Factory	TOTO Ltd.
Viet Nam/Introduction of Energy Saving Equipment to Automotive Wire Production Factory	Yazaki Parts Co., Ltd.
Viet Nam/Energy Saving by Introduction of Inverters for Raw Water Intake Pumps	Yokohama Water Co., Ltd.
Viet Nam/Introduction of High Efficiency Water Pumps in Da Nang City	Yokohama Water Co., Ltd.
Viet Nam/Introduction of High Efficiency Centrifugal Chiller to Rubber Products Factory	YUASA TRADING CO., LTD.
Viet Nam/Energy Saving in Factories with Air-Conditioning Control System	Yuko Keiso Co., Ltd.
Viet Nam/Introduction of Amorphous High Efficiency Transformers in Southern and Central Power Grids	Yuko Keiso Co., Ltd.

Project Outline	Organisation
Viet Nam/Introduction of Amorphous High Efficiency Transformer in Northern, Central and Southern Power Grids	Yuko Keiso Co., Ltd.
Viet Nam/Introduction of amorphous high efficiency transformers in power distribution systems	Yuko Keiso Co., Ltd.
Viet Nam/Introduction of Amorphous High Efficiency Transformers in Southern and Central Power Grids	Yuko Keiso Co., Ltd.

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