ERIA Research Project Report FY2024, No. 37

Investment Opportunities in Low-Carbon and Cutting-Edge Technology Deployment in Asia

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ERIA Research Project Report FY2024 No. 37
Published in March 2025

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List of Abbreviations

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BBK	Batam Bintan Karimun
BEDB	Brunei Economic Development Board
BOI	Board of Investments (Philippines, Thailand)
CCS	carbon capture and storage
CCUS	carbon capture, utilisation, and storage
CDC	Council for the Development of Cambodia
CES	Clean Energy Scenario
CIT	corporate income tax
ECC	Environmental Compliance Certificate
EDF	Électricité de France
EGAT	Electricity Generating Authority of Thailand
EHIA	environmental health impact assessment
EIA	environmental impact assessment
EIS	environmental impact statement
ERIA	Economic Research Institute for ASEAN and East Asia
EV	electric vehicle
EVN	Vietnam Electricity
FIT	feed-in tariff
FSPV	floating solar photovoltaic
GHG	greenhouse gas
IEA	International Energy Agency
IEEJ	The Institute of Energy Economics, Japan
ISO	International Organization for Standardization

JBIC	Japan Bank for International Cooperation
JDA	joint development agreement
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
KHN	Kayan Hydropower Nusantara
KIS	Knowledge Integration Services
LNG	liquefied natural gas
MIHEP	Mentarang Induk Hydroelectric Project
MOU	memorandum of understanding
MRC	Mekong River Commission
NDC	Nationally Determined Contributions
NEA	National Environment Agency (Singapore)
NSDP	National Strategic Development Plan (Cambodia)
NSEDP	National Socio-Economic Development Plan (Lao PDR)
PDP	Power Development Plan (Thailand, Viet Nam)
PEP	Philippine Energy Plan
PPA	power purchase agreement
PV	photovoltaic
SAF	sustainable aviation fuel
SEA	Strategic Environmental Assessment
SEZ	special economic zone

Executive Summary

Through broad market research on low-carbon energy projects under development or cancelled in ASEAN countries, the research focuses on identifying business risks and opportunities inherent in such energy projects to provide some recommendations for the stakeholders.

The following drivers are assumed to lead to project feasibility or suspension/cancellation, which are potential risks and/or opportunities for business operators.

- The background to the planning and execution of projects is the strong expectation to a stable electricity supply and low-carbon development. This is particularly the case for power source types that are considered mature technologies amongst low-carbon technologies, such as hydropower and solar power with large output. The fact that not only national and regional governments but also operators are placing importance on this point is noteworthy from the perspective of mitigating the global risk on energy security or environmental sustainability.
- The economic ripple effects on local communities are also a strong driver of power supply development, second only to the contribution to stable power supply and low carbonisation. However, hydropower, which requires large site areas and large-scale natural development, can be a positive driver of project execution and vice versa, as it can also negatively impact local communities.
- In some aspects of ground-mounted solar photovoltaic (PV), which has become sufficiently low-cost through accumulated experience in developed countries, the benefits of its lower costs are becoming apparent in emerging countries. On the other hand, technologies such as floating solar PV, which are still in the developing phase even in developed countries, still have a non-negligible risk of cost overruns.
- It is interesting and thought-provoking that 'stability of policy' is mentioned as a driver for both positive and negative aspects. As low-carbon energy technologies are largely dependent on nature and the environment, and environmental regulations at national and local levels have a significant impact on project viability, policy predictability may be the most important factor for operators in determining the fate of their projects.

There are not many studies that focus on the risks whilst many economists, researchers, and news releases emphasise business opportunities or successfully completed projects. However, it is also important to learn about business risks not only from completed projects but also from ongoing or failed projects. In this regard, this research may provide new perspectives for those involved in low-carbon innovative energy projects.

Chapter 1

Background and Purpose

Recently, every country in Asia is deploying or planning to deploy low-carbon energy technologies such as solar photovoltaic (PV), wind energy, hydropower, biomass, hydrogen, etc. There can be several reasons for deploying such technologies: (i) to meet the rapidly increasing energy demand in their country, (ii) to achieve carbon neutrality during the mid-21st century, (iii) to mitigate air pollution that is harmful for the people's health, etc.

In any case, appropriate and timely decisions of investment in such new technologies would be a key issue for business entities and stakeholders in ASEAN and East Asian countries.

Therefore, this research project, conducted by the Institute of Energy Economics, Japan (IEEJ), focuses on identifying business risks and opportunities inherent in such energy projects to provide recommendations for the stakeholders.

In this regard, IEEJ carried out broad market research on low-carbon energy projects under development or cancelled in ASEAN countries. This research includes brief explanations of energy policy, investment promotion, and environmental protection policy of each country. After gathering information of each country, IEEJ sorted the projects by country, by technology, and by their status. And IEEJ conducted more detailed research to identify risks and opportunities of each project. In this process, IEEJ classified each risk and opportunity factor into several categories to make an efficient and effective analysis. Finally, IEEJ found some implications to improve the business environment of low-carbon energy technologies in ASEAN countries.

At the same time, IEEJ held an online workshop to explain the outline of this research project and to share views of international experts. The summary of the workshop is also included in this report (see Appendix).

Not many studies focus on the risks whilst many economists, researchers, and news releases emphasise business opportunities or successfully completed projects. However, it is also important to learn about business risks not only from completed projects but also from ongoing or failed projects. In this regard, this research may provide new perspectives for those involved in low-carbon innovative energy projects.

Chapter 2

Status in ASEAN Member Countries

2.1. Brunei Darussalam

(1) Basic Energy Policy

In 2004, Brunei announced Wawasan Brunei 2035, instituted a long-term development planning policy through 2035. Based on this plan, the Energy White Paper was formulated in 2013 as an action framework for the country to address challenges and manage anticipated risks. In the Energy White Paper, three strategic objectives in Brunei's energy sector development strategy were set out as follows (Energy Department, 2013).

- Strategic objective 1: Enhancement and growth of upstream and downstream activities on oil and gas. In upstream sectors, the reserve replacement ratio (RRR, the ratio of production to stockpile) is used as an indicator of production control to ensure sustainable production in existing mining areas and explore new mining areas. Brunei is also actively attracting foreign investments to promote the development of unconventional resources such as coal bed methane and shale gas.
- Strategic objective 2: Security of safe, secure, reliable, and efficient energy supply and use. In accordance with the commitment to the Asia-Pacific Economic Cooperation, Brunei will reduce its energy intensity by 45% from 2005 by 2035 and increase the share of renewable energy in its total electricity generation by 2.7% (124,000 MWh) by 2017 and 10% (954,000 MWh) by 2035.
- Strategic objective 3: Maximisation of economic spin-offs from the energy industry and increase of local procurement rate. Brunei seeks to sophisticate and increase the efficiency of its oil and gas industries by introducing technologies from overseas and, in the long term, transfer those innovative technologies to domestic companies and foster local industries. The goal is to increase the contribution of local industries to their economy from 15% in 2010 to at least 80% by 2035.

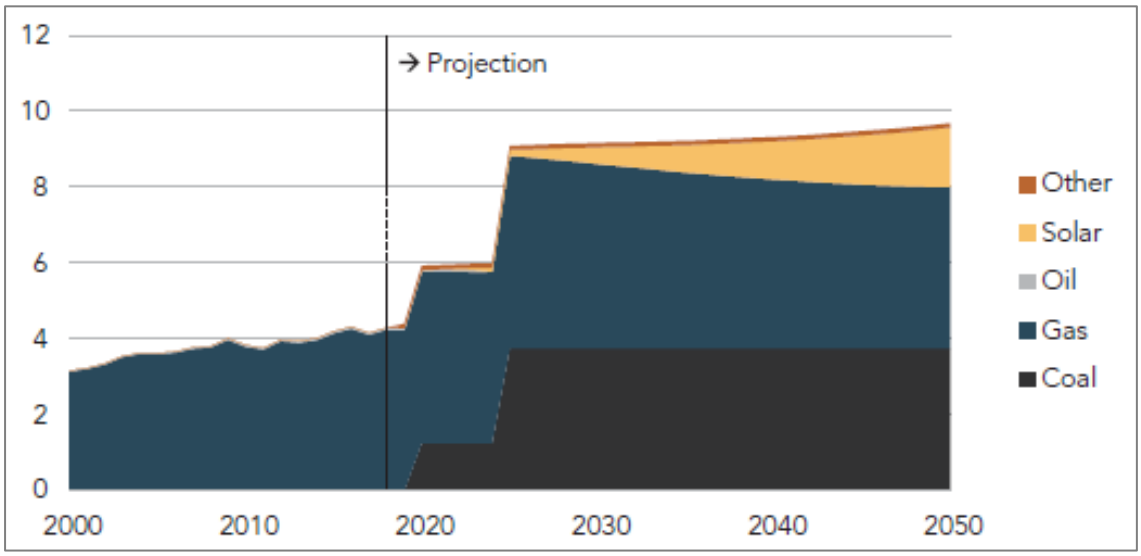
These objectives are to first conserve fossil fuel resources such as oil and gas, which

are Brunei's traditional strategic industries, and then promote renewable energy and energy conservation, which provides alternatives and economic growth, to achieve reliable and efficient energy supply.

(2) Power Portfolio and Projection

Brunei's electricity mix and projected electricity supply mix to 2050 are shown in Figure 2.1. Brunei aims to achieve low-carbon emissions and higher efficiency in its power sector by adding renewable energy to its electricity mix, which is approximately 80% dependent on natural gas as of 2020, and by improving the efficiency of power generation.

Figure 2.1. Electricity Generation Projection in Brunei



Source: APERC (2022).

At the Mid-Year Conference and Exhibition 2023 – Energy Seminar in July 2023, Haji Awang Halbi, a Minister in the Office of the Prime Minister of Brunei, said that the country's solar power generation capacity will be expanded to 200 MW by 2025, and that 35% of electricity will come from renewable energy by 2035 (Xinhua, 2023).

(3) Support Schemes and Regulations

Support for Investment

Brunei is actively attracting foreign investments to develop its economy and sophisticate strategic industries such as oil and gas. The Brunei Economic

Development Board (BEDB), reorganised from the former Foreign Direct Investment Action and Support Center, has been working on developing new industries, including attracting foreign companies, starting in May 2019. The BEDB has identified (i) downstream oil and gas, (ii) manufacturing, (iii) food, (iv) tourism, and (v) information and communications as the main sectors attracting investment and has made each English application form available on the web. Businesses wishing to develop operations in these areas in Brunei will submit their plans to the BEDB for approval using this form.

Environmental Regulation

The Department of Environment, Parks and Recreation, established in 2002 under the Ministry of Development, is responsible for assessing the environmental impact of projects and development. This department has issued guidelines for environmental impact assessment (EIA) based on the law, with which operators are obliged to comply in any development.

With 72% of its land covered by forests, Brunei focuses on environmental conservation and resource development. In July 2020, the National Council on Climate Change announced the Brunei Darussalam National Climate Change Policy, which consists of the following 10 strategies (Brunei Climate Change Secretariat, 2020).

1. Reduce greenhouse gas (GHG) emissions in the industrial sector, including emissions from flaring, as much as possible.
2. Strive to conserve and restore forests and plant 500,000 saplings.
3. Use electric vehicles (EVs) for 60% of their annual sales in the transportation sector.
4. Increase the share of renewable energy in its installed capacity for power generation to at least 30%.
5. Reduce GHG emissions from the power sector by 10% through appropriate management of electricity supply and demand.
6. Promote emission reductions through the introduction of a carbon pricing system.
7. Reduce waste generation to less than 1 kg per person per day.
8. Improve resilience to climate change.
9. Manage carbon emissions numerically on a monthly basis.
10. Enhance the education system on climate change impact mitigation.

(4) Low-carbon Energy Projects

Projects in the Planning or Construction Phase

As of January 2024, two solar power plants are known to operate in Brunei: the Tenaga Suria Brunei Power Station (1.2 MW), which started operation in 2011, and the Flagship Solar PV (3.3 MW), operated by Brunei Shell Petroleum Co. Sdn Bhd (BSP). Whilst other information indicates that Bukit Panggal and Belingus solar power plants are in the planning stage (The Scoop, 2021a), those for which specifications have been clarified are limited to the Brunei Solar PV Park (30 MW), which is scheduled to begin operation in 2025 (Global Energy Monitor[1]), and several other stations including floating type.

Table 2.1. Solar PV Projects under Planning in Brunei

Type	Site	Capacity (MW)
Floating PV	Tasek Dam	55
	Mengkubau Dam	126
	Benutan Dam	408
	Ulu Tutong Dam	330
	Kargu Dam	183
	Kago Dam	171
	Imang Reservoir	120
	Serasa Bay	30
	Both sides of Temburong Bridge	640
	Muara Besar Island	30
Ground-mounted PV	Brunei PV solar park (*)	30
	Kampung Sungai Akar	38
	Pekan Belait	56
	Sungai Teraban	200
Total capacity (MW)		**2,417**

Sources: (*) Global Energy Monitor (https://www.gem.wiki/Brunei_PV_solar_farm); (other than *) ERIA (2023).

[1] Global Energy Monitor, https://www.gem.wiki/Brunei_PV_solar_farm

Plans for low-carbon technology plants other than solar power (hydro, wind, geothermal, and biomass) have not been confirmed from public information.

Projects Delayed, Suspended, or Cancelled

Amongst the planned plants in Table 2.1, the plan for the Kampung Sungai Akar solar farm is reported to have been postponed to 2023 (Global Energy Monitor[2]).

In June 2021, Brunei's Ministry of Energy identified the following nine locations as candidate sites for medium- to long-term introduction of floating solar photovoltaics (FSPV) (The Scoop, 2021b):

- Ulu Tutong Dam
- Benutan Reservoir
- Kago Dam
- Mengkubau Dam
- Tasek Lama
- Imang Reservoir
- Sengkurong Lake
- Ikas Lake
- Tasek Pelangi Biru

In the Renewable Energy Policy and Development Forum co-hosted by the Ministry of Energy and the University of Brunei Darussalam, Muhammad Hasbur Rahman Yahaya of the ministry's Renewable Energy Division said that a 1 MW scale demonstration project would soon be launched at Tasek Pelangi Biru in Mentiri. He stated at that time that he was waiting for confirmation from the partner, but as of 2024, no further information has been confirmed. Also, there is no information that FSPV demonstrations are in progress at any of the other eight candidate sites.

The ministry's study up to 2021 showed that FSPV would be more expensive than ground-mounted PVs. Based on this, the ministry planned to compile data from demonstration tests, including construction and commissioning. According to Mr Muhammad, in a country like Brunei where land is limited, it is highly significant to open the land for other industrial uses. He also pointed out that FSPV projects have an affinity for aquaculture industry, and the panels on the water surface will help alleviate water shortages by reducing pater evaporation and algae blooms (Brunei Darussalam, 2021).

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[2] Global Energy Monitor, https://www.gem.wiki/Kampung_Sungai_Akar_solar_farm

2.2. Cambodia

(1) Basic Energy Policy

Cambodia formulates a National Strategic Development Plan (NSDP) every 4 to 5 years, the latest being NSDP 2019–2023 issued in July 2019. In the NSDP, Cambodia's environments are analysed from various perspectives, including social, economic, and political aspects as well as international relations, to develop objectives and prospects for the future. The objectives for the energy sector in the NSDP are focused on low-carbon emissions and resilience with an eye towards the development of nuclear energy as a part of this focus.

- Promoting the development of the energy sector and electricity by enhancing the connectivity to people with quality, stable, and affordable electricity from various, including hydropower, combustion, and solar power.
- Strengthening the energy techniques and electricity standard in buildings and housings.
- Strengthening the science and technology of civil nuclear energy, including radiation and nuclear energy techniques.

The Cambodian government is developing and implementing the following three national plans to balance climate change measures with economic growth, promoting the development of environmentally compatible technologies.

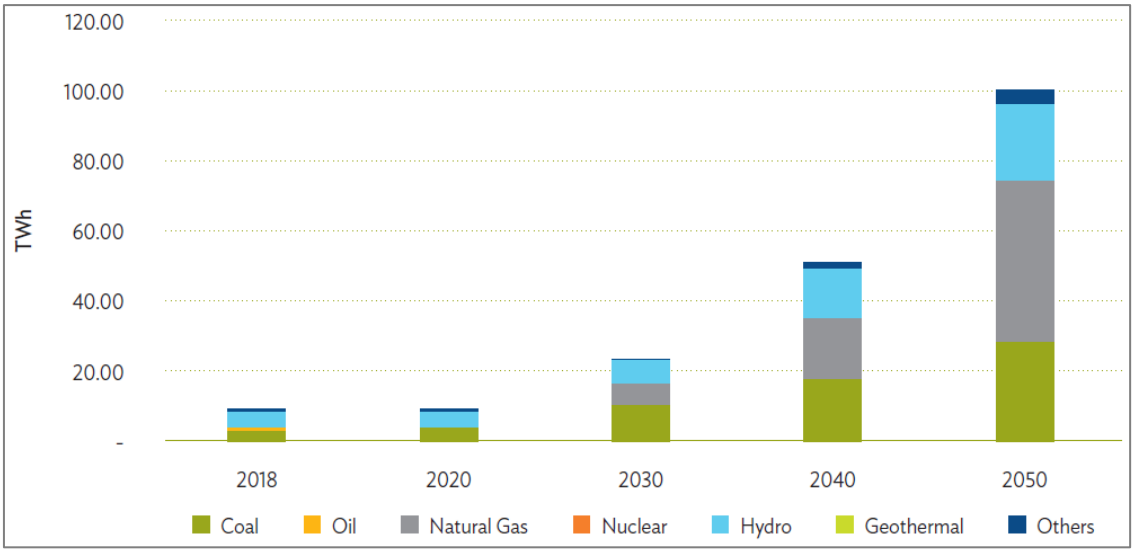
- National Strategic Plan on Green Growth 2013–2030
- Cambodia Climate Change Strategic Plan 2014–2023
- National Environment Strategy and Action Plan 2016–2023

All the plans focus on the active development of renewable (especially solar) energy, reduction of dependence on fossil fuels, and energy conservation in the energy sector. In the Nationally Determined Contributions (NDC)submitted to the UNFCCC in December 2020, the CO_2 emission reduction target by 2030 was 42% of BAU (UNFCCC, 2020).

(2) Power Portfolio and Projection

Cambodia's electricity mix and projected electricity supply mix to 2050 are shown in Figure 2.2. The country is highly dependent on coal-fired power generation. Amongst the renewable energy sources, only hydropower and solar power have room for development in the country. Both coal-fired power and hydropower are expected to increase significantly through 2050, together with a dramatic increase of natural gas.

Figure 2.2. Electricity Generation Projection in Cambodia



Source: ERIA (2021).

(3) Support Schemes and Regulations

Support for Investment

The Council for the Development of Cambodia (CDC) is the decision-making authority for development and investment activities in Cambodia and is the only one-stop service provider. Depending on the conditions, approval from the Council of Ministers, a higher-level body of the CDC, is required. Most projects related to low-carbon technology and energy are subject to approval by the Council of Ministers because they fall under the following conditions: (i) exploration and development of mineral resources, (ii) cases where adverse environmental impacts are concerned, and (iii)cases requiring a long-term development strategy. The organisation and role of the CDC is based on Sub- decree No. 60 on the Organization and Functioning of the Council for the Development of Cambodia, which stipulates cooperation with various ministries and agencies depending on the type of project.

The following are CDC's committees on investment evaluation, with their roles.

(a) Cambodian Investment Board

The roles and responsibilities are as follows:

- Implementation and coordination of the 'one-stop service mechanism' for the evaluation and approval of investments applying for a qualified investment project
- Formulation and coordination of strategies and plans for overall private

investments

- Marketing and investment promotion to potential investors
- Policy proposals for improving the legal system for investment promotion
- Coordination of and reporting to internal and external stakeholders

(b) Cambodian Special Economic Zones Board

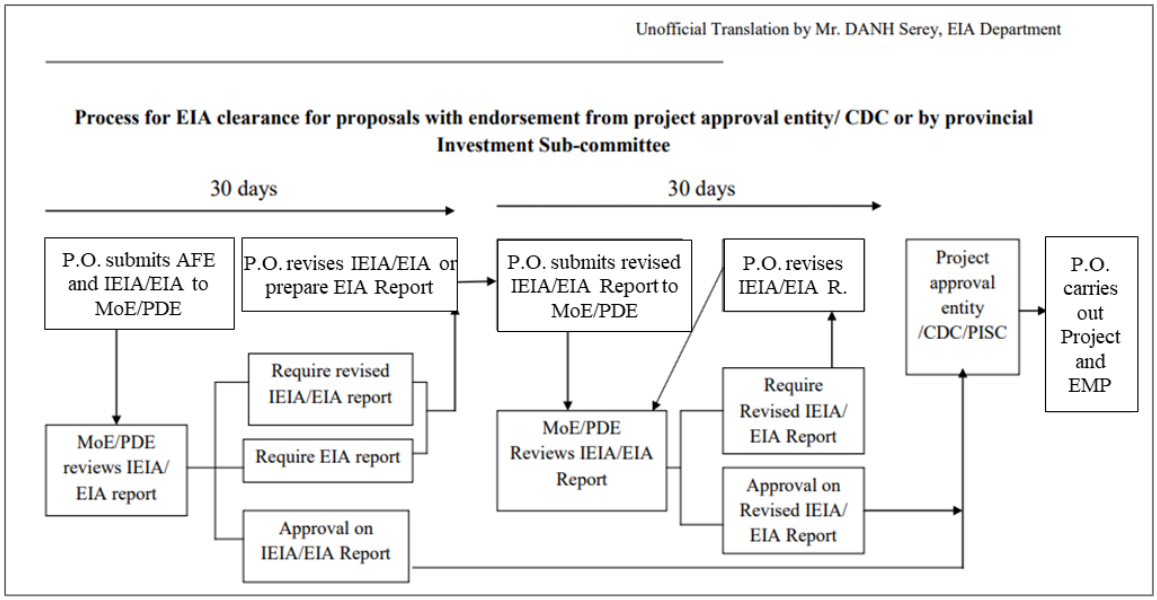
This board provides one-stop services for development, management, and supervision in special economic zones (SEZs). An SEZ is an area designated by the Cambodian government by decree, and 48 areas designated in May 2016 are covered as of 2023 (Open Development Cambodia, 2016).

Environmental Regulation

Operators involved in the development and sale of industrial infrastructure, including low-carbon energy technologies, must navigate an approval and authorisation process that encompasses site acquisition, environmental impact assessments (EIA), and compliance with various other regulations. In accordance with Sub-Decree No 72 on Environmental Impact Assessment Process (1999) on the EIA process, operators are required to undergo a review of their investment projects in the targeted sectors. The targeted sectors include mining, chemical industry facilities, power plant, and infrastructure.

The government is obliged to evaluate a project within 30 days of EIA submission from the operator, and to conduct a site visit and consultation with relevant parties within that period. Thereafter, consultations are held with other ministries and agencies as well as stakeholders from other sectors, and recommendations on project feasibility and conditions are considered. Finally, the Minister of the Environment decides on whether to approve the project (Figure 2.3).

Figure 2.3. EIA Process of Development Projects in Cambodia



Notes:

AFE = Application Form of Environment; CDC = Council for Development of Cambodia; EIA = Full Environmental Impact Assessment; EMP = Environmental Management Plan; IEIA = Initial Environmental Impact Assessment; MoE = Ministry of Environment; P.O. = Project Owner; PDE = Provincial Department of Environment; PISC = Provincial Investment Sub-committee

Source: Author based on Open Development Cambodia (2014).

According to Open Development Cambodia, which introduces policies, regulations, and projects in Cambodia, commercial consulting companies handle EIA procedures in Cambodia on behalf of its clients.

(4) Low-carbon Energy Projects

Projects in the Planning or Construction Phase

Table 2.2 lists the projects in the planning stages in Cambodia (status: announced, submitted, authorised, under construction).

Table 2.2. Projects under Planning, Licensing, or Construction in Cambodia

Plant Name	Plant Status	Operator	Commissioning Year	Energy	Technology	Net Capacity (MW)
EDC Cambodia	Announced	EDC		Solar	PV	100
Srepok	Authorised		2024	Hydro	Dam	416
Tramkok	Authorised	Global Purify Power (GPP)		Solar	PV	225
Lower Sekong	Authorised		2025	Hydro	Dam	190
Stung Veay Thmar Kambot	Authorised			Hydro		100
Stung Tatai Leu	Under construction	China National Heavy Machinery Corp (CHMC)	2025	Hydro	Dam	150
Mondulkiri	Authorised	The Blue Circle and The Royal Group	-	Wind	Onshore	100

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan (IEEJ).

(a) Tramkok Solar PV Park

Whilst no large capacity (>100 MW) solar power plants operate in Cambodia yet, Global Purify Power's (GPP) Tramkok Solar PV Park (225 MW), which received approval from the Ministry of Minerals and Energy in January 2016, is a distinctively large project. This power plant is a pilot project for PV technology development in Cambodia, with a 75 MW plant each in three commercial districts of Kampong Speu, Kampong Chhnang, and Takeo, for a total output of 225 MW. The total investment to the three facilities will be more than $400 million, according to Sok Mony, head of GPP, the operator (The Phnom Penh Post, 2016).

(b) Mondulkiri Wind Farm

Global Energy Monitor's data as of November 2023 showed that the status of this project was 'announced', but other information indicates that the project has been on hold since June 2023.[3] In May 2019, the former Ministry of Mining and Energy authorised the Chinese-capitalised renewable energy operator, Xinglan Maritime Energy Co Ltd, to conduct the first phase of its applicability study. Maritime Group announced that this study was completed in January 2021. At that time, Kong Vara, chief operating officer of Maritime Group, responded to the press that the company was in the process of negotiating the power prices after submitting a detailed technical report on the results of the applicability study to the government authorities. This situation, where no further reports have been confirmed since then and the project is said to be on hold, suggests that the price negotiations may not have been successful.

In January 2024, a Singapore-based renewable energy developer, the Blue Circle, signed a memorandum of understanding (MOU) with a Cambodia-based company, the Royal Group, to develop a 100-MW scale wind farm in Mondulkiri province. This MOU is expected to be a long-term agreement, as it relates to the development, finance, building, ownership, and operation. In March 2023, the Royal Group signed a power purchase agreement (PPA) with Keppel Energy to transmit electricity from Cambodia to Singapore via submarine cables until 2035.

Both the Blue Circle and the Royal Group claim that this project will not only contribute to the 2050 carbon neutrality goal declared by Cambodia's Ministry of Environment in 2022. It will also contribute to the stability of cost and price, further enhancing energy security and supply stability.

[3] Global Energy Monitor, https://www.gem.wiki/Mondulkiri_(XME)_wind_farm

Projects Delayed, Suspended, or Cancelled

On the other hand, many projects that were once announced have frozen or have not shown any progress. Some were cancelled by the operator. Table 2.3 lists the frozen projects.

Table 2.3. Projects Delayed, Suspended, or Cancelled in Cambodia

Plant Name	Operator	Commissioning Year	Energy	Technology	Net Capacity (MW)
Sambor			Hydro	Dam	2500
Stung Treng			Hydro	Dam	1200
Reah Solar	Willowbrook		Solar	PV	250
Russey Chrum		2016	Hydro		235
Pok Kroam - 2		2017	Hydro		222
Sesan Kroam - 2		2017	Hydro		207
Stung Cheay Areng	Sinohydro		Hydro		108
Mondulkiri - XME	Xinglan Maritime Energy CO LTD (XME)		Wind	Onshore	100

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

All of the more than 100 MW projects that have been frozen or cancelled are either solar power or hydropower plant, with the Sambor Hydropower Plant (2,500 MW) and Stung Treng Hydropower Plant (1,200 MW) being the most prominent for large-scale projects. In solar power plants, the Reah Solar Power Plant falls under this category. The following is an overview of these projects and the circumstances leading up to the freeze.

(a) Sambor Hydropower Plant

According to media reports, the Cambodian government announced in March 2020 that it would postpone its plan for large-scale hydropower plants on the Mekong River for at least 10 years, which was welcomed by nongovernmental organisations (NGOs) and environmental activists in Cambodia. Reportedly, the reason for the cancellation of the plan was that even fragile biodiversity could be further damaged by the dam development. According to Victor Jona, director of Cambodia's Ministry of Energy, the government's decision was made after a Japanese consultant recommended that the government look for another energy source.

Mak Bunthoeurn, secretary-general of Cambodia's NGO Forum, said that he expects the plan to be withdrawn completely as this development will force coastal residents to relocate their dwellings. Another environmental activist, Marc Goichot of WWF, praised the decision saying, it is 'scientifically evident' that large-scale dams will seriously impact the fish environment and river flows in this basin, and ultimately

agriculture downstream in Viet Nam (Ratcliffe, 2020).

(b) Reah Solar Power Plant

In 2014, the Willowbook Company, a renewable energy developer based in New York, USA, reportedly planned to develop a 250-MW-scale solar power plant in Cambodia. At that time, the total investment by the company was $400 million, with construction to begin in 2015 and commercial operation to start in 2017 (Southeast Asia Infrastructure, 2014). However, no further progress has been reported and the status as of 2023 is unknown.

2.3. Indonesia

(1) Basic Energy Policy

In Indonesia, the Ministry of Energy and Mineral Resources sets the policy for mineral resources such as oil, coal, and gas. The basic policy for the long-term energy outlook and policy until 2050 was established in the National Energy Policy, formulated in October 2014. Indonesia has abundant oil and natural gas resources, but recently its oil production has been declining due to ageing oil fields. Demand-side measures have been taken to curb demand, such as the abolition of subsidies on petroleum products, in addition to supply-side measures such as increased exploration and development investment, including foreign capital, and increased oil refining.

Indonesia has also been focusing on expanding renewable energy. In September 2020, the Government of Indonesia and the United Nations Development Programme, with financial support from the Korea International Cooperation Agency, launched the Accelerating Clean Energy Access to Reduce Inequality project to install solar power generation facilities with a total installed capacity of 1.4 MW in 23 rural villages in 4 provinces.

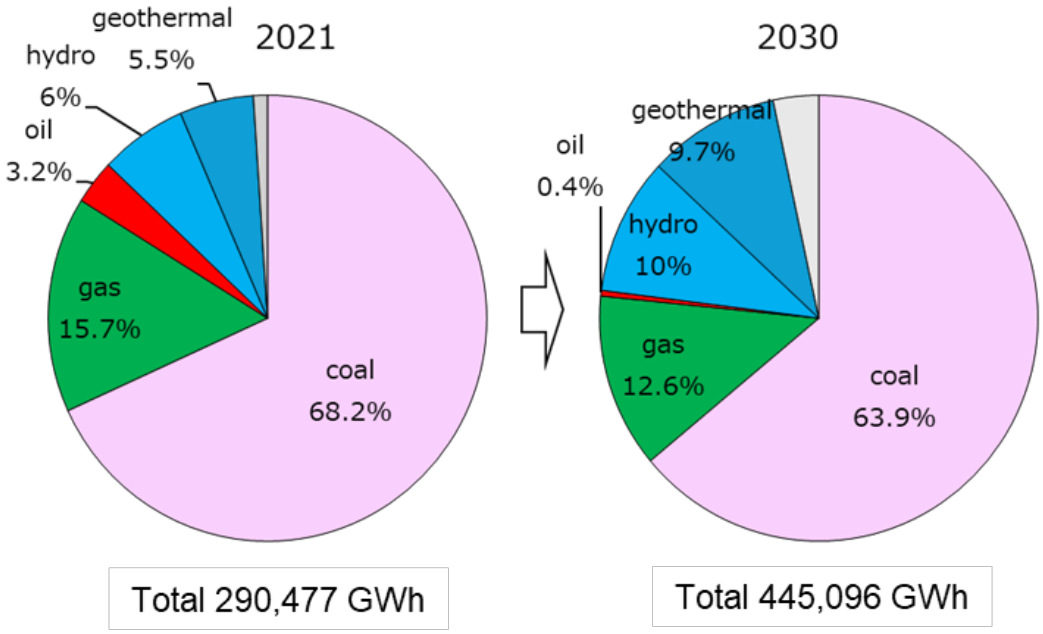
In June 2023, the World Bank announced a total of $1.14 billion in financing for a plan to provide sustainable, low-cost electricity in eastern Indonesia. This new Indonesia Sustainable Least-cost Electrification-1 plan aims to encourage the additional electrification of nearly 2 million people, increase investment in solar power generation, reduce generation costs by 20%, improve management capacity of the state-owned electricity provider PLN in the energy transition, and reduce GHG emissions by 32% by 2030 (World Bank, 2023).

(2) Power Portfolio and Projection

Indonesia's electricity mix and projected electricity supply mix to 2050 are shown in

Figure 2.4. According to the Electricity Supply Business Plan (2021–2030) announced in October 2021, the share of electricity generated from renewable energy sources is planned to increase from 12.9% (forecast) in 2021 to 23.0% in 2030.

Figure 2.4. Electricity Generation Projection in Indonesia



Source: PLN (2021).

(3) Support Schemes and Regulations

Support for Investment

The Indonesian government provides incentives such as corporate tax reduction for investments from abroad to promote businesses that contribute to technological transfer and infrastructure development. Specifically, the incentives include (i) corporate tax reduction for companies that make new investments in pioneering industries (tax holiday scheme), and (ii) corporate income tax benefit for investments in specified business categories or areas such as the renewable energy sector (tax allowance scheme).

The following describes the tax allowance scheme, slightly in detail. Specific matters such as deduction rates and conditions are as follows.

- Deducting up to 30% of the investment from the taxable income, 5% per year for 6 years
- Shortening the useful life to half the normal length to accelerate the

depreciation

- Reducing the tax rate on dividends to overseas shareholders to 10%
- Extending the deferral period for deficits for 1 year every time one of the following conditions is met

<Conditions>

- Investment that satisfies the basic conditions for the benefit above (extended for 1 year)
- Investment in industrial zones and bonded areas (extended for 1 year)
- Investment in new and renewable energy sectors (extended for 1 year)
- Investment of 10 billion rupiahs or more in local economic and social infrastructure (extended for 1 year)
- Starting to use domestic raw material at 70% or more in the second year of investment (extended for 1 year)
- Continuing to additionally employ 300 or more Indonesian workers for at least 4 years (extended for 1 year)
- Continuing to additionally employ 600 or more workers for at least 4 years (extended for 2 years)
- Spending a research and development expense accounting for 5% of the total investment for at least 5 years (extended for 2 years)
- Exporting 30% or more of the total sales in cases where the business base is in other than bonded areas (extended for 2 years)

Further, for investments made inside 20 SEZs in Indonesia, facilities such as preferred application of the tax holiday or tax allowance schemes, which enable 100% foreign investment even in sectors where foreign investment is regulated, are provided.

Environmental Regulation

The regulations that the government has set are meant to prevent environmental destruction caused by excessive development and to improve the business environment by recommending processes that are more efficient also for business operators.

Indonesia has a stratum that can be used to permanently store carbon emissions using technologies for carbon capture and storage (CCS) and carbon capture,

utilisation, and storage (CCUS). The Ministry of Energy and Mineral Resources published the '2023 Ministry of Energy and Mineral Resources Regulation No. 2 concerning the Implementation of Carbon Capture and Storage and Carbon Capture Utilisation and Storage in Oil and Gas Upstream Business Activities (*Peraturan Menteri Energi dan Sumber Daya Mineral Nomor 2 Tahun 2023 tentang Penyelenggaraan Penangkapan dan Penyimpanan Karbon, Serta Penangkapan, Pemanfaatan, dan Penyimpanan Karbon Pada Kegiatan Usaha Hulu Minyak dan Gas Bumi*)' in March 2023. This is to promote the use of CCS/CCUS in the stratum to achieve the targets of the Paris Agreement on the United Nations Framework Convention on Climate Change intended for low GHG emissions and climate change–resistant development by 2050 and to contribute to increasing domestic production of oil and gas.

This regulation focuses on technological aspects, business scenario, legal aspects, and economic aspects, to be considered in the implementation of CCS/CCUS in the oil and gas upstream sectors. The regulation may consider that the business operator will also receive benefits by formulating a development plan and pursuing it in accordance with this regulation.

(a) Technological aspects

The first rule stipulates matters ranging from the capture, transport, injection, and storage to monitoring and measurement, reporting, and verification. The second rule requires that excellent technical standards based on the characteristics of the respective region be used.

(b) Business scenario

The scenario assumes that CCS and CCUS are implemented based on a collaboration agreement in oil and gas mining zones. It assumes that CO_2 is supplied not only from oil and gas, but also from other industries (CCUS, in particular) through the B2B mechanism with contractors in oil and gas work areas.

(c) Legal aspects

Proposals for CCS/CCUS activities by production sharing contractors of oil and gas companies should also be part of the development plan. The monitoring activity shall continue to be conducted at least 10 years after the completion of the CCS/CCUS activities. Matters such as the transfer of responsibility to the government are also stipulated in the details section.

(d) Economic aspects

The regulation also stipulates the handling of results of potential monetisation

through CCS/CCUS implementation, in addition to that of potential monetisation of carbon credits based on the '2021 Presidential Regulation No. 98 concerning the Implementation of Carbon Economic Value for Greenhouse Gas Emissions Control'.

(4) Low-carbon Energy Projects

Projects under Planning or Construction

In Indonesia, which represents the largest population, gross domestic product, and energy supplies amongst ASEAN counties, and needs to respond to the growing electricity demand whilst seeking decarbonisation, several low-carbon energy source development projects have been pursued. As of November 2023, 52 projects for power generating facilities of a certain scale are being planned or constructed in Indonesia.

Table 2.4. Projects under Planning, Licensing, or Construction in Indonesia

Plant Name	Plant Status	Commissioning Year	Technology	Net Capacity (MW)	Operator	Shareholders
Riau Islands floating solar	Announced	2018	Solar (Floating)	4800		
Citlim island	Announced		Solar	1682	Sunseap	
Combol islands	Announced		Solar	1380	Sunseap	
Kamojang–Darajat	Announced		Geothermal	1465	IPP	
Grindulu	Announced	2028	Hydro (PHS)	1000		
Bbk solar farm	Announced		Solar	1000	Sembcorp Industries LTD/PT PLN Batam/PT Trisurya Mitra Bersama	
Sinar Mas	Announced		Biomass	1000	Sinar Mas	
Bantar Gebang, Sumur Batu	Announced		Biomass	362		
Matenggeng	Announced	2025	Hydro (PHS)	900	PT PLN	PT PLN
Spread Pembangkit Hydro IPP (Sumbagut)	Announced	2025	Hydro	710		
Spread (Jawa–Bali) (geothermal)	Announced	2025	Geothermal	1428		
South Sumatra solar farm	Announced		Solar	600		
Pangalengan	Announced		Geothermal	1106	IPP	
Spread (Jawa–Bali) (waste)	Announced		Biomass	175		
Dataran Tinggi Dieng	Announced		Geothermal	780	IPP	
Karaha Cakrabuana	Announced		Geothermal	725	IPP	
Cirata Floating–Expansion	Announced		Solar (Floating)	500	Masdar	PT PJB
Pembangkit Panas Bumi Spread (Sumbagselteng)	Announced	2023–2024	Geothermal	580		
Pembangkit Panas Bumi Spread (Sumatera)	Announced	2023–2024	Geothermal	540		
Sarimuk	Announced		Biomass	146		
East Kalimantan solar farm	Announced		Solar	200		
West Sumatra solar farm	Announced		Solar	200		
Kap Pandeglang wind	Announced		Wind	200		
Pertamina Rokan Block solar plant	Announced	2023	Solar	150	JAKARTA–Pertamina Power Indonesia	
Kab Lebak wind farm	Announced		Wind	150		
Lombok Wind	Announced		Wind	115		
Aceh Utara	Announced		Wind	100		
Bantaeng wind	Announced		Wind	100		
Palmerah Bridge	Announced		Marine energy	108	Tidal Bridge	
Benowo II	Announced		Biomass	106		
Surakarta, Klaten, & Boyolali	Announced		Biomass	101		
Krakatau Steel Solar floating	Announced		Solar (Floating)	40	PT Krakatau Steel	
Kuansing (biogas)	Announced		Biogas	10		
Duriangkang Reservoir	Announced	2024	Solar/Electricity storage (Floating)	6200	Sunseap Group	Badan Pengusahaan Batam
Hydrogen Project	Announced		Hydrogen/Solar	110		
Tanjung Sauh	Bidding process		Biomass	200	PT PLN Batam	
Karangkates Solar	Bidding process		Solar (Floating)	100	PT PLN Nusantara Power	
West Nusa Tenggara Tidal	Bidding process /Authorized		Marine energy	150	SBS Energi Kelautan (SBSEK)	SBS; Atlantis Resources(50%)
Garut	Authorized		Wind	150	PT Medco PI	
Jeneponto WPP	Authorized		Wind	132.5	PT Indo Wind Power Holding	
Lebak	Authorized		Wind	100	PT Viron Energi	
Rokan Jaya	Authorized		Biogas	10		
Saguling Floating solar	FID		Solar (Floating)	60	Acwa Power	
Singkarak Floating solar	FID		Solar (Floating)	50	Acwa Power	
Tanah Laut BESS	PPA signed	2025	Electricity storage	10	Total Eren	
Kayan	Under construction /Authorized	2026	Hydro	9000	State Power Investment Corporation (SPIC)	State Power Investment Corporation (SPIC)
Data Dian	Under construction	2025	Hydro	1200	PT Indonesia Dafeng Heshun Energy Industri	
Upper Cisokan	Under construction	2025	Hydro (PHS)	1040	PT PLN	PT PLN(100%)
Batang Toru (Tapsel)	Under construction	2026	Hydro	510	PT North Sumatera Hydro Energy	
Amamapare	Under construction	2023	Biomass	128	PT Freeport Indonesia	
Sukabumi	Under construction	2024	Wind	150	PT Viron Energi	
Bantar Gebang II	Under construction		Biomass	120	PT Pertamina	PT Pertamina(100%)

Note: Small-scale projects except for biomass are excluded.

Source: IEEJ

(a) Riau Islands floating PV power plant

Concerning the 4,800 MW floating PV power plant, which was to commence commercial operation in 2018 as shown in Table 2-4, there is no other literature indicating that the plant is operating as of January 2024. Meanwhile, a report that the

Sunseap Group, a general energy company headquartered in Singapore, reached an agreement with the Riau Islands provincial government on the construction of large-scale PV power plants and power storage facilities in the region in April 2022, has been confirmed (Reuters, 2022). According to the report, the planned installations consist of a 1,380 MWp PV power plant and a power storage facility capable of storing 3,000 MWh in Combol Island, and a 1,682 MWp PV power plant and a power storage facility with a capacity of 3,500 MWh in Citlim Island. Judging from the above, the initial 4,800 MW plan may have been halted or frozen and then the Sunseap Group's plan surfaced.

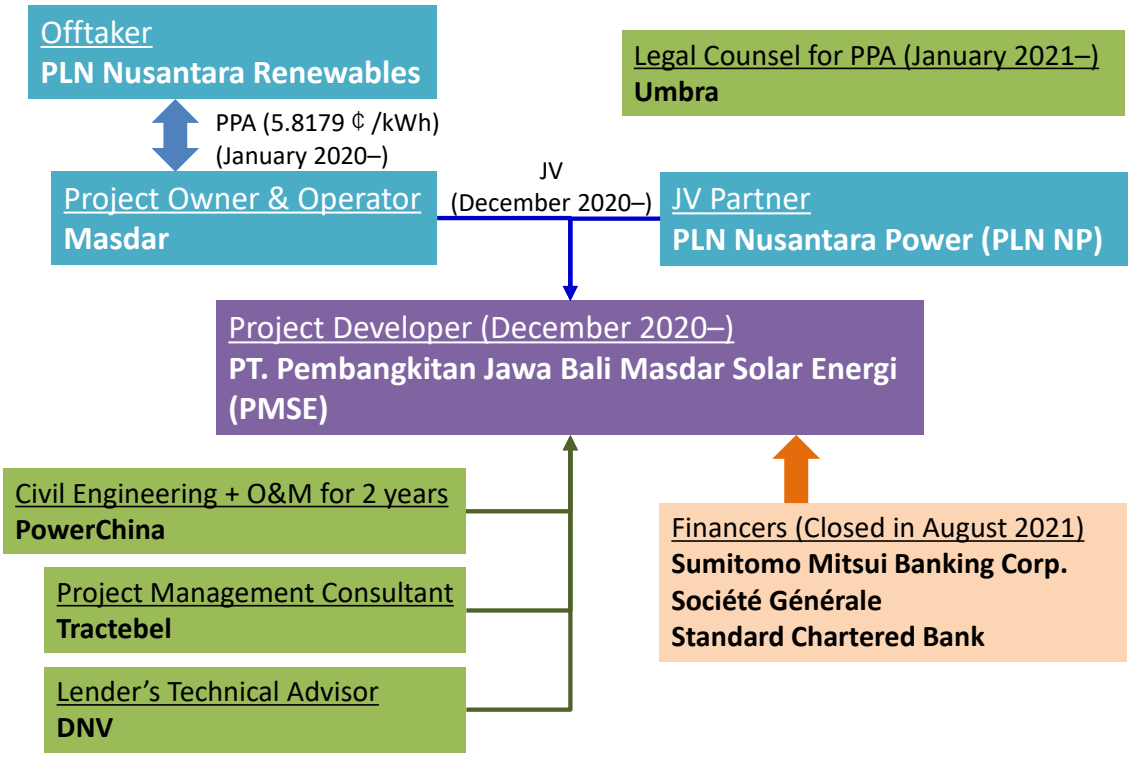
Further, the Sunseap Group operates diversified businesses such as a distributed PV power generation business, large-scale PV power generation independent power producer business, clean electricity retail business, (energy service company) business and Virtual Power Plant business in the Asia-Pacific region. Sumitomo Corporation in Japan also has had a stake in the group since 2021 (Sumitomo Corporation, 2021).

(b) Cirata floating PV power plant expansion plan

On 9 November 2023, a floating PV power plant with a capacity of 145 MW (peak power 192 MW), whose units line up on a dam reservoir in Cirata, West Java, commenced operation. This power plant is a joint venture between Abu Dhabi Future Energy Company (Masdar), headquartered in the United Arab Emirates and PLN Nusantara Power (PLN NP), Indonesia's state-owned power company group. In September 2023, both companies agreed to expand the power plant to 500 MW in Phase II (NS Energy, 2023).

In July 2017, PT PJB (PLN NP's predecessor) and Masdar agreed to study a sustainable method for responding to the energy demand in Indonesia. In January 2020, Masdar concluded a PPA with PLN Nusantara Renewables at ¢5.8179/kWh. In November 2020, both companies formally agreed on a development project for a floating PV power plant on the Cirata reservoir. A joint venture (Pembangkitan Jawa Bali Masdar Solar Energi [PMSE]) was established in December 2020, and investments in the joint venture by Sumitomo Mitsui Banking Corporation, Société Générale, and Standard Chartered Bank. were completed in August 2021. This project was also designated as a national strategic project of the Indonesian government. In addition, parties including experienced overseas and domestic consulting firms are engaged in this project. For example, Tractebel was appointed as the project management consultant, which would support the PMSE. Figure 2.5 shows the scheme of this project.

Figure 2.5. Project Scheme of Cirata Floating Solar Photovoltaic Power Plant



Source: The Institute of Energy Economics Japan.

(c) Banten and South Sulawesi Wind Power Project

The potential of wind energy in Indonesia is smaller than that of geothermal and PV energy, and the planned wind generation projects are also fewer. In the meantime, data indicate that the country has a wind energy potential of 60.647 GW in onshore wind power generation, and 94.231 GW in offshore wind power generation, 154.88 GW in total (Sikumbang, 2022), and the government supports development projects. Therefore, protections have been crystallised and are being pursued.

Information on many projects is not published, and their details are unknown. Under such circumstances, for the Banten and South Sulawesi Wind Power Project, the Asian Development Bank (ADB) has contributed $500,000 to be appropriated to part of the development expense as a preparatory technical assistance (Project Preparatory Technical Assistance [PPTA]) since 2016, and some facts can be seen from the information published by ADB.

According to ADB, when this project was planned, Indonesian electric utility PLN had little experience in operating intermittent renewable power sources including wind energy, and no developer could execute a wind energy applicability study in the

country. Therefore, ADB assessed the technological, environmental, and social impacts of the connection of wind power generators to the power grid. The PPTA by ADB was completed in July 2019 (ADB, 2020).

In March 2022, the PLN announced that it would move ahead with this project in cooperation with the French Development Agency (VOI, 2022). The announcement at that time indicated that the PLN planned to begin the construction of a 200 MW facility in 2022 first and commence its operation in 2025, with the possibility of expanding its capacity to 350 MW. However, as of January 2024, no follow-up report has been confirmed.

(d) Batam Solar Farm (Duriangkang Reservoir Floating Solar Power Project)

In Global Energy Monitor's list, the capacity of the floating PV power plant serving also as an energy storage facility in this project is 6,200 MW. Another information source indicates that the capacity is 2,200 MWp, and the commercial operation will commence in 2026 (Power Technology, 2024).

According to a press report, Sunseap concluded a contract with Indonesian development organisation BP Batam in July 2021 for the construction of a 2.2 GWp floating PV power plant and an energy storage facility with a capacity of 4 GWh or more (Scully, 2021). When this report was published, the construction was supposed to be completed in 2024. Therefore, it is assumed that subsequently, a slight delay in the construction schedule occurred. Matters such as the capital relationship and the firm awarded the construction work are unknown.

(e) Kayan Hydropower Plant

The Kayan Hydropower Plant represents a plan for a 9,000 MW large-capacity hydraulic power plant on the Kayan River in the north of Kalimantan Island, Indonesia. Based on the Masterplan for Acceleration and Expansion of Indonesia Economic Development 2011–2025, Indonesian developer PT Kayan Hydropower Nusantara (KHN) undertakes the project in cooperation with Shanghai Electric Power and Sumitomo Corporation, with Kalimantan Island being positioned as the base (hub) for mineral resources and energy storage (Power Technology, 2024). KHN is a joint venture between PT Adaro Energy Indonesia, Sarawak Energy Berhad, and PT Kayan Patria Pratama (all based in Indonesia), and is developing the Mentarang Induk Hydroelectric Project (MIHEP) (1,375 MW), located in Malinau of North Kalimantan. According to the company, it aims at commencing commercial operation in 2030 with a project approved by the Economic Affairs Ministry in December 2022 (KHN). On KHN's official website, any 9,000 MW–scale hydraulic power plant project cannot be

confirmed.

In the meantime, it was reported in September 2023 that Sumitomo Corporation would participate in a 9,000 MW hydraulic power generation project that KHN operates. This report also indicated that Chinese state-run electric utility PowerChina would undertake the construction work. PowerChina would finance $170 billion, the first 900 MW portion would be completed by 2026, and the whole work will be completed by 2035. Sumitomo Corporation has not directly mentioned its participation in this project. However, since it concluded a cooperative MOU concerning energy conversion in the country with Indonesian state-run electric utility PLN in November 2022 (Seneca, 2023), its compatibility with this project is high.

(f) Biogas plant

A compressed biogas plant that produces biogas from palm oil waste started commercial operation in Langkat Province of North Sumatra, Indonesia in January 2024 (Ministry of Energy and Mineral Resources, 2024). With a production capacity of 300 MMBtu/day, it is one of the largest plants in Asia, and its inauguration was held on 22 January with Edi Wibowo, director of Bio-energy Agency, Ministry of Energy and Mineral Resources, attending. It is in the premises of a palm oil plant that PT United Kingdom Indonesia Plantations owns, and the Knowledge Integration Services (KIS) Group undertakes the development and operation. At the inauguration, Edi stated that this compressed biogas would replace Indonesia's LPG in the future. According to Raghunath, CEO of the KIS Group, the produced biogas will be transported to an oleochemical plant of PT Unilever Oleochemical Indonesia and used as the raw material with zero carbon emission in line with the company's approach for using zero chemical fuel in 2030 (GAPKI, 2024).

In this project, commercial operation has already started and can, therefore, be counted as a successful project. The success of the largest-scale biogas production project in Asia may include the fact that this project was introduced with foreign capital from advanced countries and overseas technology. The KIS Group, a developer, was inaugurated in India in 2006, made inroads into Singapore in 2007, and then expanded its bases to Malaysia in 2010 and Indonesia in 2011. Its management team includes engineers who gained experience, for example, in petrochemical plants in multiple countries, including CEO Raghunath. Unilever, the parent company of Unilever Oleochemical Indonesia, which will receive a supply of produced biogas, is a general consumer goods manufacturer headquartered in London and operates its business in more than 180 countries, including Asia. Given the quantity of palm oil waste in this region and the business scale of Unilever, further expansion of its clients

by using the KIS Group's business network can be expected.

Projects Delayed, Suspended, or Cancelled

Table 2.5. Projects Delayed, Suspended, or Cancelled in Indonesia

Plant Name	Plant Status	Commissioning Year	Technology	Net Capacity (MW)	Operator	Shareholders
Sumatra Pump Storage	Announced/ Frozen	2024-2027	Hydro (PHS)	1,500	PT PLN	PT PLN
Long Sempajang	Frozen		Hydro	1,000		

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

(a) Sukabumi Wind Farm

This was initially a 30 MW wind farm that had been planned in Sukabumi in the west of Java by Viron Energy, a renewable energy development company in Indonesia (Renewables Now, 2011). However, it is assumed that this company withdrew from this plan.[4] Subsequently, according to Power Technology as of 19 July 2023, UPC Renewables, a global energy company that operates its business internationally mainly in Asia, was moving ahead of a plan to construct and operate a 258.2 MW wind farm in this site (Power Technology, 2023). In September 2021, UPC Renewables was said to have announced that it would commence installation work for a 150 MW wind turbine soon. It was also reported that the work would be completed in 2024 (Karysa, 2021).

However, with the progress after the preparatory work phase being not confirmed thereafter, UPC Renewables and PTPN VIII, a local utility, announced in March 2023 that they would extend a cooperation agreement on the development of the Sukabumi wind farm (Fauziah, 2023). Further following that, Barito Wind Energy and ACEN Renewables Pte. Ltd agreed to buy out 100% of UPC Sidrap Bayu Energi's shares. With this acquisition, Barito Wind Energy and ACEN were to acquire 51%, and 49%, respectively, of the shares for three wind farms, including Sukabumi (320 MW in total)

[4] Global Energy Monitor, https://www.gem.wiki/Sukabumi_(Viron_Energy)_wind_farm

(Asian Power, 2023). The transfer procedures are expected to be completed in the first quarter of 2024 (Barito Renewables, 2023).

This ownership transfer will have specific effects on the output and model (vendor) of the Sukabumi Wind Farm. Other matters, such as the start and completion of the work, are unknown.

(b) Batam Bintan Karimun solar farm (BBK solar farm)

Although the plant status of BBK solar farm is indicated as 'Announced' (Table 2-4) as of November 2023, this project has been 'Terminated' according to the announcement by Sembcorp, the business operator, as of 27 March 2023. The following is an excerpt from their announcement:

> Sembcorp Industries (Sembcorp) refers to its announcement dated 25 October 2021 in relation to its signing of a joint development agreement (JDA) with PT PLN Batam and PT Trisurya Mitra Bersama to develop a large-scale integrated solar and energy storage project in Indonesia. Sembcorp wishes to inform that all parties have mutually agreed to terminate the JDA, and the consortium has been dissolved. (Sembcorp, 2023)

When Sembcorp announced the JDA with PT PLN Batan and PT Trisurya Mitra Bersama in October 2021, the provincial government had high hopes for the construction project plan of 1 GWp solar PV power plants and energy storage facilities in three areas (Batan, Bintan and Karimun [BBK]) and create direct and indirect employment of 1,000 people during their construction in Indonesia and Singapore, thereby contributing to the development of technology and human resources and to the promotion of clean energy in Indonesia and Singapore, its neighbouring country (Sembcorp, 2021). The top management of the business operators (i.e. PT PLN Batan and PT Trisurya Mitra Bersama) have expressed their intention to accumulate business experiences related to large-scale energy facilities through the project.

Sembcorp, a developer, and two business operators have not explained the reasons for the termination of the project, and it is said that the termination will not affect Sembcorp's share price or capital value. Thus, the background of the cancellation of the project is unknown.

At the same time, in the beginning of March 2023, before the announcement of the cancellation of the project, Singapore and Indonesia agreed to jointly promote the Green Corridor Project, which will construct large-scale renewable energy facilities

in Indonesia and export the generated energy to Singapore.[5] The amount of overseas direct investment in the Green Corridor Project-led clean energy industry in Indonesia is said to be nearly $50 billion, which will create tens of thousands of jobs and generate income for Indonesia through clean energy export.

The cause-and-effect relationship between the agreement for this large-scale project and the termination of the 1-GWp BBK solar project by Sembcorp is unknown. However, there is an overwhelming difference in the project scale and the number of stakeholders between the BBK project, which is operated solely by Sembcorp and the local power corporation, and the Green Corridor Project, which includes a 5-GWp solar photovoltaic power plant project in Riau and is led by the Sustainable Energy Association of Singapore with participation of a Chinese-owned company as a developer. It cannot be denied that the Indonesian provincial government and concerned parties might have agreed to prioritise larger projects.

In addition, with respect to the future of the Green Corridor Project, a dispute in the future concerning this plan could arise in the form of 'green negotiation' because of a deterioration in the relationship between Indonesia and Singapore in the past – such as the Indonesian government's reduction of the pipeline gas exports to Singapore by half (Lei, 2023).

2.4. Lao PDR

(1) Basic Energy Policy

The Lao PDR has formulated the National Socio-Economic Development Plan (NSEDP) about every 5 years; the latest one is the 9th NSEDP (2021–2025) issued in 2021. The 9th NSEDP aims to achieve socio-economic development through good-quality, focused, green, and sustainable development. The main targets in the energy and environmental fields in the 9th NSEDP are green development by the maximum utilisation of domestic natural resources, as follows (Government of the Lao PDR, 2021):

- Promoting the use of clean energy or locally available energy to reduce the use of the import and use of fossil fuels and GHG emissions in the transport sector.

[5] SEAS, LinkedIn Post, https://www.linkedin.com/posts/sustainable-energy-association-of-singapore-seas-_seas-members-and-partners-have-signed-an-activity-7042142981990072320-sUcZ/

- Encouraging the development of renewable energy such as hydro, solar, and wind power by creating financial incentives for both domestic and foreign investors.
- Promoting green infrastructure development and improve energy efficiency in households and other places.

Also, the Lao PDR government sets more specific targets in energy in its NDC published in March 2021.

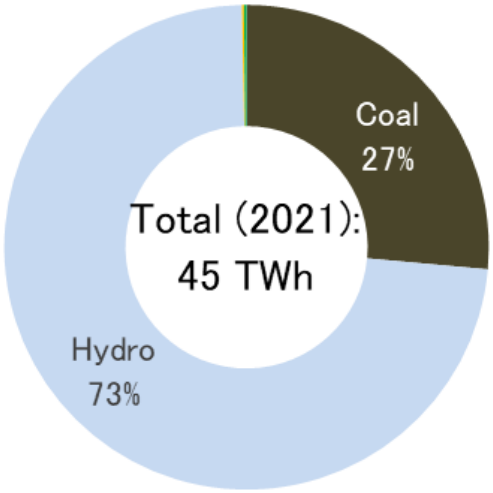
- 13 GW total installed hydropower capacity (domestic and export use) in the country by 2030
- 1 GW total installed solar and wind power capacity in the country by 2030.
- 300 MW total installed biomass power capacity in the country by 2030.
- 10% reduction of final energy consumption compared to the business-as-usual scenario.

By taking these measures, the country aims to achieve an unconditional emission reduction target of 60% by 2030, relative to the baseline scenario.

(2) Power Portfolio and Projection

Lao PDR's power source composition (2021) is shown in Figure 2.6. Hydropower and coal-fired power account for about 70% and 30%, respectively, and there are also a small portion of biomass and solar power generation. The Lao PDR has long relied on hydropower generation for almost all its power generation, but there has been a progress in the diversification of power sources in recent years due to the commencement of the operation of the only coal-fired power plant in the Lao PDR in 2015 and the development of renewable energy.

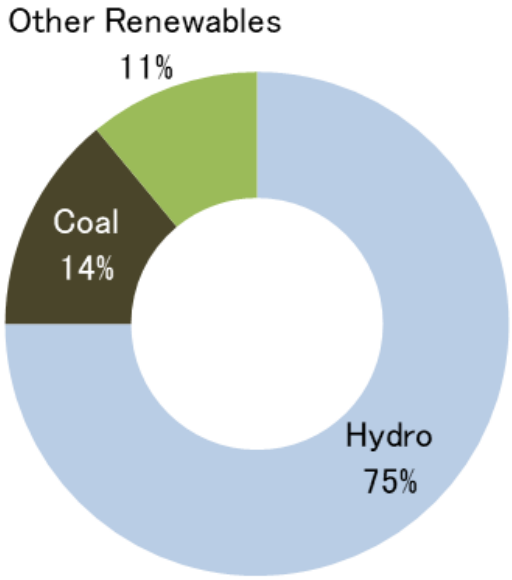
Figure 2.6. Electric Power Generation in the Lao PDR (2021)



Source: IEA (2023).

Lao PDR's power source composition plan for 2030 in its power source development plan is as shown in Figure 2.7. Whilst greatly expanding the share of solar and wind power that is currently small, the Lao PDR intends to continue the development of hydropower that still has great potential and of coal-fired power that can also be utilised as regulated power supply. In addition, the plan does not provide any detailed numerical target for installed capacity.

Figure 2.7. Planned Power Generation Mix in the Lao PDR (2030)



Source: Ministry of Energy and Mines (2021).

(3) Support Schemes and Regulations

Support for Investment

The Law on Investment Promotion specifies nine privileged investment sectors that can receive support, such as exemption of company tax (for up to 15 years) or of a lease/concession fee for government land. The projects in which investment is promoted in the power generation sector are as follows (JETRO, 2021a):

- Development of alternative energies (solar, wind, organic, bioenergy)
- Biogas production from industrial or agricultural wastes, and biogas power generation, transportation, and use for processing goods
- Energy generation from garbage or waste.

Investment business in the Lao PDR is divided into two types: general business and concession business, under the Law on Investment Promotion, and the power generation business falls under the latter. The promotion of investment in the concession business is under the jurisdiction of the Committee for Investment Promotion Management (CIPM) and their permanent administration offices – One Stop Services Office (OSSO) under the Ministry of Planning and Investment and the Department for Planning and Investment of the provincial government. This means there are two CIPMs and OSSOs at the central and provincial government levels, respectively (JETRO, 2023a). An electricity generation business of 5 MW or more is under the jurisdiction of the central government, whilst that of 5 MW or less is under the provincial government (Japanese Chamber of Commerce and Industry, Lao PDR, 2019).

Environmental Regulation

In the Lao PDR, the 1999 Environmental Protection Law requires an EIA in the implementation of a project that may impact the protection, conservation, and utilisation of natural resources. Various cabinet orders and rules specify the detailed process of an EIA.

The projects are categorised into two groups according to their scale: the initial environmental examination (IEE) and the EIA are required to be conducted for the project smaller than a certain scale (Group I) and for the project greater than a certain scale (Group II), respectively. The categories of projects in the power development sector are shown in Table 2.6. (Environmental Impact Assessment Network, 2018).

Table 2.6. Categories of Power Generation Projects

Investment Projects and Activities	Group I: IEE Subject Projects and Activities	Group II: EIA Subject Projects and Activities
Construction of hydroelectric power plants	Capacity: 1～15 MW Water storage capacity: Less than 2 million m^3 Water storage area: Less than 1,500 ha	Capacity: 15 MW or more Water storage capacity when full : 2 million m^3 or more Water storage area: 1,500 ha or more
Nuclear power plants, nuclear waste management and disposal facilities		All
Natural gas and biogas power generation facilities	5～50MW	Over 50 MW
Wind farm	2～10 units	Over 10 units
Coal, oil, and biomass power generation facilities	10 MW or less	Over 10 MW

IEE = initial environmental examination, EIA = environmental impact assessment.

Source: Environment Impact Assessment Network (2018).

Also, the Procedures for Notification, Prior Consultation, and Agreement of the Mekong River Commission (MRC) requires hydropower development projects in the mainstream of the Mekong River to go through the PNCPA (MRC, 2024).

(4) Low-carbon Energy Projects

Projects in the Planning or Construction Phase

It has been confirmed that 41 power generation facility construction projects (using low-carbon technology with net capacity of 100 MW or more) are in the construction

or planning phrase in the Lao PDR as of November 2023.

Table 2.7. Projects under Planning, Licensing, or Construction in the Lao PDR

	Unit Name	Net Capacity (MW)	Status	Operator
Hydro	Nam Muan	100	Announced	Asia Invest and Service
Hydro	Pak Ngeum	110	Announced	Vientiane Automation
Hydro	Nam Noen 1 (Nam Mouan-2)	124	Authorised	Vang Sup Development and Investment
Hydro	Nam Neun – 1	124	Announced	
Hydro	Sekong Downstream	126	Authorised	V&H Corporation
Hydro	Nam Imun (Dak Imun) (Nam E moun)	129	Under construction	TK Construction and Road Sole
Hydro	Dak e Meule	130	Announced	Viet-Lao Power
Hydro	Nam Bi	130	Under construction /Authorised	Nam Bi Power Co. Ltd 1-2-3
Hydro	Se Kaman 2	135	Announced	Electricité du Laos
Hydro	Nam Ma 1-2-3	149	Authorised	Guangdong Electric Company
Hydro	Nam Phak (Kobe Green Power)	150	Authorised	Kobe Green Power
Hydro	Nam Sam 4	150	Announced	Simon Consulting
Hydro	Nam Sam 3	156	Under construction	Phongxubthavi bridge-road construction company
Hydro	Nam Bak – 1	160	Authorised	Southeast Asia Energy
Hydro	Se Xet (Xeset) (Se Set)	164	Operational/Authorised /Announced	Electricité du Laos
Hydro	Xekaman – 2 (Se Khaman 2)	164	Under construction	China Southern Power Grid (CSPG)
Hydro	Thakho (Mekong Thakho)	172	Announced	Compagnie Nationale du Rhône (CNR)
Hydro	Nam Fa (Nam Pha)	180	Announced	AP Bizlink Group
Hydro	Nam Fa 2	180	Announced	Huamchai Phathana
Hydro	Nam Mo	180	Authorised	Phongsupthavy Group
Hydro	Nam Ngum 4	240	Under construction	Electricité du Laos
Hydro	Sekong 3 (Xe Kong 3)	286	Authorised	Asia Longtheun Development
Hydro	Nam Seuang	299	Authorised/Announced	China Sichuan Gurong Group
Hydro	Sekong – 5 (Se Kong 5) (Xe Kong 5)	330	Authorised	Inter RAO
Hydro	Se Kong 4	340	Authorised	Lao Woen Group
Hydro	Nam Et	429	Operational/Frozen /Announced	Hong Anh Gai Lai Mineral
Hydro	Nam Ngum 3	480	Under construction	LHSE
Hydro	Sanakham (Nam Khong)	684	Under construction	China Datang Overseas Investment
Hydro	Pakbeng (Pak Baeng) (Nam Khong)	912	Bidding process	China Datang Overseas Investment
Hydro	Phu Ngoi (Nam Khong) (Lat Sua)	686	Authorised	Charoen Energy and Water Asia
Hydro	Paklai (Nam Khong)	770	Authorised	Sinohydro
Hydro	Luangphabang (Nam Khong)	1,460	Under construction	Luang Prabang Power Company Limited
Hydro	Ban Koum (Ban Kum) (Nam Khong)	1,872	Authorised	Italian Thai
Solar	Nam Theun floating solar	240	Bidding process	EDF
Solar	Adapoo	436	Under construction	Syouei Create
Solar	Champasak	545	Under construction	Syouei Create
Wind	Khammuan – Savannakhet – Xekong	600	Authorised	Impact Electrons Siam
Wind	Monsoon Wind Power Project	1600	Under construction /Announced	Impact Energy Asia Development Limited
Wind	Lako Wind	1200	Announced	Savan Vayu Renewable Company
Wind	AMI Savannakhet Wind Power Plant	252	Announced	AMI Renewables Quang Binh
Wind	Sepon wind farm	1200	Announced	

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

It is said that the Lao PDR can potentially generate 23,000 MW hydropower, and the already-developed portion remains 9,600 MW, which means there is still high potential for future development (Ingram, 2023). The actual status of development shows the overwhelming dominance of hydropower both in number and capacity, widely ranging from small-scale projects of 120 MW to large-scale ones of over 1,800 MW.

With respect to other renewable energies, wind power and solar PV power generation

have been developed to complement hydropower generation, which is highly vulnerable to seasonal variations.

Currently, no wind power plant is operational in the Lao PDR, but almost all plants under development are large-scale ones of over 500 MW.

The second-largest solar PV power plant is currently the largest existing one of 15 MW, but those under development are significantly large in scale: 240 MW, 436 MW, and 545 MW. Also, one of those three is an FSPV power plant (240 MW).

(a) Luang Phabang Hydropower Plant

The largest hydropower plant in the Lao PDR is the Xayaboury hydropower plant (1,285 MW). However, the Luang Phabang hydropower plant has a capacity of 1,460 MW beyond the capacity of the former. The project is for a run-of-river hydropower plant that will be developed in accordance with the MOU concluded between the Lao PDR government and PetroVietnam Power Corporation in 2007 (MRC, 2019). The investment amount is said to be $3 billion (Vietnam–Lao Industry and Trade Relations, 2022). It is reported that the electricity generated will be exported to Thailand or Viet Nam, and that a PPA with a 35-year take-or-pay provision has been concluded with Thailand's Electricity Generating Authority of Thailand (EGAT) (Deetes and Lee, 2023).

(b) Nam Theun FSPV Power Plant

In July 2021, the Lao PDR government and Électricité de France (EDF) concluded the project development agreement for a hybrid floating solar project at the reservoir of the Nam Theun 2 Hydropower Plant (1,080 MW) that has a capacity of 240 MW, said to be the world largest hybrid floating solar project. It can be developed without environmental and social impacts, and power generation is expected to increase by 6% by controlling evaporation in the dry season (Nam Theun 2, 2021).

(c) Monsoon Wind Power Plant

The plant has a capacity of 600 MW, the largest capacity in Southeast Asia. Also, 133 generators and a power line of 27 km up to the border with Viet Nam will be constructed with about $950 million in total. The electricity generated will be sold to Viet Nam, and an electricity purchase agreement has been concluded with Vietnam Electricity (EVN) in 2021[6]. Also, the project will be implemented by joint financing

[6] Monsoon Wind, 'Monsoon Wind Power Project', https://www.monsoonwindasia.com/monsoon-wind-power-laos/monsoon-wind (accessed 7 January 2025).

with ADB, the Japan International Cooperation Agency, Thai EXIM, Sumitomo Mitsui Banking Corporation, etc. (JICA, 2023).

(d) Lako Wind Power Plant

This is a wind power plant with a capacity of 1,200 MW, which has the largest capacity amongst the power plants currently planned in the Lao PDR. The estimated construction cost is $2.15 billion, and the electricity generated is planned to be domestically consumed or otherwise mainly exported to Viet Nam (The Laotian Times, 2022).

Projects Delayed, Suspended, or Cancelled

At the same time, there are many cases where a project was announced, but it was frozen or showed no progress thereafter, or where the operator announced the cancellation of the project.

Table 2.8. Projects Delayed, Suspended, or Cancelled in the Lao PDR

	Unit Name	Net Capacity (MW)	Status	Operator
Hydro	Huai Palai Lower (Houay Palai Downstream)	3	Frozen	Palai Dam Electric
Hydro	Nam Poen 3	5	Frozen	
Hydro	Huai Chiat	8	Frozen	Champa
Hydro	Houay Gnoy-Khod	11	Frozen	
Hydro	Nam Tha 2	15	Frozen	Micro Hydropower
Hydro	Nam Kalabai	39	Frozen	Electricité du Laos
Hydro	Nam Ngum (Down)	60	Frozen	
Hydro	Nam Ngum Nam Ken	70	Frozen	
Hydro	Xebanghieng	102	Frozen	Song Da Corporation Company
Hydro	Nam Et	429	Operational/Frozen /Announced	Hong Anh Gai Lai Mineral
Hydro	Nam Ngiep	483	Operational /Suspended construction	Kansai Electric - Nippon Keoi

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

All projects that have been announced to be frozen or cancelled were hydropower ones, but their details are unknown.

2.5. Malaysia

(1) Basic Energy Policy

In 2022, the Malaysian government announced the National Energy Policy 2022–2040 (DTN). The DTN indicates the direction of comprehensive policy in the energy sector. The Low-carbon Targets 2040 that constitutes part of DTN sets out the following nine targets to be achieved by 2040 (compared with 2018 levels):

- Increase the rate of public transportation use from 20% to 50%.
- Increase the rate of penetration of EVs from less than 1% to 38%.
- Introduce B30 (fuel blended with 30% biofuel) to large vehicles.
- Increase the rate of liquefied natural gas use in marine transportation from 0% to 25%.
- Increase the energy-saving rate in the industrial sector from less than 1% to 11%.
- Increase the energy-saving rate in the housing sector from less than 1% to 10%.
- Increase the total installed capacity of renewable energy from 7,597 MW to 18,431 MW.
- Decrease the percentage of coal in installed capacity from 31.4% to 18.6%.
- Increase the percentage of renewable energy in primary energy total supply from 7.2% to 17.0%.

In 2023, the Malaysian government announced the National Energy Transition Roadmap. The government sets out new numerical targets to be achieved by 2050 in six major fields in a manner that overwrites the targets specified in the National Energy Policy.

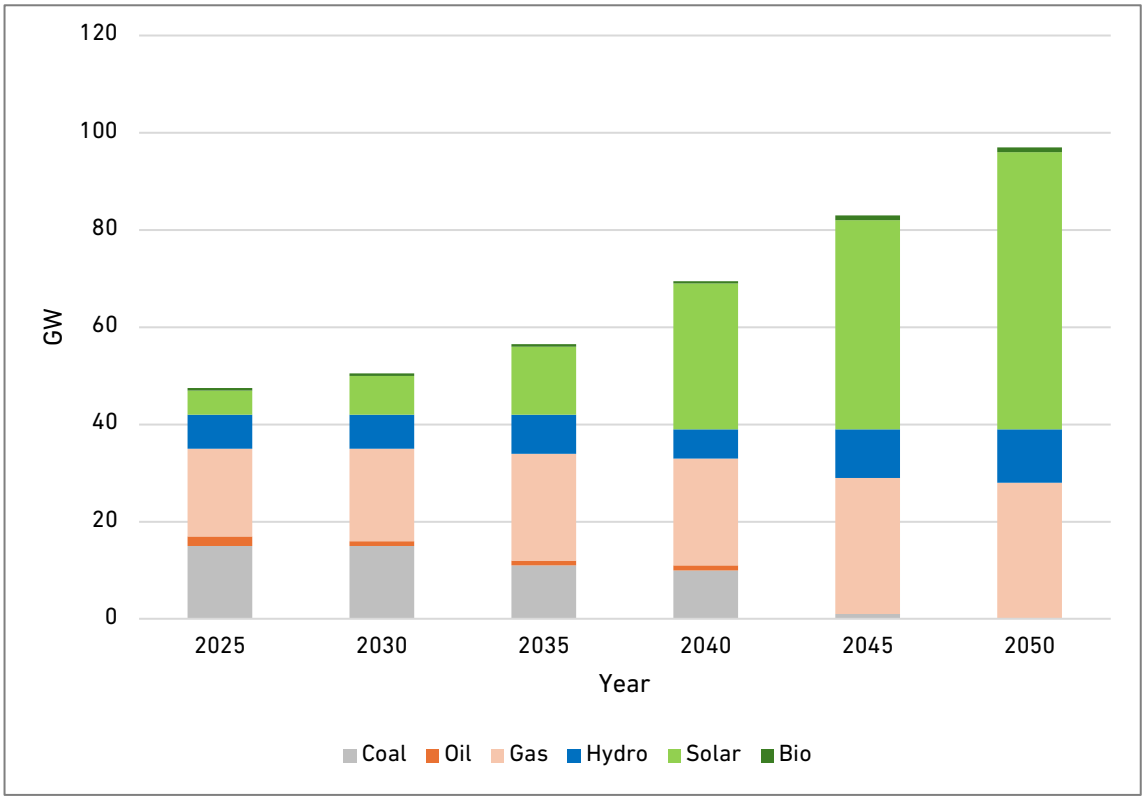
- Renewable energy: Increase the installed capacity to 70% by 2050
- Hydrogen hubs: Bring the total to three hubs
- Bioenergy: Increase the biorefinery capacity to 3.5 billion litres by 2050
- Green mobility: Increase the ratio of EVs in total industry volume to 80%
- Saving energy: Reduce energy consumption by 23% in the industrial sector and 20% in the housing sector

- CCUS: 40–80 Mtonne per year of carbon storage capacity by 2050, etc.

(2) Power Portfolio and Projection

According to the National Energy Transition Roadmap, the estimates of power generation installed capacity in Malaysia until 2050 are shown in Figure 2.8. The policy aims to gradually reduce the dependence on fossil fuels, whilst reducing the use of coal to zero by 2050 and expanding solar energy amongst renewable energies.

Figure 2.8. Projection of Installed Power Generation Capacity in Malaysia



Source: Ministry of Economy (Malaysia) (2023).

(3) Support Schemes and Regulations

Support for Investment

With respect to investment, two preferential tax measures for investment – Pioneer Status and Investment Tax Allowance – are introduced.

The Pioneer Status allows a 70% tax exemption for 5 years. In addition, total tax exemption may be granted, if the project is in a recommended area in large-scale and long-term development areas such as Sabah or Sarawak, or if a high-tech project

(e.g. in the alternative energy industry) will be carried out. Furthermore, for important projects, such as those with large equipment investments that may cause a significant economic impact, total tax exemption may be granted for 10 years.

Investment tax allowance can be granted at the rate of 60%. This can be deducted in respect of qualified expenditure incurred within 5 years from the initial expenditure, which is to be offset against 70% of statutory income for each year of assessment. Also, any unused amount of allowance can be carried forward to subsequent years of assessment until it is fully used. Furthermore, for a project in a recommended region or a high-tech or important project, investment tax allowance can be granted at the rate of 100% (JETRO, 2023c).

Environmental Regulation

In industrial activities, the business operators are required to obtain prior approval of the Director General of Environmental Quality for the EIA of prescribed activities in accordance with the Environmental Quality Act and its Orders and Regulations.

The prescribed activities for which EIA is required include large-scale agriculture, airports, drainage or irrigation, land reclamation, fisheries, forestry, housing, industry, infrastructure, ports or harbors, mining, petroleum, power plants or power transmission facilities, quarries, railways, transportation, resort or recreational facility development, waste treatment or disposal facilities, and water supply. The EIA includes (i) the preliminary EIA to assess the impact of activities on the environment) and (ii) the detailed EIA which is required for projects that may cause significant environmental impacts (JBIC, 2014).

After approval of an EIA, monitoring is required to ensure that the implementation of the project will not significantly impact the environment. Items, places, indexes, frequency, and other factors of monitoring will be presented as the conditions of approval of an EIA report (Institute for Global Environmental Strategies, 2019).

(4) Low-carbon Energy Projects

Projects in the Planning or Construction Phase

Table 2.9 shows the construction projects of power generation facilities with output of 100 MWe or more (excluding those related to fossil fuels), which are under construction or planning as of November 2023.

Table 2.9. Projects under Planning, Licensing, or Construction in Malaysia

	Plant Name	Net Capacity (MW)	Status	Operator
Hydro	Baleh HEP	1285	Under construction	Sarawak Energy
Hydro	Baram 3	300	Announced	Sarawak Energy
Hydro	Metjawah	300	Announced	Sarawak Energy
Hydro	Nenggiri	300	Under construction	Tenaga Nasional Berhad (TNB)
Hydro	Lebir	274	Announced	Tenaga Nasional Berhad (TNB)
Hydro	Linau	182	Bidding process	Sarawak Energy
Hydro	Tekai	168	Bidding process	Tenaga Nasional Berhad (TNB)
Hydro	Limbang - 1	150	Announced	Sarawak Energy
Hydro	Liwagu	150	Under construction	
Hydro	Upper Padas	150	Under construction	Norplan Hydropower
Hydro	Telom	132	Announced	Tepsco
Hydro/Solar	Batang Ai HEP	158	Operational/Under construction	Sarawak Energy
Solar	Sultan Ibrahim	450	Authorized	Ibrahim Ibni Almarhum Sultan Iskandar
Solar	Durian Tunggal floating solar	150	Bidding process	Shizen Energy Group

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

Listed in this table are hydropower and solar projects that show the increasing trend in the National Energy Transition Roadmap. Some typical examples are outlined below.

(a) Hydro: Baleh HEP

The largest hydropower generation project of Sarawak Energy, a business operator. The project aims to be completed by the last quarter of 2028 to ensure sufficient renewable energy capacity for the development and future growth in Sarawak state and satisfy local needs for highly reliable renewable energy.[7] The project does not include the transfer of villages and settlements. This project has carried out trainings for local young people, provided scholarships, implemented development programmes for entrepreneurs or other programmes of social investment in the region (Sarawak Energy, 2020).

(b) Hydro: Nenggiri

A largest-scale hydropower generation project by TNB, a business operator. The power generation unit is provided by ANDRITZ, and the test run is planned by the middle of 2026. In addition to power generation, this project provides flood mitigation effects to the downstream area. Tourism and agricultural development associated with the project are anticipated (ANDRITZ, 2022). The development of the plant requires relocation of local inhabitants, and the scope of the project includes the construction of two new townships with infrastructure such as roads, power network, drinking water, and sewerage.[8]

(c) Hydro: Upper Padas

A 187.5 MWe hydroelectric dam will be constructed across the Ulu Padas River near Kuala Tomani to meet increasing demand for electricity in Sabah. After its completion, the power generation facility will contribute significantly to Sabah's power grid, supplying an additional 15% of the state's electricity and substantially reducing its reliance on fossil fuels. The Ulu Padas site offers advantageous characteristics such as convenient access, a straightforward land use pattern, and minimal inundation of residential areas.[9]

(d) Solar: Sultan Ibrahim

Sultan Ibrahim Solar Park will be the biggest solar generation project in the region,

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[7] Sarawak Energy, https://www.sarawakenergy.com/baleh-hep

[8] SMEC, https://www.smec.com/project/nenggiri-hydropower-project/

[9] Sabah Energy, https://www.sabahenergycorp.com/hydro/

boosting economic growth and providing opportunities for jobs of various levels. The project will also position Johor, a state with high levels of solar irradiance, as a leading renewable energy producer internationally (MIDA, 2021).

(e) Solar: Durian Tunggal floating solar

The floating solar facility slated for construction at Durian Tunggal Dam in Melaka is set to be one of the largest facilities of its kind in Southeast Asia. It will be constructed with the support of the Japanese government's Asia Energy Transition Initiative (Shizen Energy, 2022).

Several hydrogen projects are included in the International Energy Agency (IEA) Hydrogen Production and Infrastructure Projects Database. Examples are shown below.

(f) H2biscus

Located in Bintulu, Sarawak, the plant aims to supply hydrogen and ammonia to the Malaysian state of Sarawak and to the Republic of Korea (henceforth Korea). It will be capable of producing 630,000 tonnes of green ammonia; 600,000 tonnes of blue ammonia; 460,000 tonnes of green methanol; and 7,000 tonnes of green hydrogen per year (Hydrogen Central, 2022).

(g) PETRONAS–ENEOS MoU

Located in Kerteh, Terengganu, this commercial hydrogen project seeks to produce low-carbon hydrogen at PETRONAS' existing facilities, produce green hydrogen from a new hydro-powered electrolyser facility, and convert hydrogen into methylcyclohexane (MCH). The facilities are projected to have a total hydrogen production and conversion capacity of up to 50,000 tonnes per year by 2027. MCH will be exported to Japan, where the clean hydrogen will be distributed to Japanese industries through ENEOS' refineries. The project has been selected as a Green Innovation Fund project by the Japanese government (PETRONAS, 2022).

Projects Delayed, Suspended, or Cancelled

Table 2.10 presents a list of power generation facility construction projects that have been delayed, suspended, or cancelled as of November 2023. The list includes hydro projects with a generation capacity of 100 MWe or more, and other projects with a generation capacity of 10 MWe or more. It excludes fossil fuel–based projects.

Table 2.10. Projects Delayed, Suspended, or Cancelled in Malaysia

	Plant Name	Net Capacity (MW)	Status	Operator
Biomass	Eco-Biomass	20	Frozen	Eco-Biomass
Geothermal	Apas Kiri	37	Cancelled	Tawau Green Energy
Hydro	Baram-1 HEP	1200	Cancelled	Sarawak Energy
Hydro	Murum 2	900	Frozen	Tenaga Nasional Berhad (TNB)
Hydro	Pelagus	410	Frozen	Sarawak Energy
Hydro	Belaga	220	Frozen	Sarawak Energy
Hydro	Kaiduan	180	Frozen	
Hydro	Tutoh	160	Frozen	
Hydro	Umbang	150	Frozen	Tenaga Nasional Berhad (TNB)
Hydro	Punan Bah	130	Frozen	Sarawak Energy
Hydro	Belepeh	110	Frozen	Sarawak Energy
Hydro	Chenderoh	52.5	Frozen/Operational	Tenaga Nasional Berhad (TNB)
Nuclear	TNB Nuclear	1000	Cancelled	Tenaga Nasional Berhad (TNB)
Solar	Tanjung Malim	50	Cancelled	Malakoff Corporation Berhad
Solar	Tanjung Malim PV	50	Cancelled	Consortium Malakoff Corporation Bhd and DRB-HICOM Environmental Services
Solar	Kulai PV	29	Frozen	Consortium Zelleco Engineering, Pengkalan Bumijaya and Amled Illumination
Solar	Sandakan-PV	10	Frozen	Sun Energy Ventures and Baywa R.E. Ltd

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

Examples are shown below.

(a) Geothermal: Apas Kiri

Approval has been withdrawn for Sabah's first-ever geothermal power generation project in Apas Kiri, which had a planned capacity of 37 MWe, as no signs of progress could be seen. The Minister for Energy, Science, Technology, Environment, and Climate Change reasoned that 'This is because geothermal projects sometimes cost more than new energy sources' (Malaysiakini, 2018).

(b) Hydro: Baram-1 HEP

A proposed 1,200 MWe hydroelectric plant in Baram River, Sarawak, has been cancelled in the wake of strong opposition. The construction of the hydroelectric dam would have flooded roughly 150 square miles and forcibly displaced many Dayak communities (Harris, 2016).

(c) Solar: Tanjung Malim

The Energy Commission has withdrawn permission for the construction of a large-scale solar PV plant with a generation capacity of 50 MWe on a 200-acre site in Tanjung Malim, Perak. The landowner could no longer commit to leasing the land for the duration of the project due to other corporate activities (Azman, 2017).

2.6. Myanmar

(1) Basic Energy Policy

In 2014, Myanmar developed the National Energy Policy aiming to systematically explore and exploit the various energy resources, which are the main driving forces for economic development. The nine policies comprising the framework are as follows (National Energy Management Committee, 2014):

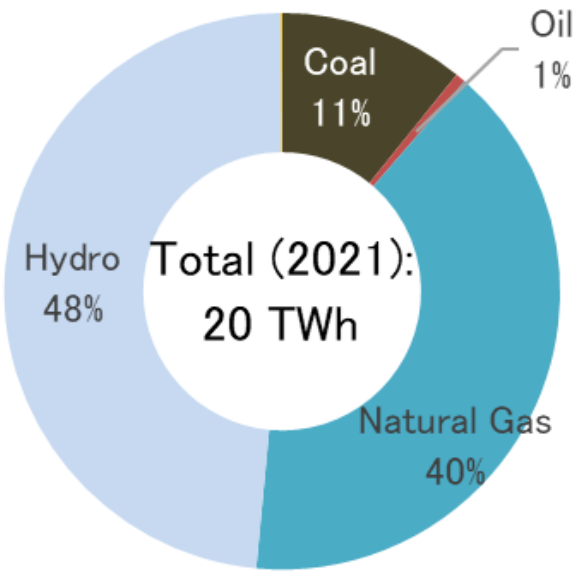
- To implement the short-term and long-term comprehensive energy development plan based on systematically investigated data on the potential energy resources, which are feasible and can be practically exploited, considering minimum impact on natural environment and social environment
- To institute laws, rules, and regulations to promote private sector participation and to privatise (100% foreign direct investment (FDI), joint FDI, international independent power producer (IPP), local IPP/small power producer/very small power producer) state energy organisations in line with State Economic Reform Policy

- To compile systematic statistics on domestic demand and supply of different kinds of energy resources of Myanmar
- To implement programmes by which the local population could proportionally enjoy the benefit of energy reserve discovered in the areas
- To implement programmes on a wider scale, utilising renewable energy resources such as wind, solar, hydro, geothermal, and bioenergy for Myanmar's sustainable energy development
- To promote energy efficiency and conservation
- To establish a research, development, design, and dissemination institution to keep abreast of international practices in energy resources exploration and development works and to produce quality products to conduct energy resources exploration works in accordance with international standards
- To promote international collaboration in energy matters
- To formulate appropriate policies for energy product pricing that meet the economic security of energy producers and energy consumers.

(2) Power Portfolio and Projection

Myanmar's energy mix for 2021 is shown in Figure 2.9. In 2010, hydro accounted for approximately 70% of its supply. However, since the 2010s, Myanmar has gradually diversified its energy; recently, natural gas has taken up an increasing share of its supply. In addition to hydro, Myanmar also generates renewable electricity in the form of solar and biomass, though quantities are minimal.

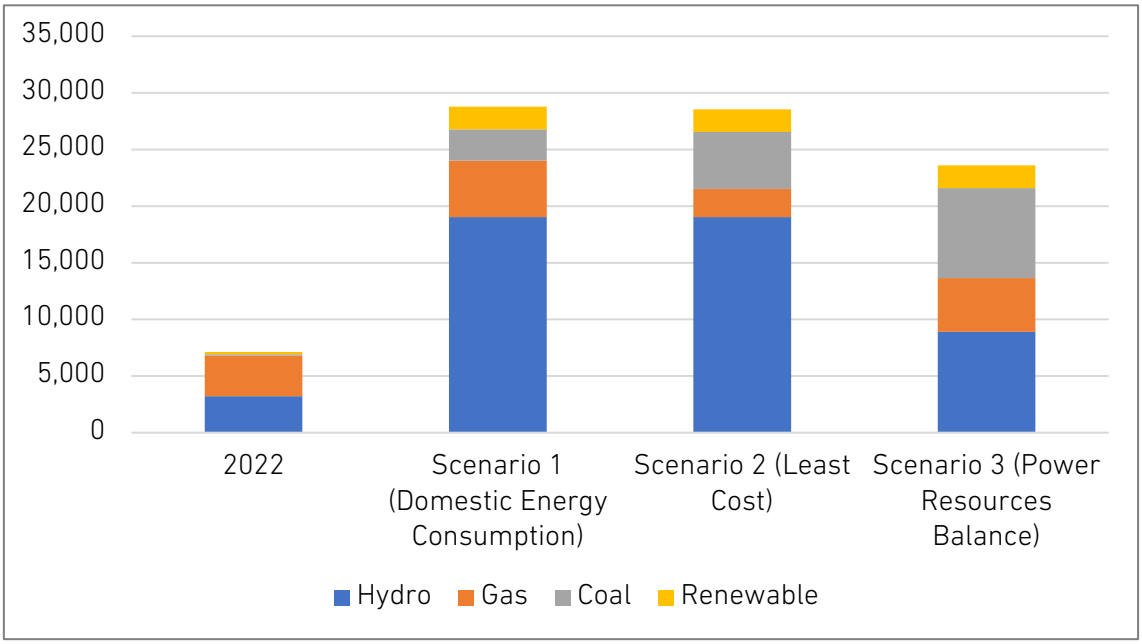
Figure 2.9. Electric Power Generation in Myanmar (2021)



Source: IEA (2023).

Myanmar's planned energy mix for 2030 is shown in Figure 2.10. Its policy is to develop an installed power generation capacity three to four times greater than 2022 levels. A significant increase in hydro, coal-fired, and renewable energy capacity can be expected.

Figure 2.10. Planned Power Generation Mix in Myanmar (2030) (MW)



Source: The World Bank (2023), ERIA (2023).

(3) Support Schemes and Regulations

Support for Investment

The Myanmar Investment Commission (MIC) is responsible for promoting, regulating, approving, and authorising investments. The Directorate of Investment and Company Administration (DICA) serves as the secretariat for MIC (JETRO, 2023b).

The Myanmar Investment Law and the Myanmar Special Economic Zone Law provide difference incentives for investment, and different incentives are therefore applied according to which law an investment is made under. The Myanmar Investment Law grants income tax exemptions for a maximum of 7 years to businesses that invest in investment promotion sectors, as well as the right to obtain long-term leases of land. Power generation has been designated an investment promotion sector (JETRO, 2023d). The Myanmar Special Economic Zone Law provides incentives – including income tax exemptions and the right to long-term leases of land – greater than those of the Myanmar Investment Law to companies established within the special economic zones of Kyauk Phyu, Dawei, and Thilawa (Mizuho Bank, Ltd. and Mizuho Research Institute, 2019).

Environmental Regulation

In 2012, Myanmar announced the Environmental Conservation Law, obligating companies to consider the potential for major impacts on the environment when executing projects. Concrete procedures are provided in the Environmental Impact Assessment Procedure, which came into effect in 2015. Specifically, a company is required to carry out an initial environmental examination (IEE) when the scale of the environmental impact of the project is comparatively small, and an environmental impact assessment (EIA) when the scale of the environmental impact of the project is large. Table 2.11 shows the standards related to electric power businesses (Ministry of Environmental Conservation and Forestry, 2015).

Table 2.11. Power Generation Projects Subject to IEE and EIA

Investment Projects and Activities	IEE Subject Projects	EIA Subject Projects
Hydro	Installed capacity ≥ 1 MW but < 15 MW and Reservoir volume (full supply level) < 20,000,000 m^3 and Reservoir area (full supply level) < 400 ha	Installed capacity ≥ 15 MW or Reservoir volume (full supply level) ≥ 20,000,000 m^3 or Reservoir area (full supply level) ≥ 400 ha
Nuclear	-	All sizes
Natural Gas or Bio gas	Installed capacity ≥ 5 MW but < 50 MW	Installed capacity ≥ 50 MW
Coal-fired	Installed capacity ≥ 1 MW but < 10 MW	Installed capacity ≥ 10 MW
Waste Products	Installed capacity ≥ 50 MW	All activities where the Ministry requires that the project shall undergo EIA
Geothermal	Installed capacity ≥ 5 MW but < 50 MW	Installed capacity ≥ 50 MW
Combined Cycle (gas & thermal)	Installed capacity ≥ 5 MW but < 50 MW	Installed capacity ≥ 50MW
Thermal (other than the types in items above)	Installed capacity ≥ 5MW but < 50MW	Installed capacity ≥ 50MW
Wind	Installed capacity ≥ 5 MW but < 50 MW	Installed capacity ≥ 50 MW
Solar	Installed capacity ≥ 50 MW	All activities where the Ministry requires that the project shall undergo EIA

Source: Ministry of Environmental Conservation and Forestry (2015).

As stipulated by the MRC, Myanmar – like the Lao PDR – is required to carry out Procedures for Notification, Prior Consultation and Agreement before developing hydropower facilities along the trunk of the Mekong River.

(4) Low-carbon Energy Projects

Projects in the Planning or Construction Phase

As of November 2023, 58 low-carbon power generation facility projects with a net capacity of 100 MW or more are in the planning or construction phase in Myanmar.

Hydro projects are by far the greatest in number and scale, ranging from small-capacity projects to large-scale 7,000 MW projects.

Solar power generation projects are second-largest in scale. In addition to the projects shown in Table 2.12, in 2020, Myanmar also issued its first-ever invitation to tender for solar power plants – seeking to build 30 plants each with a capacity of 30–50 MW, for a total of 1,000 MW (Bellini, 2020). In 2021, Myanmar again sought bids for a combined capacity of 20 MW. It has been is actively working to expand its solar power generation capacity.

Whilst Myanmar has no wind power generation facilities at present, two projects are currently under planning or under construction.

Table 2.12. Projects under Planning, Licensing, or Construction in Myanmar

	Unit Name	Net Capacity (MW)	Status	Operator
Hydro	Nam Tu	100	Announced	
Hydro	Nanli 1-2 Hydropower Station	100	Under construction	China International Water & Electric Company
Hydro	Lower Nam Pawn (Nam Pawn)	105	Authorised	
Hydro	Pha Nam (Nam Pawn)	105	Authorised	
Hydro	Tha Htay	111	Under construction	Ministry of Electric Power
Hydro	Gawlan (Ngaw Chang Kha)	120	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Dum Ban	130	Authorised	
Hydro	Tum Baing	130	Announced	
Hydro	Hekou (Nam Lwe)	138	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Khan Kawn (Ngaw Chang Kha)	140	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Upper Bu	150	Announced	Ministry of Electric Power
Hydro	Upper Nam Pawn (Nam Pawn)	150	Authorised	
Hydro	Middle Paunglaung	152	Under construction	Ministry of Electric Power
Hydro	Baw gata	160	Announced	Ministry of Electric Power
Hydro	Nam Li HPP	165	Authorised	
Hydro	Keng Tong (Nam Lwe)	170	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Upper Hawkhan (Nam Pawn)	180	Authorised	
Hydro	Nam Kha	200	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Namlang	210	Authorised	
Hydro	Man Taung	225	Authorised	
Hydro	Solue (Nam Lwe)	240	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Belin	280	Authorised	
Hydro	Upper Yeywa (Ahtet Yeywa)	280	Under construction	Ministry of Electric Power
Hydro	Nam Tabak (Kachin)	285	Announced	Yunnan Power Investment Corporation's (YPIC)
Hydro	Tongxinqiao (Ngaw Chang Kha)	340	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Dapein (Tarpein)	380	Operational/Authorised	China Datang
Hydro	Manipur	380	Under construction	
Hydro	Mawlaik	520	Announced	China Energy Investment Corporation (CEIC)
Hydro	Shweli-2	520	Authorised	Huaneng
Hydro	Lawngdin (Ngaw Chang Kha)	600	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Laymyo	690	Announced	Shwetaung Hydro
Hydro	Middle Yeywa	700	Authorised	
Hydro	Tapar	1160	Announced	Hanergy
Hydro	Nao Pha	1200	Under construction	Hydrochina
Hydro	Yenam	1200	Authorised	Yunnan Power Investment Corporation's (YPIC)
Hydro	Hutgyi	1360	Authorised	Electricity Generating Authority of Thailand (EGAT)
Hydro	Kunlong (Upper Thanlwin)	1400	Under construction	Goldwater Resources
Hydro	Laiza	1560	Under construction	State Power Investment Corporation (SPIC)
Hydro	Pashe (Lawdin)	1600	Announced	State Power Investment Corporation (SPIC)
Hydro	Wutsok (Lakin)	1800	Announced	State Power Investment Corporation (SPIC)
Hydro	Phizaw	2000	Announced	State Power Investment Corporation (SPIC)
Hydro	Khaunlanphu	2700	Authorised	State Power Investment Corporation (SPIC)
Hydro	Chibwe	3400	Under construction	State Power Investment Corporation (SPIC)
Hydro	Ywathit	4000	Bidding process	China Datang
Hydro	Weigyi	5800	Announced	
Hydro	Mongton (Mong Ton)	7000	Authorised	Electricity Generating Authority of Thailand (EGAT)
Solar	Sagaing	100	Announced	Quasar Resources
Solar	Thapaysan	100	Authorised	Jewoo Lightech
Solar	Chauk, Taungtwingyi and Tanyaung Solar Power Project	100	Announced	Ministry of Electricity and Energy
Solar	Taungoo, Tharyargone, Thephyu, Kamarnat and Minhla Solar Power Project	150	Announced	Ministry of Electricity and Energy
Solar	Myaungtagar Solar Power Project	150	Announced	Ministry of Electricity and Energy
Solar	Belin, Letpanhal, Myingyan, Thapyaywa and Taungtawgwin Solar Power Project	200	Announced	Ministry of Electricity and Energy
Solar	Minbu	220	Operational /Under construction/FID	Green Earth Power
Solar	Kamari Panit PV-1	300	Announced	Kamrai Panit
Solar	Kyaukpahtoe, Monywa, Ngapyawdine, Nyaungbingyi and Ohntaw Solar Power Project	300	Announced	Ministry of Electricity and Energy
Solar	Mandalay & Sagaing	880	Authorised	Asian Ecoenergy Development/Primus
Wind	Projet Rosatom	172	Authorised	Rosatom
Wind	Infra Capital Myanmar wind project	263	FID	Infra Capital Myanmar

FID = Final Investment Decision

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

(a) Manipur Hydropower Plant

The Manipur Hydroelectric Power Plant will consist of two dams along the Laymyo River. Joint planning of the facility was started in 2009 by Myanmar's previous military regime and the Chinese government, but the plans were cancelled in 2012. When the National League for Democracy came to power in 2016, it conducted a feasibility study with the help of $1 million in support from the French government (Khonumthung, 2019). However, the present state of the project is unclear.

(b) Laymyo Power Plant

The Laymyo Power Plant project started in 2004, was suspended in 2011, then restarted. However, in August 2020, the government decided to suspend the project once again, since 'this project was found to be more risk than reward' (Myanmar Water Portal, 2020). The Minister for Electricity and Energy is reported to have inspected the project in June 2021, raising the possibility that it has once again been restarted (Myanmar International TV, 2021).

(c) Hatgyi Hydropower Plant

The Hatgyi Hydropower Plant is a joint venture of the Electricity Generating Authority of Thailand (EGAT), the Myanmar Ministry of Electric Power, Sinohydro (a Chinese firm), and International Group of Entrepreneurs Co. (a consortium of Burmese companies). Located just 47 kilometres from the Thai border, the plant has a planned capacity of 1,360 MW. In Table 2-12, this project is shown to be 'Under Construction'. However, a media report from April 2023 indicates that the project is currently on hold, due both to strong opposition from affected communities and the fact that the construction site is in a conflict area (Tano and Sukkaew, 2023).

(d) Kunlong (Upper Thanlwin) Hydropower Plant

In 2014, the Government of Myanmar granted approval to local company Asia World and China's Hanergy Group Holding Ltd. to develop a 1,400 MW hydropower plant along the Thanlwin River. Some 90% of the electricity generated by the plant was set to be exported to China (Harris, 2014). However, the project was reported to have been cancelled in 2015 due to conflict in the region (Tano and Sukkaew, 2023); the current state of the project is unclear.

(e) Mongton (Mong Ton/Mong Tong) Hydropower Plant

The Mong Ton Hydropower Plant is a joint project between the China Three Gorges Corporation, EGAT, Myanmar's Ministry of Electricity Power, and the International Group of Entrepreneurs. With a capacity of 7,000 MW, it has the greatest generation

capacity of any project currently under planning or construction. However, approximately 90% of the electricity generated from the plant is set to be exported to Thailand and China. The project's investment value is estimated at $7.99 billion or 27 billion baht (Wangkiat, 2015).

(f) Minbu Solar Power Plant

The Minbu Solar Power Plant is set to be constructed in four phases. Each of the first three phases will add 40 MW of capacity, and the fourth will add 50 MW, for a planned total capacity of 170 MW. Phase One was completed in 2019 and, as of January 2023, 97% of the groundwork for Phase Two has been completed. When the power plant is fully operational, it will supply the electricity needs of regions in its immediate vicinity and neighbouring regions (The Global New Light of Myanmar, 2022 and 2023).

(g) Project ROSATOM Wind Power Plant

In June 2023, NovaWind (ROSATOM's wind power division) and Primus Advanced Technologies Ltd. signed an MoU to conduct a feasibility study for two wind power generation facilities. The facilities have a planned generation capacity of 56 MW and 116 MW, respectively, for a combined generation capacity of 172 MW (Rosatom, 2023).

(h) Infra Capital Myanmar wind project

Headed by Infra Capital Myanmar – ReEx (ICM), the Infra Capital Myanmar wind project is slated to have a capacity of 263 MW. Infra Capital Myanmar – ReEx (ICM) is a subsidiary of ReEx Capital Asia, a leading clean energy investment banking and consulting boutique specialising in the Asia and Pacific region. The project aims to demonstrate the government's ability to regulate power generation in line with international standards, and to foment understanding of wind power generation amongst Myanmar's citizens. Its goal is to develop a pipeline of 'shovel-ready' and internationally bankable wind power projects.

Projects Delayed, Suspended, or Cancelled

Even after being announced, many projects in Myanmar have been frozen, whose progress cannot be confirmed, or which have been officially cancelled by project operators. These projects are shown in Table 2.13.

Table 2.13. Projects Delayed, Suspended, or Cancelled in Cambodia

	Unit Name	Net Capacity (MW)	Status	Operator
Hydro	Thaukyegat	140	Cancelled	Ministry of Electric Power
Hydro	Shwesayay	600	Cancelled	
Hydro	Shweli-3	671	Suspended construction	Ministry of Electric Power
Hydro	Tamanthi	1,200	Cancelled	Ministry of Electric Power
Hydro	Myitsone	6,000	Frozen	Asia World Company
Solar	Wundwin (Meikgtila)	150	Frozen	ACO Investment
Solar	Nabuaing (Myingyan)	150	Frozen	ACO Investment
Geothermal	Myanmar geothermal	200	Frozen	

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

(a) Shwesayay Hydropower Plant and Tamanthi Hydropower Plant

In 2008, the then Myanmar Ministry of Electric Power and the Indian public sector hydropower development organisation NHPC signed an MOU to conduct a feasibility study into Shwesayay and Tamanthi Hydropower Plants. However, in 2013, both projects were reported to be put on hold. According to detailed project reports compiled by the NHPC, both projects would likely have had social and environmental impacts and were economically unviable (Singh, 2013).

(b) Shweli-3 Hydropower Plant

In March 2021, the French state-owned EDF announced that it would temporarily suspend plans for the Shweli-3 Hydropower Plant due to concerns about the human rights abuses of Myanmar's military regime. The Myanmar government issued a Notice to Proceed in 2018, and the plant was originally scheduled to commence operations in 2027. EDF and Marubeni were each set to provide 32.5% of the funding

for the project, whilst the Myanmar Ministry of Electricity and Energy would contribute 25%, and local company Myanmar Ayeyar Hinthar would contribute 10%. As of December 2020, the construction progress rate stood at approximately 12%.

(c) Myitsone Dam

Myitsone Dam was the largest of seven dams to be developed jointly by the then Myanmar Ministry of Electric Power and China Power Investment Corporation in 2006. Construction commenced in December 2009, with 90% of the electricity generated by the dam scheduled to be delivered to China. However, the project was suspended in September 2011 for the following reasons:

- The construction of the large-scale dam would adversely affect the environment and the lives of residents.
- The dam would provide limited benefit to the Myanmar people, since most of the electricity generated would be used by China.
- The project plans lacked transparency.

2.7. Philippines

(1) Basic Energy Policy

The Philippine Energy Plan (PEP) 2020–2040 aims to chart a transformative direction towards attaining a more sustainable, more resilient energy system. PEP's policies for different energy types are outlined below.

(a) Petroleum

In upstream sectors, PEP aims to increase domestic development of petroleum fields. In the petroleum industry, the plan aims to supply an appropriate quantity and quality of petroleum products to the market. About domestic development of petroleum fields, PEP outlines goals to increase known reserves to 116 MMB and to increase production to 66 MMB by 2040.

(b) Natural Gas

In upstream sectors, PEP aims to expand the domestic development of gas fields. In the natural gas industry, the plan aims to establish a world-class, investment-driven, and efficient natural gas industry that ensures that natural gas is efficiently used by all end-use sectors.

Regarding domestic development of natural gas fields, PEP outlines goals to increase known reserves to 5.87 Tcf and to increase production to 3.5 Tcf by 2040. However,

the depletion of reserves in the Malampaya Gas Field, the country's only existing gas field, indicates an impending shortage of natural gas; several plans for importing liquefied natural gas (LNG) are therefore under discussion.

(c) Coal

Coal continues to be a reliable and cheap source of energy, and PEP aims to promote the implementation of technologies that increase efficiency and minimise environmental pollution. Regarding domestic development of coal mines, PEP outlines goals to increase known reserves to 766 MT and to increase production to 282 MT by 2040.

(d) Nuclear Power

To achieve a diverse and balanced energy mix, PEP aims to consider both the technological and economic feasibility of using nuclear power as a long-term means of generating electricity. The plan sets out a roadmap for commencing nuclear power generation by 2027 at the earliest.

(e) Energy Efficiency and Conservation

PEP calls for improved energy efficiency and conservation to achieve the Sustainable Development Goals and meet the country's NDC targets.

(f) Hydro

In its Reference Scenario, PEP expects the country's hydro energy supply to increase from 1.8 Mtoe in 2020 to 12.8 Mtoe in 2040.

(g) New Energies

PEP aims to increase the share of renewable energies in its supply mix to 35% by 2030, and to 50% by 2040. With regard to biofuels, PEP aims to achieve a 5% biodiesel blend and a 10% bioethanol blend by 2040.

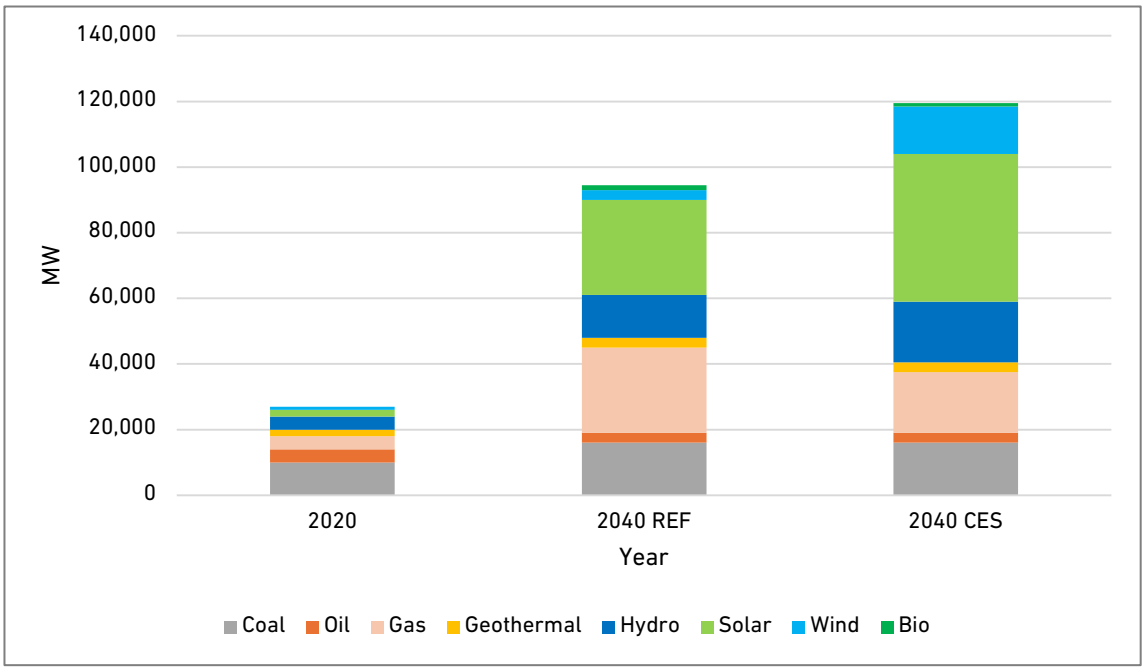
(h) Hydrogen

The Philippine Department of Energy recognises hydrogen to be a clean source of alternative energy and intends to discuss its use.

(2) Power Portfolio and Projection

The projected power generation capacity in the Philippines in 2040, according to two different PEP 2020–2040 scenarios, is shown in Figure 2-11.

Figure 2.11. Projection of Total Installed Capacity in Philippines



CES = Clean Energy Scenario, Ref = Reference Scenario.

Source: Department of Energy (2020).

In the Reference Scenario, the total power generation capacity is projected to increase from 26,250 MW in 2020 to 95,670 MW in 2040, with natural gas and solar power dominating the energy mix.

In both the Reference Scenario and the Clean Energy Scenario (CES), coal use will only increase slightly. The main difference between the two scenarios lies in the extent to which the country can shift from the use of natural gas to renewable energies. In particular, solar power and wind power account for a far larger proportion of the energy mix in CES.

(3) Support Schemes and Regulations

Support for Investment

Every year, the Philippine Board of Investments (BOI) announces an Investment Priorities Plan (IPP), of which the energy sector is also a part. BOI incentives include tax exemptions for a maximum of 6 years for newly registered pioneer enterprises, and a maximum of 4 years for newly registered non-pioneer enterprises. However, these exemptions can be extended to a maximum of 8 years if certain conditions are met. The term 'pioneer enterprise' here refers to a company that fulfills the criteria outlined as follows (JBIC, 2024a):

- Involves the manufacturing or processing of goods or raw materials that have not been produced in the Philippines on a commercial scale
- Uses a design, formula, scheme, method, process, or system of production or transformation of any element or raw material or finished good, which is new and untried
- Engages in agricultural, forestry, or mining activities and services
- Produces non-conventional fuels or manufactures equipment that utilise non-conventional sources of energy
- Uses or converts to coal or other non-conventional fuels or sources of energy in its production, manufacturing, or processing operations

Environmental Regulation

In the Philippine Environmental Policy (Presidential Decree No. 1151), signed in 1977, the country recognises its duty to establish and maintain an environment in which 'man and nature can thrive in harmony with one another'. Accordingly, when government and private agencies and entities carry out projects that significantly impact the quality of the environment, they are required to prepare an environmental impact statement (JBIC, 2024b).

Projects falling under the EIA System's Project Categories A or B are required to obtain an Environmental Compliance Certificate (ECC) before the project can be approved. Projects in Category A are defined as environmentally critical projects and are required to submit an environmental impact statement (EIS); projects in Category B only have to submit an initial environmental examination, so long as they are not located in an environmentally critical area and, after screening, are not required to submit an EIS. Power generation facilities fall under Category A.

After the issuance of an ECC, the agency or entity in question will be subject to monitoring to ensure that environmental management plans and ECC issuance conditions are properly met (Institute for Global Environmental Strategies, 2019).

(4) Low-carbon Energy Projects

Projects in the Planning or Construction Phase

A list of low-carbon power generation facility projects under planning or under construction in the Philippines as of November 2023 is in Table 2.14. The table includes projects with a net capacity of 100 MWe or more; it excludes fossil fuel projects.

Table 2.14. Projects Under Planning, Licensing, or Construction in the Philippines

	Plant Name	Net Capacity (MW)	Status	Operator
Biomass	Bohol biomass	100	Announced	CIMON BAGO Bio-Power Plant
Geothermal	Tiwi	361	Operational/Mothballed/Under construction	AP Renewables
Geothermal	Bacman-1	135	Operational/FID	Bac-Man Geothermal
Hydro	Ahunan Pumped Storage	1200	Bidding process	Ahunan Power
Hydro	Agus	828	Operational/Under construction	NPC - Mindanao Generation
Hydro	Dambo Hydro	800	Submitted	Belisama Hydropower
Hydro	Wawa Pumped Storage HEP	650	Bidding process/Submitted	Olympia Violago Water and Power
Hydro	Dingalan Pumped Storage HEP	500	Announced	Strategic Power Development Corp
Hydro	Kibungan Pumped-Storage HEPP	500	Announced	COHECO Badeo Corporation
Hydro	San Roque Lower East Pumped Storage	400	Announced	Strategic Power Development Corp
Hydro	Paete Pumped Storage	350	Submitted	Citicore Power
Hydro	Diduyon Hydro	320	Submitted	Global Utility Development/Green Energy Management
Hydro	Aklan	300	Submitted	Sunwest Water & Electric Company
Hydro	Aklan PSPP	300	FID	Strategic Power Development Corp
Hydro	Bolusao PSPP	300	Authorised	San Lorenzo Ruiz Builders (SLRB)
Hydro	Pililla HPP	300	Bidding process	Trans Asia Power
Hydro	Alimit PSP	240	Authorised	Aboitiz Power
Hydro	Binongan	175	Submitted	
Hydro	Chico River HEP	150	Authorised	San Lorenzo Ruiz Builders (SLRB)
Hydro	Wawa	150	Authorised	San Lorenzo Ruiz Builders (SLRB)
Hydro	Gened HPP-1	150	Authorised	Pan Pacific Renewable Power Phils. Corp
Hydro	Batang Hydro	150	Submitted	Bukidnon Hydro Energy
Hydro	Davao SLRB	140	Authorised	San Lorenzo Ruiz Builders (SLRB)
Hydro	Alimit	120	Authorised	Aboitiz Power
Hydro	Pantabangan (Aya)	120	Authorised	First Gen Hydro Power Corp
Solar	Batangas Solar Farm - III	2000	Announced	Solar Philippines Biga Corporation
Solar	Laguna Lake floating Solar	1300	Authorised	Blueleaf Energy
Solar	General Santos City	1200	Announced	Astroenergy Gensan
Solar	Iba Palauig Solar 1	1200	Submitted	Solar Philippines, Inc.
Solar	Iba Palauig Solar 2	1200	Submitted	Solar Philippines Commercial Rooftop Projects
Solar	Laguna Lake Solar Floating	1000	Authorised	AC Energy Corp. (ACEN)
Solar	Balayan	600	Submitted	Solar Philippines Commercial Rooftop Projects
Solar	Cabatang Tiaong	600	Submitted	Solar Philippines Commercial Rooftop Projects
Solar	Peñaranda solar	500	Under construction	Solar Philippines
Solar	Ilagan Solar	440	Authorised	Nextnorth Energy Group
Solar	GigaSol Palauig Solar	363	Operational/Under construction	AC Energy
Solar	Zambales Solar	300	Announced	ERS Energy Group
Solar	San Marcelino solar	283	Under construction	AC Energy
Solar	Maragondon-Naic-Tanza 2	200	Submitted	Solar Philippines Commercial Rooftop Projects
Solar	Daanbantayan Solar	150	Announced	Acciona Energia
Solar	San Rafael Solar 1	140	Submitted	Solar Philippines Commercial Rooftop Projects
Solar	Lal-lo Solar	133	Authorised	Natures Renewable Energy & Development (NAREDCO) Corp.
Solar	Sta. Maria Solar PV	125	Announced	Greenergy Solutions, Inc.
Solar	Talugtug Solar	125	Submitted	Greenergy Solutions, Inc.
Solar	Mitsui Luzon Solar	115	Under construction	Mitsui Bussan
Solar	Baras solar	115	Under construction	Global Business Power Corp. (GBPC)
Solar	Sta. Rita Solar	105.46	Operational/Authorised	Jobin-Sqm (JOBIN)
Solar	Calamba and Tanauan Solar	100	Submitted	Solar Philippines Tanauan Corporation
Solar	Ceko Solar	100	Announced	CEKO Solar Farm Systems Corp.
Solar	Ilagan II Solar	100	Submitted	Greenergy Solutions, Inc.
Solar	Magsingal Solar	100	Submitted	Neoenergy Corporation
Solar	Medellin Solar	100	Submitted	Solar Philippines
Solar	Nueva Ecija Solar	100	Announced	Firmgreen Phils. Inc.
Solar	Sanpalo solar	100	Authorised	Sunpalo Solar Energy
Solar	Tanauan Batangas Solar I	100	Announced	Solar Philippines Tanauan Corporation
Solar	Sarangani Solar	100	Authorised	Total Power Incorporated
Solar	Pasuquin Solar	100	Under construction	Energy Logics Philippines, Inc. (ELPI)
Solar	Maragondon-Naic 1	100	Submitted	Solar Philippines Commercial Rooftop Projects
Solar	Cadiz Floating Solar	100	Announced	
Wind	Manila Bay	1248	Announced	ACEN
Wind	Aparri Bay & Guimaras Strait offshore wind (Triconti)	1200	FID	Triconti Windkraft Group
Wind	Bulalacao offshore	1200	Announced	Blue Circle
Wind	Calatagan	1024	Announced	ACEN
Wind	Iloilo Wind	713	Authorised	Energy Development Corp
Wind	San Miguel Bay	600	Under construction	Iberdrola
Wind	Matnog Wind	565	Announced	Energy Development Corporation
Wind	Fontera Bay	450	FID	Iberdrola
Wind	Ayala Wind	335	Authorised	ACEN
Wind	Negros Wind	262	Authorised	Energy Development Corp
Wind	Talim Wind	212.5	Announced	Currimao Solar Energy Corp.
Wind	San Isidro Wind	206	Announced	Aboitiz/Vivant/Vena
Wind	Burgos 2 Wind	183	Announced	Energy Development Corporation Pagali Burgos Wind Power Corporation
Wind	Alabat Island Wind	164	Authorised	Altenergy
Wind	Balaoi and Caunayan	160	Under construction	AC Energy
Wind	Pagudpud Wind	160	FID	AC energy corp
Wind	GigaWind	160	Synchronized	ACEN
Wind	Pasuquin Wind	132	Under construction	Energy Logics Philippines
Wind	Rizal-Laguna Wind	102	Bidding process	Aboitiz Renewables
Wind	Bronzeoak	100	Authorised	Bronzeoak Philippines
Wind	Bohol I (Ubay) WPP	100	Announced	Tri-Conti Elements Corporation
Wind	Oslob Wind	100	Authorised	Coro Energy

FID = Final Investment Decision

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

PEP forecasts that the power generation capacity of hydro, solar, and wind will increase, and they account for the majority of projects under planning or construction. There are also plans for one biomass and two geothermal projects. Some typical examples are outlined below.

(a) Biomass: Bohol biomass

A biomass power plant will be built in stages on a 9-hectare site in Barangay Poblacion, Bohol. The plant aims to generate 100 MW, which equates to the estimated future power demand of Bohol. By purchasing grass from local farmers, plant operators will secure fuel for the plant and provide income to the farmers (Obedencio, 2017).

(b) Geothermal: Tiwi

This project entails constructing a 17 MW binary power generation facility that runs on residual heat in the oldest geothermal power plant in the Philippines. The project will hopefully deliver an additional source of clean energy to the Luzon grid (Aboitiz Power, 2023).

(c) Hydro: Agus

The Agus-Pulangi complex in Mindanao is composed of seven hydropower plants with a total installed capacity of 1,001 MW. However, only 600–700 MW are currently available due to limitations in its old facilities. This project aims to rehabilitate the complex, reducing the island's reliance on coal and accelerating its shift to clean energy sources (Cervantes, 2022).

(d) Solar: Peñaranda Solar

A 500 MWe solar park is being constructed in Peñaranda, Nueva Ecija, in the Central Luzon region. It is expected to sell its output during the sunniest hours, when demand for electricity is highest (Bellini, 2021). Plans have subsequently been made to add 3.5 GW to the original 500 MW solar farm in Luzon, expanding the project eightfold. According to the project developer, this expansion will make it one of the largest solar projects in the world (Skujins, 2024).

(e) Solar: GigaSol Palauig Solar

The Palauig 2 Solar project adds 300 MW of capacity to the existing 63 MW Palauig 1 Solar farm in Palauig, Zambales. Palauig 2 Solar is projected to generate over 450 GWh of clean energy per year. Together with Palauig 1 Solar's 90 GWh output, it will sustainably power the equivalent of around 139,000 homes and eliminate 350,000 tonnes of carbon emissions per year. Since starting development of Palauig 1 Solar

in 2020, project operator ACEN has created around 2,200 green energy jobs in Zambales, thereby contributing to the local economy (ACEN, 2023).

(f) Solar: San Marcelino solar

The San Marcelino solar project aims to establish one of the largest solar farms in the country in San Marcelino, Zambales. With a capacity of 283 MW, the farm can produce over 421 GWh of renewable energy per year, eliminating 287,796 tonnes of CO_2 emissions per year in the process. The farm's capacity can potentially be expanded to 700 MW (ACEN, 2021).

(g) Solar: Baras Solar

Solenergy Systems has been commissioned to construct a solar power plant in Baras, Rizal, with the capacity to generate approximately 165,000 MWh of electricity per year. Consisting of 211,020 PV modules located within a 135-hectare area, the project will aid the country's growing demand for a clean and affordable power supply.[10]

(h) Solar: Pasuquin Solar

Energy Logics initially planned to establish a 100 MW solar power plant in Pasuquin, Ilocos Norte. However, the plant has since been relocated to Burgos. Both national and provincial governments support the project, which will provide an alternative and viable energy supply capable of competing with the existing high energy prices in the market (Adriano, 2023). However, the project is opposed by local indigenous groups (Rappler, 2024).

(i) Wind: Balaoi and Caunayan

Located in Pagudpud, Ilocos Norte, Luzon Island, the project is set to become one of the largest wind farms in the Philippines, with 32 turbines each capable of generating 5 MW. Farm operator AC Energy aims to achieve a total renewable energy capacity of 5,000 MW by 2025 (Renewables Now, 2021).

Projects Delayed, Suspended, or Cancelled

A list of power generation facility construction projects that have been delayed, suspended, or cancelled in the Philippines as of November 2023 is provided in Table 2.15. The list includes hydro projects with a generation capacity of 100 MWe or more, and other projects with a generation capacity of 10 MWe or more. It excludes fossil fuel–based projects.

[10] https://solenergy.com.ph/projects/baras-solar-plant/

Table 2.15. Projects Delayed, Suspended, or Cancelled in Philippines

	Plant Name	Net Capacity (MW)	Status	Operator
Biomass	Mina Multi-Fuel	33	Frozen	Green Power Panay Phils.
Biomass	Misamis Oriental Biomass	10.8	Frozen	Misamis Oriental Bio-Energy Corporation
Biomass	Kalilangan	10	Frozen	Kalilangan Bio-Energy Corporation
Electricity storage	Zamboanga Battery Energy Storage	200	Frozen	SMCGP Philippines Energy Storage Co. Ltd.
Geothermal	Southern Leyte	30	Frozen	Energy Development Corp
Hydro	Kalayaan	1084	Operational/Frozen	CBK Power Company
Hydro	Pantabangan Expansion	300	Frozen	First Gen
Hydro	Kanan B1	145	Frozen	Energy World
Solar	Toledo PV	60	Frozen	SunAsia Energy
Solar	Tantangan Solar	50	Cancelled	NVVPSE Five Inc.
Solar	Negros	30	Frozen	Youil Ensys
Solar	Digos II	19.58	Frozen	Enfinity Philippines Renewable Resources
Wind	Energy World Wind Farm	50	Frozen	Energy World
Wind	Northwind Pamplona	30	Frozen	NorthWind Power Development
Wind	Calauag	10	Frozen	Trans-Asia Renewable Energy
Wind	Infanta	10	Frozen	Trans-Asia Renewable Energy

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

Examples are shown below.

(a) Biomass: Mina Multi-fuel

Two multi-fuelled biomass power plants, running on multiple types of biomass sourced from the Philippine food processing and agricultural industries, were planned for an 11-hectare site in Mina, Iloilo, on Panay Island[11]. The plants were expected to deliver an estimated 3,400 green jobs in the local community.[12]

(b) Biomass: Misamis Oriental Biomass and Kalilangan

The project entailed the construction of three biomass power facilities in Mindanao. The plants were to be fueled by bana grass, an energy crop that produces gas with a 60% methane content, and a sellable byproduct of green coal (Rappler, 2015).

(c) Hydro: Kanan B1

For this project to develop a hydroelectric power facility in General Nakar, Quezon province, the Renewable Energy Management Bureau of the Department of Energy is reported to have called for the developer to finalise its investment model for pre-development (Eco-Business, 2012).

[11] Green Power Panay Philippines, https://www.green-power-panay.com/biomass

[12] Green Power Panay Philippines, https://www.green-power-panay.com/project

(d) Solar: Negros

Korean company Youil Ensys plans to invest in the construction of a solar facility near Bacolod City in Negros Occidental. However, the company claims that it cannot proceed in the absence of FITs (Eco-Business, 2011).

(e) Solar: Digos II

Operations commenced for this solar project in Davao del Sur, Mindanao, in 2016, but FIT incentives have since been rescinded. The facility is set to be expanded when certain policies of the Department of Energy come into effect (Velasco, 2018).

2.8. Singapore

(1) Basic Energy Policy

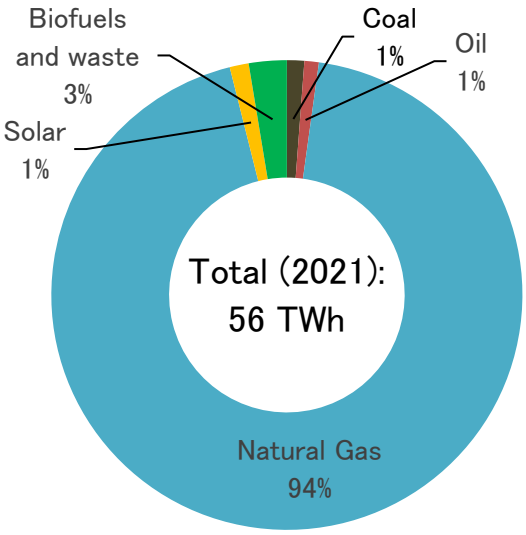
In February 2021, the Singapore government announced an environmental action plan entitled 'Singapore Green Plan 2030'. Designed to advance Singapore's national agenda on sustainable development, it comprises five pillars: (i) City in Nature, (ii) Energy Reset, (iii) Sustainable Living, (iv) Green Economy, and (v) Resilient Future. Energy-related policies fall under the Energy Reset pillar and include various goals, such as to increase solar energy capacity by a minimum of 2 GW by 2030, to import up to 4 GW of low-carbon electricity by 2035, and to ensure that all vehicles run on clean energy by 2040.[13]

(2) Power Portfolio and Projection

Singapore's energy mix for 2021 is shown in Figure 2.12. Natural gas accounted for more than 90% of its supply. In addition to solar, Singapore also generates renewable electricity in the form of biofuels and waste, though quantities are small.

[13] Singapore Green Plan, https://www.greenplan.gov.sg/key-focus-areas/energy-reset/

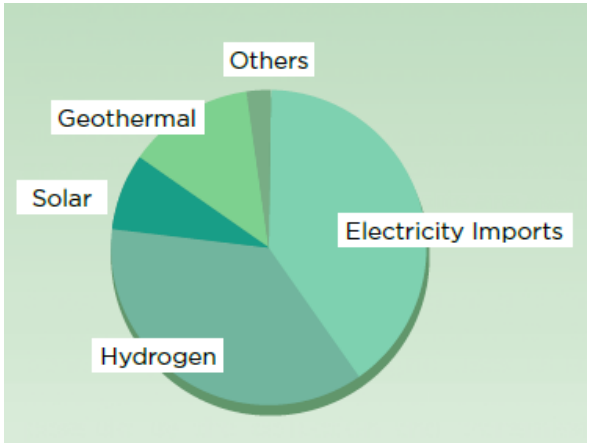
Figure 2.12. Electric Power Generation in Singapore (2021)



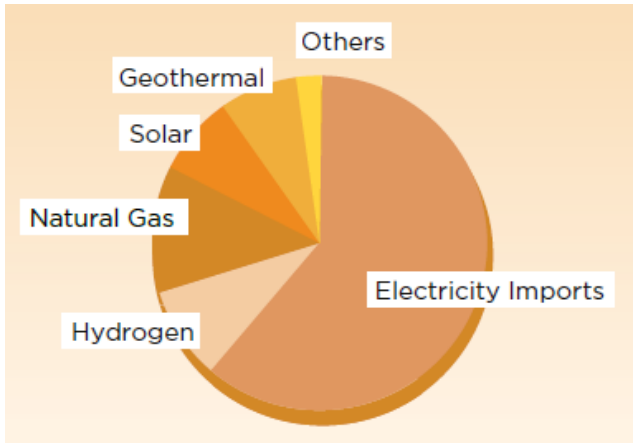
Source: IEA (2023).

In October 2022, the Singapore government committed to achieving net-zero emissions by 2050 (National Climate Change Secretariat, 2022). However, due to the country's small geographical size, the government recognised that the transition would be difficult and contingent on various factors. According to a report issued by the government-appointed Energy 2050 Committee, net-zero emissions by 2050 is a realistic goal. However, the report indicates that achieving net-zero emissions will require low-carbon electricity or hydrogen to be imported from other countries and, as such, will be difficult without international cooperation. The Energy 2050 Committee Report outlines three potential energy scenarios for 2050: (i) in the Clean Energy Renaissance scenario, Singapore achieves a diversified supply mix; (ii) in the Climate Action Bloc scenario, it increases its reliance on electricity imports; and (iii) in the Emergent Technology Trailblazer scenario, the country makes proactive investments in hydrogen and other new technologies. Figure 2.13 shows the approximate supply mix required to achieve net-zero emissions by 2050 under each of the three scenarios. Whilst there are differences, it is notable that electricity imports play a role in all three scenarios (Energy Market Authority, 2022).

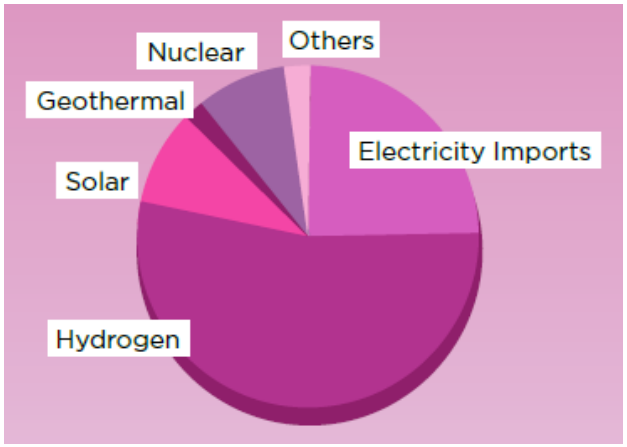
Figure 2.13. Estimated Power Generation Mix in 2050 in Singapore



Clean Energy Renaissance



Climate Action Bloc



Emergent Technology Trailblazer

Note: 'The illustrative supply mix is purely for scenario planning purposes. It does not represent the Singapore government's ambition, target, or projection. 'Others' represents waste-to-energy, biomethane etc. (cited from the source)

Source: Energy Market Authority (2022).

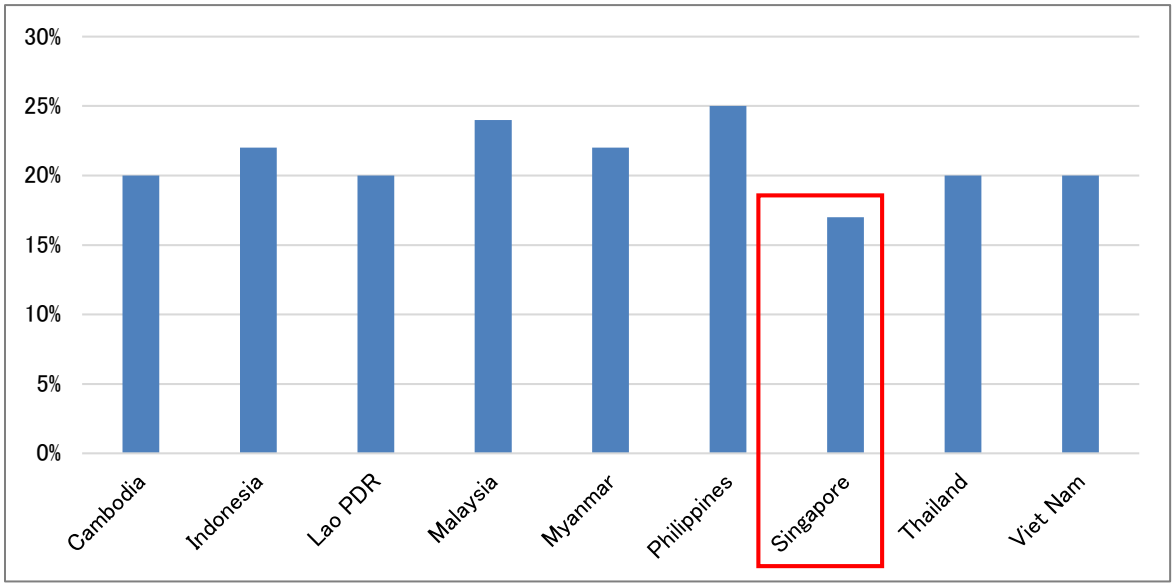
(3) Support Schemes and Regulations

Support for Investment

The Economic Development Board (EDB) is responsible for Singapore's investment promotion strategies. To promote investments, the EDB offers various tax and other incentives. Singapore has a corporate income tax (CIT) rate of just 17% which, as Figure 2.14, shows is the lowest verifiable CIT rate of any ASEAN country. Companies that utilise sophisticated technologies or that are recognised as offering high added value receive additional tax incentives, too.

To promote investments in energy, Singapore subsidises up to 50% of the certified costs related to energy efficiency improvements, with subsidisation rates varying on a sliding scale according to the volume of emissions reduced. Specifically, the EDB offers Resource Efficiency Grants to Energy for major manufacturers, whilst the National Environment Agency offers the Energy Efficiency Fund to small and medium-sized manufacturers (Economic Development Board, 2018).

Figure 2.14. Headline CIT Rate of ASEAN Economies (as of 2023)



Note: Brunei Darussalam is not included in the source.

Note: 'The headline CIT rate is generally the highest statutory CIT rate, inclusive of surtaxes but exclusive of local taxes'. (cited from the source)

Source: PwC (https://taxsummaries.pwc.com/quick-charts/corporate-income-tax-cit-rates#qc-2d3fdca6-2c158969-5e3d0644-35ef2a19-97dc246e-1c8f7534-971fb017-9b6bf943-791da177).

Environmental Regulation

NEA, which falls under the jurisdiction of the Ministry of Sustainability and the Environment, is primarily responsible for environmental regulations in Singapore. For all development plans, it carries out checks and authorisations related to air, water, and noise pollution. If a development is planned in a nature reserve or coastal area, discussions take place between the company responsible, NEA, and relevant government agencies. If deemed necessary, a detailed EIA is then carried out. Previously, the project developer would hold discussions with the relevant government agency, and the agency would independently select a consultant to carry out the EIA. In August 2022, however, the Minister of National Development announced a policy to centralise this consultant selection process under its subordinate organisation, the National Parks Board (National Parks Board, 2022). This centralised selection process was scheduled to commence on a trial basis in the first half of 2023. As of January 2024, however, the current state of progress is unclear.

Regarding regulations for solar power facilities, the Ministry of National Development's Urban Redevelopment Authority (URA) issued Planning Guidelines for Solar Panels in 2019 (Urban Redevelopment Authority, 2019). These guidelines stipulate that URA planning permission is required when installing solar panels in areas subject to urban design guidelines and conservation areas, or on the roofs of residential, commercial, and civic buildings.

(4) Low-carbon Energy Projects

Projects under Planning or under Construction

Table 2.16 lists the low-carbon power generation facility projects under planning or construction in Singapore as of November 2023. The table includes projects with a net capacity of 100 MW or more; it also includes biomass projects of all capacities.

Table 2.16. Projects Under Planning, Licensing, or Construction in Singapore

	Plant Name	Net Capacity (MW)	Plant Status	Operator
Solar	Lower Selector	100	Submitted	
Solar	Hybrid floating solar power project	100	Submitted	Keppel Infrastructure

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

Although many small-scale solar power projects are under planning or construction in Singapore, at present only two projects have a capacity of 100 MW or more. Both projects consist of floating solar farms. Due to its small geographical size, the use of floating solar farms can be a particularly promising option for Singapore. Of these two projects, the Lower Seletar solar farm will be located on a reservoir, which is important from the standpoint of biodiversity. As such, the Public Utilities Board has stipulated that the project will require an EIA (The Straits Times, 2022). The other one, a hybrid floating solar power project, will be developed on Jurong Island by Keppel, a company that carries out infrastructure and real estate development, and engages in sustainability projects. In contrast to conventional floating solar farms installed on calm water bodies, this project is set to adopt new technologies that enable the farm to be installed on a water body with strong waves (Keppel, 2022).

An advanced low-carbon project to produce green methanol as a marine fuel is also being planned in Singapore, although it is not included in the above table as it does not entail the construction of a power generation facility. Six companies, including the major international shipping company A.P. Moller-Maersk, have agreed to jointly establish a production plant capable of transforming green hydrogen into green e-methanol. The companies anticipate a minimum production capacity of 50,000 tonnes per year (The Maritime Executive, 2022). A related project took place in July 2023. With the support of the Maritime & Port Authority of Singapore (MPA), Maersk successfully conducted a methanol bunkering operation, refuelling one of its container vessels with approximately 300 metric tonnes of biomethanol from a Hong Lam Marine tanker (Maritime & Port Authority, 2023).

Projects Delayed, Suspended, or Cancelled

No power generation facility construction projects are confirmed to have been delayed, suspended, or cancelled in Singapore as of November 2023.

There is, however, one example of a non-power generation facility low-carbon energy project that has been cancelled. The oil major Shell had planned to build a facility to produce biofuel for aviation use within Singapore. But in March 2023, the project was reported to have been cancelled. The facility was to produce 550,000 tonnes of hydrotreated vegetable oil (HVO) annually, using waste vegetable oils and green hydrogen. The project was cancelled due to a shortage of raw materials, and since there were no plans to require airlines to use sustainable aviation fuel (SAF) in the Asia region (Yap and Tan, 2023). However, in February 2024, the Civil Aviation Authority of Singapore announced that the use of SAF would be required for flights departing the country from 2026. The required proportion of SAF would start at 1%, rising to a target of 3%–5% by 2030 (Civil Aviation Authority of Singapore, 2024). If other Asian countries follow Singapore in requiring the use of SAF, then projects like the Shell HVO facility can be expected.

2.9. Thailand

(1) Basic Energy Policy

In 2015, the Thai government announced the 'Thailand Integrated Energy Blueprint (TIEB)' for the period 2015–2036. It has five chief aims: (i) supply security, (ii) cost competitiveness, (iii) environment, (iv) energy support sustainability, and (v) socio-economic support for the needed people/sector (Sutabutr, 2015). The blueprint also has five plans—the Energy Efficiency Plan, Power Development Plan (PDP), Alternative Energy Development Plan, Gas Plan, and Oil Plan. Each of these will be revised as necessary.

In 2021, TIEB was renamed the 'National Energy Plan', signifying its position as an overarching framework covering the five plans outlined above. The framework was approved by the National Energy Policy Council, which was chaired by then Prime Minister Prayut Chan-o-cha. The National Energy Plan set out a goal of achieving carbon neutrality by 2065–2070, roughly within the next 50 years. It also outlined four key policies to meet this goal: (i) increasing renewable electricity production capacity by at least 50%; (ii) increasing energy efficiency by more than 30%; and (iii) restructuring the energy business to support energy transition under 4D1E (Decarbonisation, Digitalisation, Decentralisation, Deregulation, and Electrification)

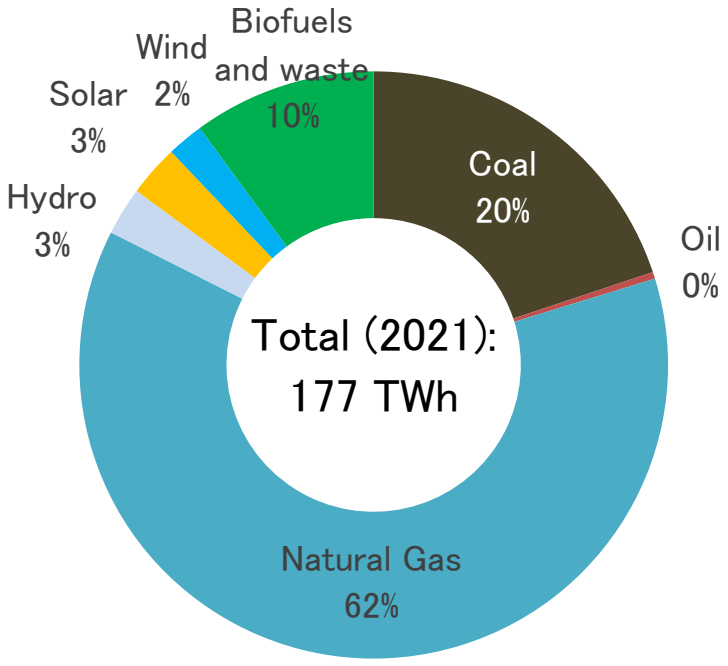
guidelines (JETRO, 2021b).

In 2020, the Cabinet approved PDP 2018 Rev. 1, which replaced the 2018 version of the PDP. The revised plan placed greater importance on securing a stable energy supply. At the same time, its focus on low-carbon initiatives demonstrated a larger emphasis on decarbonisation and energy conservation. In September 2022, the Energy Policy and Planning Office (EPPO) announced it was working on PDP 2022, which would cover the period 2022–2037 (Energy Policy and Planning Office, 2022). However, the plan was not finalised in 2022, and in March 2023 it was reported that a new PDP 2023 was being formulated instead. As of March 2024, the completion of PDP 2023 (or of PDP 2024) cannot be verified.

(2) Power Portfolio and Projection

Thailand's energy mix for 2021 is shown in Figure 2.15. The country depends heavily on fossil fuels – natural gas, with approximately 60% share, and coal together account for more than 80% of its supply. In terms of renewable energies, the comparatively large contribution of biofuels and waste is notable.

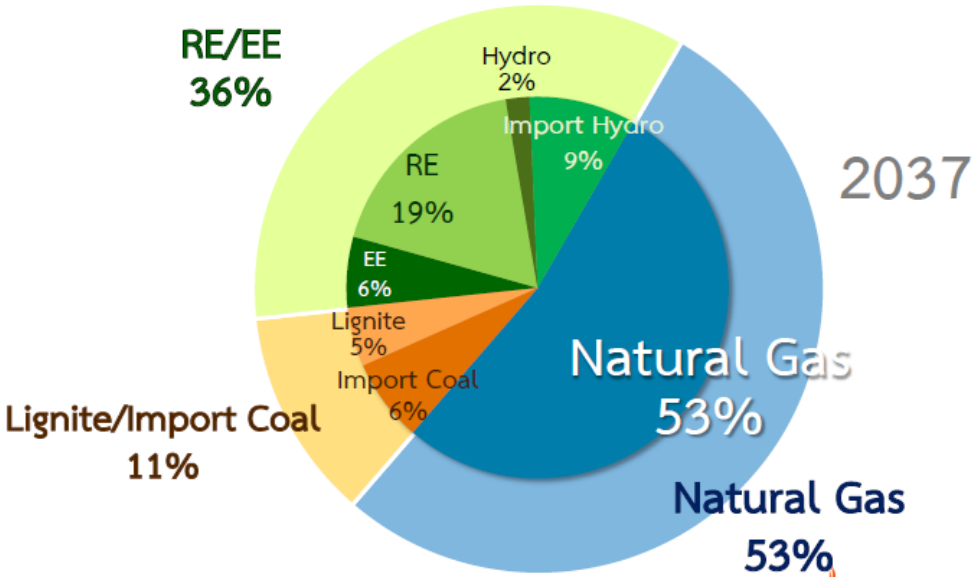
Figure 2.15. Electric Power Generation in Thailand (2021)



Source: IEA (2023).

Thailand's projected energy mix for 2037, according to PDP 2018 Rev. 1, is shown in Figure 2.16. Compared to 2021, the proportion of renewable energies has increased. However, natural gas continues to account for more than half of the supply.

Figure 2.16. Projection of Electric Power Generation by PDP2018 Rev. 1 (2037)



EE = energy efficiency, RE = renewable energy.

Source: Kiatfuengfoo (2020).

(3) Support Schemes and Regulations

Support for Investment

In Thailand, the Board of Investment (BOI) is in charge of investment-promoting projects. By meeting conditions such as the size of the investment, the amount of value added, and environmental protection, the operators can receive mainly preferential tax treatment. In January 2023, the eligible business types were restructured and expanded to include new energy-related businesses such as EVs, fuel cell vehicles, and green hydrogen and ammonia. Preferential treatments are divided into six grades: A1+, A1, A2, A3, A4, and B. These grades are determined by the type of business. Figure 2.17 shows the relationship between grades and preferential treatments.

Figure 2.17. Basic Incentives for Each Activity Group

Source: Board of Investment (2023).

The highest-level projects designated as 'A1+' are exempt from corporate income tax for 10–13 years. This exemption, primarily applying to biotechnology development, the manufacture of water, advanced materials technology development, and nanotechnology development, falls under this category. Energy-related businesses include power generation from renewable energy (A2), green hydrogen and ammonia production (A1), and blue hydrogen production (A2). Additional preferential treatments are also available for projects in particular districts designated by the government.

Environmental Regulation

In Thailand, the Enhancement and Conservation of National Environmental Quality Act of 1975 requires that prior EIAs be conducted for a wide range of development projects. The 35 types of target projects include petroleum refining and natural gas separation and reforming, as well as thermal power plants with an installed capacity of 10 MW or more (excluding waste-fuelled power plants built outside the designated area).

In addition, the 2007 Constitution requires a more rigorous environmental health impact assessment (EHIA) for projects that could significantly impact natural resources, the environment, and health. The EHIA approval process will also include a public hearing. EHIA also designates (i) coal-fired power plants with an installed capacity of 100 MW or more, (ii) biomass power plants with an installed capacity of 150 MW or more, (iii) natural gas–fired power plants with an installed capacity of 3,000 MW or more, (iv) nuclear power plants of any size, and dams with a water

storage capacity of 100 million m^3 or more or a water storage area of 15 km^2 or more (Ministry of Natural Resources and Environment, 2021). Consequently, large hydroelectric power plants are also deemed eligible for consideration.

When a project is undertaken by a government agency or a state-owned enterprise, the EIA and EHIA reports are subject to final approval by the Cabinet. In the case of other entities, the reports are subject to review and approval by the Office of Natural Resources and Environmental Policy and Planning under the Ministry of Natural Resources and Environment and the regulatory authority in charge of the project (in the case of power plant construction, the Energy Regulatory Commission) (Wangwongwatana, Sano, and King, 2015).

In addition to EIAs and EHIAs, Thailand has implemented Strategic Environmental Assessment (SEA) as a framework to facilitate the involvement of as many stakeholders as possible at an early stage of development projects. When it was first introduced in 2007, only a limited number of projects were eligible for SEA. However, in August 2023, the government announced its policy to implement SEA for all large-scale projects (Thai PBS World, 2023).

(4) Low-carbon Energy Projects

Projects under Planning or under Construction

Table 2.17 presents the low-carbon power generation projects currently under construction or planning in Thailand as of November 2023 (excluding small-scale projects with an installed capacity of 100 MW or less, except biomass). It is noteworthy that nuclear power is included in the project. However, due to the frequent opposition to nuclear power projects in Thailand, specific construction sites have not yet been determined, and the project is not included in the energy mix forecast for 2037 according to PDP 2018 Rev. 1. At present, the probability of realising nuclear power projects is low.

Table 2.17. Projects Under Planning, Licensing, or Construction in Thailand

	Plant Name	Net Capacity (MW)	Plant Status	Operator
Biomass	Loei 1	70	Announced	Khon Kaen Sugar Power Plant Company
Biomass	Napier Grass (Prachuabkirikhan)	4	Authorised	
Biomass	Ratchaburi Waste to Energy project	5	Bidding process	B.Grimm Power
Hydro	Chulabhorn HPP	840	Operational/Announced	Electricity Generating Authority of Thailand (EGAT)
Hydro /Solar	Bhumibol HPP	1,557	Operational/Announced	Electricity Generating Authority of Thailand (EGAT)
Hydro /Solar	Bang Lang HPP	150	Operational/Authorised	Electricity Generating Authority of Thailand (EGAT)
Hydro /Solar	Rajjaprabha HPP	380	Operational/Authorised	Electricity Generating Authority of Thailand (EGAT)
Hydro /Solar	Sirikit HPP	825	Operational/Authorised	Electricity Generating Authority of Thailand (EGAT)
Hydro /Solar	Srinagarind HPP	860	Operational/Authorised	Electricity Generating Authority of Thailand (EGAT)
Hydro /Solar	Vajiralongkorn HPP	350	Operational/Authorised	Electricity Generating Authority of Thailand (EGAT)
Nuclear	EGAT Nuclear Power Plant	5,000	Announced	Electricity Generating Authority of Thailand (EGAT)
Solar	EGAT floating solar	2,700	Announced	Electricity Generating Authority of Thailand (EGAT)

Note: Small-scale projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

The next largest source of electricity is solar power generation. In Thailand, both conventional land-based PV facilities and FSPV facilities installed on the water are being constructed. All solar power generation projects in Table 2-17, which identifies projects above a certain size, employ floating facilities. Bhumibol HPP, which is particularly large in scale, involves the construction of a solar power plant with an installed capacity of 778 MW in Bhumibol, in the northern province of Tak. The Bhumibol Dam already has hydroelectric facilities in operation (with a total installed capacity of 780 MW). When completed, it will be a hybrid hydro–solar power facility with a total installed capacity of over 1.5 GW. Including this case, several dams in Thailand are planned to be hybridised with solar power, with some already in operation. Not just for the Bhumibol Dam project, it has been pointed out that the utilisation of FSPV power generation can circumvent onshore land use restrictions. Also, hybrid facilities incorporating hydroelectric power generation are advantageous in that they facilitate the effective utilisation of the existing power grid and complement the generation patterns (Gadzanku et al., 2022).

Most of the projects are hybrid hydro–solar power projects. However, the Chulabhorn HPP is a stand-alone hydroelectric power development project. The facility's owner, EGAT has stated that the facility is a pumped storage generation facility that can respond quickly to the instability of renewable energy generation (EGAT, 2023). This suggests that the expansion of variable renewable energy deployment could lead to an increase in the deployment of other low-carbon technologies.

The Loei 1 biomass power plant is owned by Khon Kaen Sugar Power Plant, a group company of Khon Kaen Sugar Industry. The plant supplies electricity and steam to sugar factories using bagasse, a sugarcane pomace, as fuel. Furthermore, a portion of the generated electricity is sold to EGAT. The company owns three power generation facilities: a 70 MW power generation facility in Loei Province, a 30 MW facility in Khon Kaen Province, and a 90 MW facility in Kanchanaburi Province. Although the table classifies the status as 'Announced', information on the company's official website indicates that all 70 MW of facilities may already be in operation[14]

Although not included in Table 2-17, Thailand has also initiated a plan to construct hydrogen production facilities from renewable energy sources. In January 2024, IBCLNG, a Thailand-based LNG distributor, and Beijing Mingyang Hydrogen Technology, a Chinese energy firm, announced that they would jointly build a green hydrogen production infrastructure. According to the deal, IBCLNG will source a 25

[14] Khon Kaen Sugar Industry, https://www.kslgroup.com/index.php/en/products/electricity

MW electrolyser from Beijing Mingyang Hydrogen Technology. The hydrogen produced will be supplied to steel mills for use in green steelmaking. To provide context for this project, Charernsook Siriyong of IBCLNG stated that the European Union is gradually introducing a carbon border adjustment mechanism for products such as cement, aluminium, and steel. This could potentially reduce the competitiveness of Thai products for future exports (Reccessary, 2024).

Projects Delayed, Suspended, or Cancelled

Table 2.18 lists the low-carbon power generation facility construction projects that were in a state of 'cancelled', 'suspended', or 'delayed' as of November 2023.

Table 2.18. Projects Delayed, Suspended, or Cancelled in Thailand

	Plant Name	Net Capacity (MW)	Plant Status	Operator
Biomass	TPI Polene Power Company Limited Project	325	Operating/ Frozen	TPI Polene Power Company
Solar	Subyai PV	130	Frozen	Energy Absolute

Note: Small-scaled projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

The TPI Polene Power Company Limited Project in Table 2.18 is a waste-fuelled power plant operated by TPI Polene, a cement company. The company has set a goal of reducing greenhouse gas emissions at its cement plants in Muak Lek and Kaeng Khoi in Saraburi Province by 39% from 2020 levels by 2030 and achieving net-zero emissions by 2043 (TPI Polene, 2023). This will be achieved by converting fuel from coal to waste. Some plants are already waste-fuelled but those listed in Table 2-18 are plants where expansion projects have been suspended. The direct reason for the suspension is unclear. However, the company stated in November 2018 that the lack of waste sorting in Thailand prevents the waste from generating the necessary heat as fuel, which makes the waste-to-energy business unsustainable (CemNet, 2018). This was likely one of the reasons for the suspension of the project.

Table 2.18 above does not include thermal power generation, as it covers low-carbon technologies. However, it is worth noting that many coal-fired power plant constructions in Thailand have been met with opposition and have been cancelled due to concerns on environmental and health impacts (Kotani, 2017).

2.10. Viet Nam

(1) Basic Energy Policy

The National Energy Master Plan (NEMP) for 2021–2030, with a vision to 2050, was approved in July 2023. The plan is designed to guarantee national energy security, reduce carbon emissions to align with Viet Nam's net-zero commitment by 2050, and empower the energy industry to become independent and self-sufficient, thereby ensuring the energy necessary for the economy to grow at 7% per year through 2030 and 6.5%–7.5% per year from 2031 to 2050. The NEMP's individual energy policies are as follows:

(a) Petroleum

Domestic oil production should meet at least 70% of domestic demand. Furthermore, crude oil production is expected to reach 6–9.5 million tonnes per year by 2030 and 7–9 million tonnes per year between 2031 and 2050.

(b) Natural Gas

Natural gas production is anticipated to reach 5.5–15 billion m^3 annually by 2030 and 10 –15 billion m^3 annually between 2031 and 2050. Concurrently, LNG import capacity is projected to expand to 15.7–18.2 billion m^3 by 2030 and approximately 10.6–12.2 billion m^3 by 2050.

(c) Coal

The annual production of commercial coal is expected to reach approximately 41–47 million tonnes by 2030, before declining to approximately 39 million tonnes by 2045 and 33 million tonnes by 2050. Coal imports are projected to reach 73 million tonnes by 2030, will peak at approximately 85 million tonnes in 2035, and will gradually decline to approximately 50 million tonnes by 2045. It has been suggested that exports will need to cease by 2050.

(d) Renewable Energy

Renewable energy is expected to account for 15%–20% of Viet Nam's electricity supply by 2030 and 80%–85% by 2050.

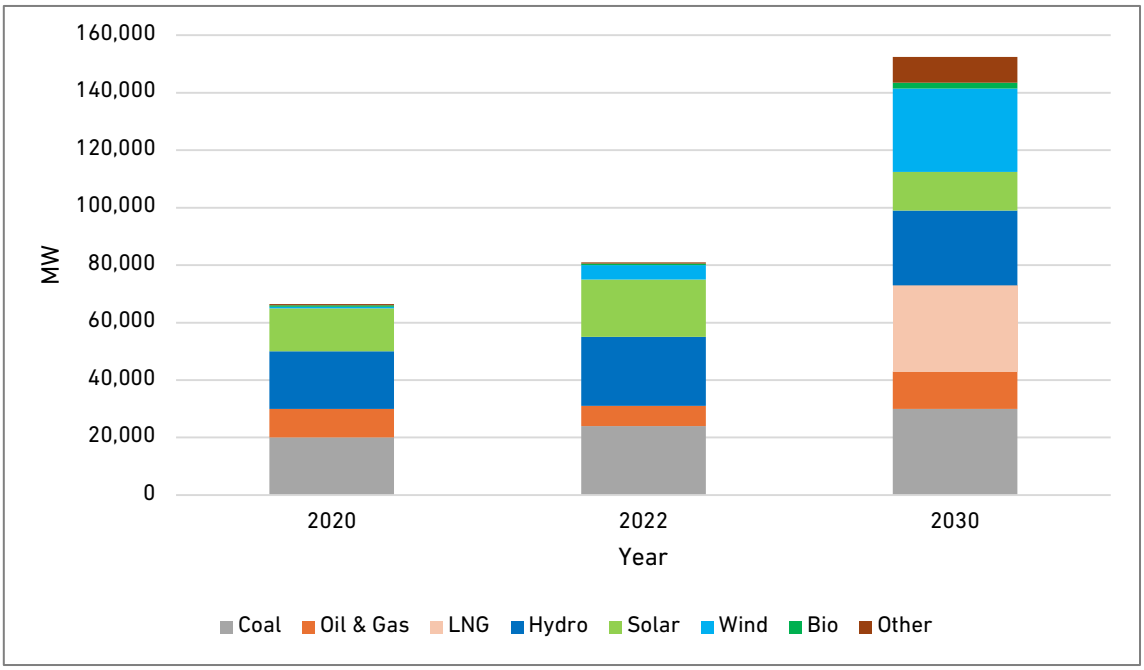
(e) Hydrogen

Green hydrogen production is expected to reach 100,000–200,000 tonnes per year by 2030 and 10–20 million tonnes per year by 2050.

(2) Power Portfolio and Projection

In May 2023, the government approved the National Electricity Development Plan 2021–2030 (PDP8). PDP8 forms part of the National Energy Master Plan. Figure 2-18 illustrates the target installed power generation capacity as outlined in the plan.

Figure 2.18. Target Installed Capacity in PDP8



Source: PDP8.

PDP8 foresees an expansion of installed power generation capacity from 69 GW in 2020 to 150 GW in 2030. Of this, the LNG-fired share is estimated to be 24.8%. PDP8 anticipates an increase in the share of renewable energy power generation, excluding hydropower, from 25% in 2020 to 31% in 2030. The planned decrease for coal is from 31% in 2020 to 20% in 2030.

(3) Support Schemes and Regulations

Support for Investment

The Law on Investment (No. 61/2020/QH14) outlines preferential treatment for

investment, including reduced tax rates under the Corporate Income Tax Law.

For an investment project to be accorded preferential treatment, it must be either a new or a scaled-up project and must meet the conditions set out in Decree 31/2021/ND-CP. These conditions include new, clean, and renewable energy sources.

In principle, the tax rate imposed on ordinary business activities is 20%. In contrast, the preferential tax rate for clean and renewable energy is 10% for 15 years, with a 4-year exemption from corporate income tax and a 9-year 50% tax reduction (JBIC, 2023a).

Environmental Regulation

Depending on the nature of the investment, investors are obliged to submit an Environmental Impact Assessment Report (EIA) or an Environmental Protection Plan (EPP) report prior to the implementation of the project during the investment preparation period. Projects that require an Environmental Impact Assessment Report include those related to energy (JBIC, 2023b).

Licensed operators are required to develop a specific environmental management plan based on the EIA report and are required to conduct monitoring during operation in accordance with the relevant legislation and the plan (Institute for Global Environmental Strategies, 2018).

(4) Low-carbon Energy Projects

Projects under Planning or under Construction

As of November 2023, Table 2-19 lists power generation facility construction projects with an output of 100 MWe or more under construction or planning, excluding fossil fuels.

Table 2.19. Projects Under Planning, Licensing, or Construction in Viet Nam

	Plant Name	Net Capacity (MW)	Status	Operator
Biomass	Dohwa renewable energy complex Biomass	100	PPA signed	Dohwa
Hydro	Son La	3200	Authorised/Operational	Vietnam Electricity (EVN)
Hydro	Hoa Binh	2400	Operational / Under construction	Vietnam Electricity (EVN)
Hydro	Bac Ai	1200	Under construction	Vietnam Electricity (EVN)
Hydro	Don Duong	1200	Announced	Vietnam Electricity (EVN)
Hydro	Dong Phu Yen	1200	Announced	Xuan Thien
Hydro	Ninh Son	1200	Announced	
Hydro	Ialy	1080	Operational/Under construction	Vietnam Electricity (EVN)
Hydro	Bac II	900	Announced	
Hydro	Se Kong 3	205	Authorised	Song Da Corporation Company
Hydro	Thac Ba	138.9	Operational/Under construction	Vietnam Electricity (EVN)
Solar	Tri An Lake	4100	Authorised	
Solar	Dak Lak (Xuan Thien)	2000	Operational/Under construction	Xuan Thien
Solar	Tri An floating solar	1000	Announced	Scatec Solar
Solar	Dohwa renewable energy complex PV	550	PPA signed	Dohwa
Solar	Dak Lak (AES)	500	Authorised	AES Corporation
Solar	SEACEF Dong Nai Floating Solar	500	Announced	South East Asia Clean Energy Facility (SEACEF)
Solar	KN Serepok 3	380	Announced	Long Thanh Golf Investment and Trading Joint Stock Company
Solar	Dong Hai PV	300	Under construction/Announced	Hoanh Son Group
Solar	Khe Go	250	Authorised	local authorities of the Nghe An province
Solar	Tinh Bien PV	210	Operational/Announced	Sao Mai group
Solar	Binh Phuoc JRB PV	200	Announced	Jaks Resources Berhad (JRB)
Solar	Loc Ninh 1	200	PPA signed	Vietnam Electricity (EVN)
Solar	Long Son PV	200	Announced	Long Son Company
Solar	Natcore	200	Authorised	Natcore Technology
Solar	Ninh Thuan (EVN)	200	Authorised	Vietnam Electricity (EVN)
Solar	Phuoc Thai	200	Operational/Under construction	Vietnam Electricity (EVN)
Solar	Song Binh	200	Announced	Vietnam Electricity (EVN)
Solar	Loc Ninh 2	200	PPA signed	Vietnam Electricity (EVN)
Solar	Loc Ninh 4	200	PPA signed	Vietnam Electricity (EVN)
Solar	KN Ialy Kon Tum Solar	200	Authorised	Ialy Kon Tum Solar Power
Solar	Vuc Mau	200	Authorised	local authorities of the Nghe An province
Solar	Kosy Binh Thuan Solar	200	Announced	Kosy Group
Solar	Trung Nam Tra Vinh	165	Under construction	Trung Nam Solar Power JSC
Solar	Thanh Hoa 1 (Nghi Son Industrial Zone, Tinh Gia district)	160	Authorised	BS Heidelberg Solar
Solar	Loc Ninh 3	150	PPA signed	Vietnam Electricity (EVN)
Solar	Tri An solar	126	Announced	Vietnam Electricity (EVN)
Solar	My son solar PV	112	Under construction	Licogi 16 JSC
Solar	Chau Duc PV	100	Under construction	Halla E&C
Solar	Thanh An PV	100	Announced	Halla E&C
Solar	Thanh Hoa solar	100	Authorised	BCG Bang Duong/Hanwha
Wind	Orsted Bach Long Vy offshore	3900	Announced	Orsted
Wind	La Gan offshore	3500	Authorised	Copenhagen Infrastructure Partners (CIP)
Wind	Ninh Thuan wind offshore 1	3000	Announced	Orsted
Wind	Thang Long wind	2800	FID	Enterprize Energy
Wind	PNE Binh Dinh Offshore	2000	Authorised/Announced	PNE
Wind	Ninh Thuan wind offshore 2	2000	Announced	Orsted
Wind	Phu Cuong Soc Trang	1400	Authorised/Announced	Mainstream Renewable Power
Wind	Soc Trang offshore	1400	Bidding process/Announced	Mainstream Renewable Power
Wind	Vinh Phong	1000	Announced	Zarubezhneft
Wind	Vinh Chau Wind Offshore - II	1000	Bidding process	
Wind	Phu Cuong Wind	800	Authorised	Phu Cuong Group
Wind	Vinh Hai Wind Offshore	800	Bidding process	
Wind	Ben Tre offshore wind farm	500	Announced	Mainstream Renewable Power
Wind	Cu Lao Dung Wind Offshore	500	Bidding process	
Wind	Vung Tau offshore	500	Bidding process	Corio Generation
Wind	Bac Lieu	399	Operational/Under construction/Announced	Cong Ly Company
Wind	Can Mau	375	Under construction	PowerChina International
Wind	Wind VN (Ben Tre)	310	Authorised	TTC Group
Wind	Ho Be wind	300	Announced	Bang Duong Consortium
Wind	Khai Long	300	Under construction/Announced	Cong Ly Company
Wind	Vinh Chau Wind Offshore - I	260	Bidding process	
Wind	AMI Savannakhet	252	Authorised	Renewables Quang Binh
Wind	Quang Binh	250	Under construction/Announced	UPC corporation
Wind	An Tho Wind Park	200	Authorised	Sembcorp
Wind	Vinh Tan Wind Offshore	200	Bidding process	
Wind	Kong Yang	175	Authorised	TSV Investment
Wind	Cư An	175	Authorised	TSV Investment
Wind	Loc Binh Wind	155	Bidding process	BayWa re Wind Projects Vietnam Co
Wind	Tan Phu Dong	150	Under construction/Operational	Ten Giang Wind Power
Wind	Vinh Chau Wind	128.4	Operational/Under construction	Quoc Vinh Wind Power
Wind	Son La Wind	128	Bidding process	
Wind	Hanbaran – Ninh Thuan	117	Announced	
Wind	Hanbaram	117	FID	Landville Energy
Wind	Ben Tre V1-3 Wind	110	Operational/Authorised	Ben Tre Renewable Energy
Wind	Dam Nai	106.5	Operational/Announced	Aboitiz Power
Wind	Cao Nguyen 1	100	Authorised	
Wind	The Ia Pech Wind	100	FID	Dien Xanh Gia Lai Investment Energy Joint Stock Company
Wind	Hung Hai	100	Under construction	Hanbaram Wind Power
Wind	Tan An Wind Offshore	100	Operational/Announced	Song Lam Hydropower Investment Joint Stock Company
Wind	Kosy Bac Lieu Wind-III	100	Announced	Kosy Bac Lieu Wind Power Joint Stock Company

Note: Small-scaled projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

Table 2.19 lists a number of solar photovoltaics, as well as hydro and wind, both of which have increasing generation installed capacities targeted in the National Electricity Development Plan. Below is an overview of typical projects.

(a) Biomass: Dohwa Renewable Energy Complex Biomass

This project, planned in Quang Binh Province with a generation capacity of 100 MW that will utilise approximately 500,000 tonnes of forestry residues and wood waste annually, is implemented by the Dohwa Group from Korea (Ministry of Construction, 2017).

(b) Hydro: Hoa Binh

This project is designed to increase the installed capacity of the Hoa Binh hydroelectric power plant up to 480 MW, thereby increasing annual production by approximately 488 GWh. This will replace fossil-fuelled power generation and reduce CO_2 emissions by approximately 225,000 tonnes. Furthermore, the project is expected to enhance water supply to downstream areas during the dry season.[15]

(c) Hydro: Bac Ai

This is the first pumped-storage hydropower project in Viet Nam invested by EVN and the largest in Southeast Asia. When operational, the plant will help ensure stable and reliable operation of the electricity system by operating the pumps during off-peak hours and reducing the difference from peak hours. This becomes significant in the context of the rapid growth of renewable energy (Construction Joint Stock Company 47, 2021).

(d) Hydro: Ialy

An EVN hydropower expansion project that will, when completed, increase generation capacity to meet peak grid loads, stabilise the electricity system, and reduce costs spent on fossil fuels and CO_2 emissions.[16]

(e) Hydro: Thac Ba

An upgrade project of the oldest hydroelectric power plant in the North. After the renovation, the efficiency of the generating units will be significantly enhanced. It provides clean and sustainable power and plays an important role in balancing and stabilising power (ANDRITZ, 2023).

[15] FUNAN Securities, https://funan.vn/en/meeting-vietnams-growing-energy-demand.495698
[16] ANDRITZ, https://www.andritz.com/hydro-en/hydronews/hn37/ialy-vietnam

(f) Solar: Phuoc Thai

When completed, the two PV projects under construction in Ninh Phuc, Ninh Thuan Province, with generating capacities of 100 MW and 50 MW, will add an annual electricity output of over 247 million kWh, contributing to supply clean electricity for the national electricity system (Vietnam Energy, 2023).

(g) Wind: Can Mau

One of the largest offshore wind farm projects in Viet Nam, it is expected to reduce CO_2 emissions and avoid the combustion of conventional coal. It could also provide enough electricity to meet the growing energy demand in the south of the country, as well as serve as a boost to local employment and trade. (Construction Review, 2022).

(h) Wind: La Gan offshore

One of Viet Nam's first large-scale offshore wind farm projects planned for the waters off Binh Thuan. With an expected capacity of 3.5 GW, the wind farm is estimated to power more than 7 million households and reduce 130 million tonnes of CO_2 emissions.[17]

Furthermore, several projects are currently under consideration for hydrogen. Typical examples are as follows:

(i) Tra Vinh Green Hydrogen Manufacturing Plant

This project is currently under development in Tra Vinh Province to manufacture green hydrogen by electrolysing seawater using electricity generated from renewable energy sources. When the project[18] is completed and put into operation, it will produce 24,000 tonnes of hydrogen per year and 195,000 tonnes of medical-grade oxygen per year. The plant will not only create jobs and boost the local economy but will also reduce CO_2 emissions by 400,000–450,000 tonnes annually, contributing to efforts to combat climate change and reduce the reliance on fossil fuels (The Green Solutions, 2023).

Projects Delayed, Suspended, or Cancelled

Table 2.20 below shows a list of power generation facility construction projects that were in a state of 'cancelled', 'suspended', or 'delayed' as of November 2023, with an output of 100 MWe or more for hydroelectric and 10 MWe or more for others,

[17] La Gan Wind, https://www.laganoffshorewind.vn/

[18] The Green Solutions, https://thegreensolutions.vn/tra-vinh-green-hydrogen-manufacturing-plant

excluding fossil fuels.

Table 2.20. Projects Delayed, Suspended, or Cancelled in Viet Nam

	Plant Name	Net Capacity (MW)	Status	Operator
Hydro	Dong Nai-6	135	Cancelled	Duc Long Gia Lai
Hydro	Dong Nai 6A	106	Cancelled	Duc Long Gia Lai
Nuclear	Ninh Thuan I	4800	Cancelled	Vietnam Electricity (EVN)
Nuclear	Ninh Thuan II	4400	Cancelled	Vietnam Electricity (EVN)
Nuclear	Mien Trung I	2700	Cancelled	Vietnam Electricity (EVN)
Solar	Thach Ha PV-1-2	300	Frozen	SolarPark Korea Company
Solar	Dak Lak (Long Thanh)	120	Operational/Frozen	Long Thanh
Wind	Phuoc Huu Wind	50	Cancelled	Phuoc Huu Wind Power Development

Note: Small-scaled projects except for biomass are excluded.

Source: The Institute of Energy Economics Japan.

Below is an overview of typical projects.

(a) Hydro: Dong Nai-6 & 6A

This project cancelled by the government based on the results of an environmental impact report. The hydroelectric power plant will destroy more than 325 hectares (ha) of forests, 128 ha of which include portions of the Cat Tien National Park near Ho Chi Minh City. The plant will also affect the Bau Sau wetlands located inside the park, allegedly violating terms of the Ramsar Convention's Laws of Biodiversity and Heritage (Hydro Review, 2013).

(b) Nuclear: Ninh Thuan I & II

These are nuclear power projects cancelled by the National Assembly due to lower demand forecasts, rising costs, and safety concerns, amongst others (Nguyen and Minh, 2016).

In June 2023, as a recent trend, Orsted, a wind power giant involved in several wind power projects that are listed as 'Announced' in Table 2-19, announced its decision to withdraw from the wind power generation business in Viet Nam. In addition, wind energy stakeholders have highlighted the lack of detailed policies and guidelines for wind energy investment in Viet Nam, as well as the perception that the Vietnamese market is less attractive than other markets (Tri, 2023).

Chapter 3

Risks and Opportunities

3.1. Definition

In Chapter 2, the IEEJ collected information on the status of each ASEAN country and found many ongoing or cancelled low-carbon energy projects in those countries. This chapter aims to make more detailed analyses on the risks and opportunities surrounding such projects. Especially, the risks are especially important considering the background of this research project explained in the first chapter.

First, it is important to clarify the definition of the risks. Therefore, this chapter focuses on identifying the business risks and where they come from. The findings in this chapter are based on the presentation done in the online workshop of this research project by Kevin Foster, chair of the Institute of Strategic Risk Management.

According to the International Organization for Standardization (ISO) 31000, a 'risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood' (ISO, 2018).

Foster (2024) identifies typical risks for the construction projects of energy-related facilities more in detail according to their levels and classifies these into three categories: (i) project risks, (ii) community risks, and (iii) global risks. There are several kinds of risks in each category. The detailed classification is as follows:

(1) Project risks

'Project risks are often expressed in terms of threats: to budget, time schedule, technical performance, stakeholder collaboration, work health and safety, and environmental impact; or unanticipated changes to scope, regulations, or market conditions' (Foster, 2024).

In short, these risks are inherent in the projects themselves. If the cost or construction period of a project exceeds too much the expected level, the business entity may be forced to suspend or give up the project. And if the technical performance of the energy facility is lower than expected, the revenue produced by the facility would be lower than planned by the operator and would have a serious effect on its financial condition.

Almost all the energy-related projects are not conducted by a single entity. In most cases, many stakeholders participate in the project. Therefore, collaborating with each other is crucial. If the project cannot satisfy some of the stakeholders' interests and they leave, it will become difficult to continue the project.

If the operator does not take enough measures to confirm the workers' health and safety or to mitigate environmental impact, the operator will be forced to stop the project or pay compensation.

Predictability of the market is also indispensable for successful projects. If the government suddenly changes its energy policy or regulation on investment, environmental protection, or safety requirements, such changes may seriously affect the projects and business entities.

(2) Community risks

'Community risks are often expressed in terms of threats: to critical infrastructure, critical services, well-being, livelihoods, culture, human rights, and public safety; or community resistance to change, misunderstandings, and conflicts of interest' (Foster, 2024).

Any construction project affects the local community and the people living there. Of course, it can positively affect the economic development of the region, but it should be careful about its effect on the lives of local people. Especially, the construction of a large-scale hydropower plant with a dam may require the people living in the basin to move away, whilst such power plants are expected to meet growing energy demand in Asian countries.

As Foster (2024) says above, the one responsible for the construction project should be aware of various forms of impacts on the local community. If the impact assessment is not sufficient, an opposition movement would happen. Such a movement sometimes becomes an enough reason to stop the project. In fact, this is one of the serous barriers for construction projects of coal-fired power or nuclear power plants in some Asian countries (though these power plants are not in the scope of this research project).

(3) Global risks

'Global risks are often expressed in terms of threats causing cascading disasters that have devastating impacts on interdependent societies, complex ecosystems, interconnected cross-border supply chains, economic stability, or geo-political

stability' (Foster, 2024).

Risks of low-carbon energy projects do not conclude in a country but also make an impact on a global level. As Foster (2024) says, a low-carbon energy project or several projects could affect international relationships, markets, or the environment. If such effects are considered serious, regulations on such economic activities may be reinforced and the projects may become more difficult or require much more costs.

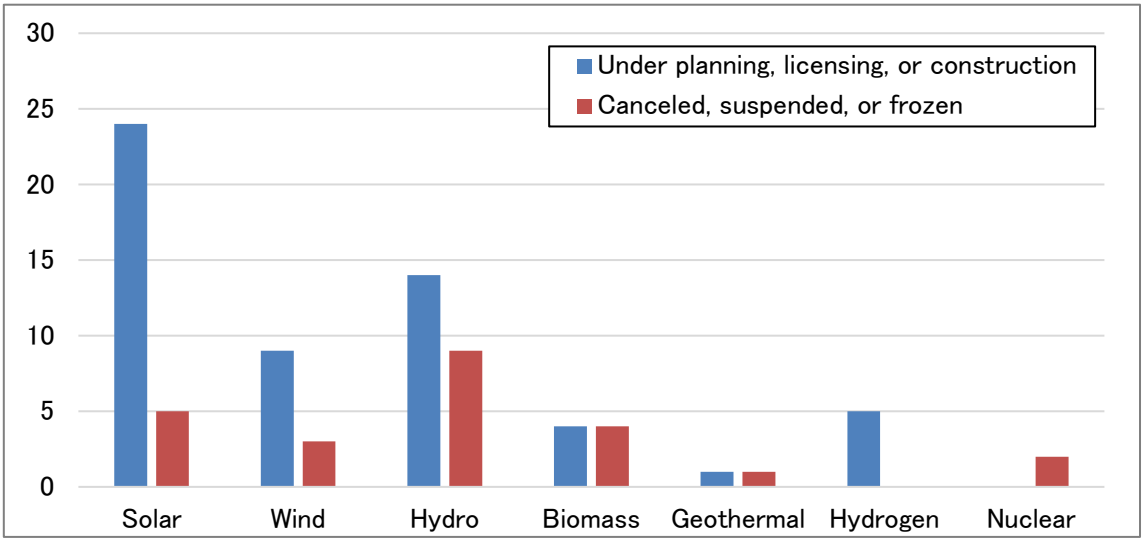
On the contrary, international affairs could seriously affect a project done in a country. For example, if a country worsens the diplomatic relationship with a supplier country of low-carbon technology, it should become difficult to have successful projects in the former. The one who wants to make a successful project should be aware of such risks.

3.2. Analysis and Discussions

(1) Analysis

Chapter 2 compiles information on over 400 projects in various countries and identified or estimated the potential opportunities or risks for 80 of them. Figure 3.1 illustrates the number of opportunities and risks associated with each type of power generation, both during the project and during shutdown.

Figure 3.1. Number of Projects Identified or Presumed Opportunities or Risks



Source: The Institute of Energy Economics Japan.

The opportunities or risks of each project were categorised into the types listed in Table 3.1.

Table 3.1. Classification of Opportunities and Risks

	Classification
1	Electricity demand
2	Cost
3	Decarbonisation
4	Impact on local communities (including economic impact)
5	Policy
6	Impact on the environment, agriculture, or fisheries

Source: The Institute of Energy Economics Japan.

The following describes each type:

1. Electricity demand

Apart from power demand, factors such as the contribution to power system stability and reliability are also included in this type. In addition to the potential for increased demand, there is also a possibility of lower demand forecasting, which could negatively impact the business. In the Lao PDR and Myanmar, electric power generation is also a means of obtaining foreign currency to meet the growing demand of neighbouring countries. In relation to solar power generation, the expected amount of electricity generated during sunny hours when demand is at its highest and the proximity of the power plant location to the demand area were also mentioned.

2. Cost

Whilst rising costs and dealing with high costs were identified as negative factors, there are also opportunities for more affordable prices in solar PV and more competitive prices with power sources on the market. For large-scale investment projects, the establishment of investment models is identified as an issue. In some cases, economically unfeasible projects have been cancelled.

3. Decarbonisation

The reduction of CO_2 emissions associated with the replacement of fossil fuel–based power generation is the main reason. The sustainability associated with this, as well as the potential to become one of the leading renewable energy centres

internationally, are also identified as opportunities. A notable trend is the growing perception of hydropower as a reliable renewable energy source. It is also emphasised that hydrogen has recently attracted significant interest as a new technology.

4. Impact on local communities

Opportunities include factors such as increased local employment, the availability of social investment programmes for the region, and the development of local industries such as tourism and agriculture that accompany development. Smaller developments have the advantage of having a less significant impact on the community. On the other hand, this type of project also carries with it certain negative risks. These include the potential for local impacts, such as the need to force residents to relocate due to large-scale development, and the need to gain the understanding of indigenous peoples.

5. Policy

Opportunities include the further expansion of the country's energy policy and being associated with low-carbon policy projects being promoted internationally. On the other hand, identified as potential negative risks are the uncertainty over the finalisation of policies and standards, the lack of policies and guidelines, the continuation of preferential treatment as represented by FIT, and the extent to which requests for decarbonisation in Asia will proliferate.

6. Impact on the environment, agriculture, or fisheries

In terms of biomass-related opportunities, some of the fuel is derived from agriculture and can provide income. However, the degree of opportunity depends on the amount of fuel. In addition, solar power generation is identified as having a minimal environmental impact. On the other hand, there are concerns about the environmental impact of projects that involve large-scale development, such as hydropower. Some projects have been cancelled by the government because of EIAs. This suggests that national policy trends in environmental protection may influence the success or failure of a project in certain instances.

(2) Discussions

The information on opportunities and risks is presented separately for each type of power generation, etc. The results are shown below.

(a) Hydropower

For hydropower, 'electricity demand' was most frequently cited as positive factors, followed by 'decarbonisation' and 'local communities'. On the other hand, in terms of negative factors, 'local communities' was the most frequently cited, followed by 'cost'. For 'environment', the number of positive and negative elements is equal.

In many cases, expectations for meeting electricity demand in their regions and neighbouring countries were mentioned. Also, as with other low-carbon energy technologies, hydropower has received significant attention in its development as a clean and low-carbon energy source. Regarding the impact on the local community, whilst the positive impact on the local community was identified as a reason for the location of the project, some projects were cancelled due to a lack of understanding about the need for residents to relocate or be evicted. This resulted in both positive and negative impacts on the progress of the project. In some cases, investment models were required for projects that had been put on hold in terms of cost. Whilst some projects have been identified as flood mitigation in the downstream area as an environmental benefit, others have been cancelled due to environmental impact considerations. For the siting of hydroelectric power plants, the positioning of EIA is expected to be important.

Table 3.2. Result: Hydropower

		Hydra-Planning		Hydro-Suspended	
		Positive	Negative	Positive	Negative
1	Electricity demand	7	0	1	0
2	Cost	0	1	0	3
3	Decarbonisation	7	0	0	0
4	Local communities	7	1	0	4
5	Policy	1	0	0	1
6	Environment	2	0	0	2
	Total	24	20	1	10

Source: The Institute of Energy Economics Japan.

(b) Solar PV

For ground-mounted solar power, the most frequently cited positive factor is 'decarbonisation', followed by 'electricity demand' and 'local communities'. 'Cost' is

most frequently cited as a negative factor, followed by 'local communities'. But the number of positive factors was higher in the latter category.

In addition to the high expectations for decarbonisation as a leading renewable energy source, projects with large outputs are expected to meet the growing electricity demand. The economic impact on the region was also identified as an important factor in the realisation of the project. In some cases, there were difficulties in making indigenous peoples understand, even in the case of solar power generation. It should be noted that social acceptability may be damaged if there are a number of cases of inappropriate project implementation. Regarding the policy aspect, there are cases where projects are put on hold due to the suspension of national policies, such as FIT, suggesting that the element of sustainable policies is important. Whilst the rapid decline in costs was identified as a key driver for adoption, business feasibility concerns were also identified. These concerns are probably linked to policy preferential treatment.

Table 3.3. Result: Solar PV (Ground-mounted)

		Solar (Ground) - Planning		Solar (Ground) - Suspended	
		Positive	Negative	Positive	Negative
1	Electricity demand	2	0	1	0
2	Cost	2	2	0	3
3	Decarbonisation	5	0	1	0
4	Local communities	2	1	1	1
5	Policy	2	0	0	0
6	Environment	0	0	0	0
	Total	13	3	3	4

Source: The Institute of Energy Economics Japan.

'Decarbonisation' is the most frequently cited positive factor for floating solar power, followed by 'local communities' and 'policy'. On the other hand, 'cost' was identified as a negative factor.

In addition to the contribution to decarbonisation, the effective utilisation of site is also a motivating factor in introducing this system. A floating solar–hydropower hybrid system is said to offer additional benefits, including the ability to utilise the

existing power grid and to streamline the installation of solar panels to meet demand in combination with pumped water. Projects are also driven by international trends and linkages to national energy policies. However, the higher cost compared to ground-mounted solar power may present a challenge for project viability.

Table 3.4. Result: Solar Photovoltaic (Floating)

		Solar (Floating) - Planning		Solar (Floating) - Suspended	
		Positive	Negative	Positive	Negative
1	Electricity demand	1	0	0	0
2	Cost	0	9	0	1
3	Decarbonisation	9	0	0	0
4	Local communities	3	0	1	0
5	Policy	3	0	1	0
6	Environment	1	0	0	0
	Total	17	9	2	1

Source: The Institute of Energy Economics Japan.

(c) Wind

'Decarbonisation' was the most frequently cited positive factor for wind power generation, followed by 'electricity demand', then 'local communities' and 'policies'. On the other hand, 'cost' was the most frequently cited negative factor, followed by 'policy'. However, the number of positive factors was higher in the latter category.

In addition to the expectation of low-carbon technology, meeting the electricity demand and the economic impact on local communities are regarded as opportunities in many projects. Several wind power projects are being led by the national government. However, if the operator has concerns about ensuring sufficient profitability, it is difficult to continue the project. In addition, the absence of clear policies and guidelines for investment was identified as a negative risk.

Table 3.5. Result: Wind

		Wind-Planning		Wind-Suspended	
		Positive	Negative	Positive	Negative
1	Electricity demand	5	0	0	0
2	Cost	0	0	0	2
3	Decarbonisation	6	0	1	0
4	Local communities	3	0	0	0
5	Policy	3	0	0	1
6	Environment	0	0	0	0
	Total	17	0	1	3

Source: The Institute of Energy Economics Japan.

(d) Hydrogen and Related Products

Regarding hydrogen power generation and its related issues, 'decarbonisation' was the most frequently cited positive factor, followed by 'policy'. 'Policy' was the most frequently cited negative factor, followed by 'cost'. The former was equal in number to the positive factor.

Hydrogen-related projects have been gaining attention in recent years as low-carbon technology. Many projects are being promoted in anticipation of international energy policy trends, with green hydrogen and ammonia exports outside of Japan in mind. On the other hand, expectations about policy can also be viewed as a negative risk due to its uncertainty. There were concerns about the cost of the new technology in ongoing projects, and some hoped that costs could be reduced. Since the technology has been newly developed in recent years, no information on interrupted projects was available.

Table 3.6. Result: Hydrogen and Related Products

		H_2-Planning		H_2-Suspended	
		Positive	Negative	Positive	Negative
1	Electricity demand	0	0	0	0
2	Cost	0	1	0	0
3	Decarbonisation	3	0	0	0
4	Local communities	1	0	0	0
5	Policy	2	2	0	0
6	Environment	0	0	0	0
	Total	6	3	0	0

Source: The Institute of Energy Economics Japan.

(e) Others

The opportunities for biomass include the use of residual materials as fuel, which previously had no value, the generation of income from fuel costs, the creation of local employment opportunities, and the possibility of becoming a local source of power. On the other hand, the following negative risks were identified: (i) the fuel supply in the case of residual material use depends on the amount of main products; (ii) lack of waste separation practices, which is a prerequisite for use; and (iii) lack of promotion policies. In the event of project failures, it was suggested that policy trends not only in the home country but also in the region may influence investment decisions.

For geothermal generation, whilst the clean energy nature was seen as an opportunity, the cost aspect was identified as a negative risk.

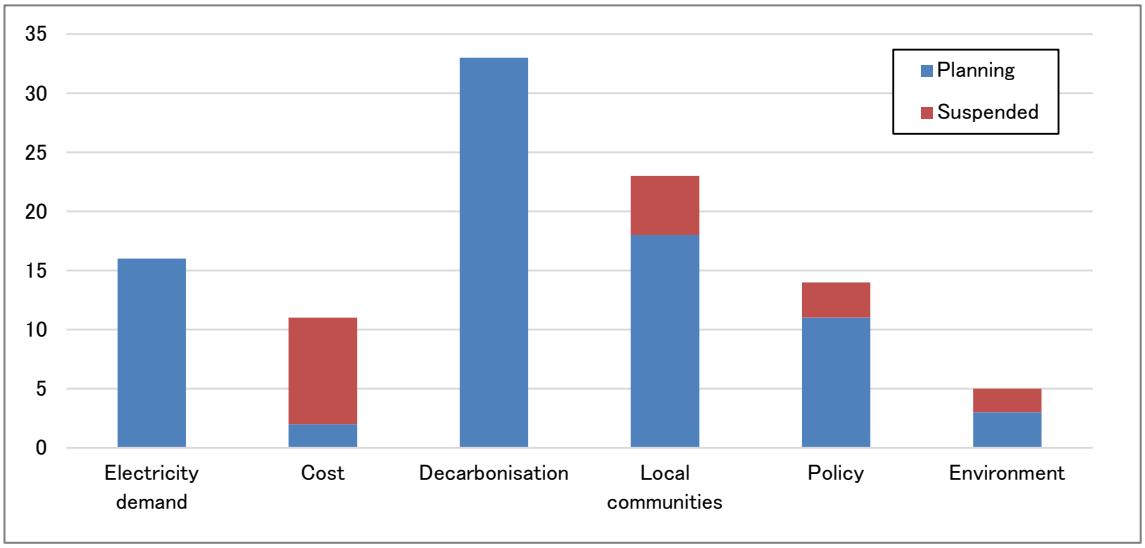
Regarding nuclear power, whilst the expansion of energy demand was identified as an opportunity, the following negative risks were identified: (i) lower demand forecasts, (ii) higher costs, (iii) safety concerns, and (iv) lack of social acceptance as represented by large-scale opposition movements. The decline in demand forecasts should also require attention in projects for other power source types that emphasise electricity supply as a key opportunity.

(3) Implications

Figure 3.2 shows the results of tabulating the positive and negative factors counted for each type of power generation in (2) for both planning and suspended (cancelled)

projects for all types of power generation.

Figure 3.2. Total Number of Risk Factors of Projects under Planning and Suspended Projects by Country



Source: The Institute of Energy Economics Japan.

From the above, the following can be inferred as key drivers leading to project feasibility, suspension, or cancelation.

- The project's planning and execution are underpinned by expectations of a stable power supply and low-carbon emissions. This is particularly evident in the case of power source types that are regarded as mature technologies amongst low-carbon technologies, such as large-output hydropower and solar power. It is notable that not only countries and regions, but also operators, are emphasising this point from the perspective of mitigating the global risk mentioned in Section 3.1.
- The economic ripple effects on local communities represent a significant driver of power source development, ranking second only to the contribution to stable power supply and low-carbon development. Nevertheless, hydropower, which necessitates a considerable site area and extensive natural development, can be a positive driver for project implementation, and vice versa, as it can also negatively impact local communities.
- Ground-mounted solar power, which has become sufficiently cost-effective through the accumulation of experience in developed countries, is beginning to demonstrate some of the benefits of its lower cost in emerging countries.

On the other hand, for technologies such as floating PV, which are still in the early stages of diffusion even in developed countries, the risk of cost overruns remains non-negligible.

- It is interesting and thought-provoking that 'policy (maintenance and certainty)' is identified as both a positive and negative driver. Given the dependence of low-carbon energy technologies on nature and the environment, and the significant impact of environmental regulations at the national and local levels on project viability, policy predictability may be the most important factor for project proponents in determining the fate of their projects.

Such are the risks derived from this research project. There can be various kinds of risks around low-carbon energy facility projects. Foster (2024) says that it is important to improve the resilience of the projects to mitigate such risks. According to ISO 22300, resilience is defined as the 'ability to absorb and adapt in a changing environment... in the context of urban resilience, the ability to absorb and adapt to a changing environment is determined by the collective capacity to anticipate, prepare, and respond to threats and opportunities by each individual component of an urban system' (ISO, 2021).

There are various ways to improve resilience of development projects on low-carbon energy technologies and mitigate their risks. For example, to mitigate project risks, referring to the guidelines published by related organisations is an effective way to improve the project costs and construction period, which can address the threats to budget and schedule. As for the threats to technical performance, it is important to use designers, suppliers, and constructors with proven experience on similar successful projects. The workers' health and safety are becoming an indispensable factor for a successful project. In this regard, safety professionals should be employed to develop and oversee the implementation of safety plans in accordance with appropriate standards. And the threats to the environment could be mitigated by using natural and built solutions that minimise impact and increase robustness and absorption of hazards, which would be effective to mitigate project and community risks.

Some international or inter-organisational initiatives would be effective in mitigating risks at each level. For example, initiatives to improve supply chain resilience can reduce the uncertainty in procurement and mitigate the global risks. Initiatives to share knowledge and increase skills would mitigate the project risks. And initiatives to develop social engagement and participation can be a key to improving public

understanding on the projects and to positively impact the local economy, which would reduce the community risks.

Finally, to make effective initiatives, governments and business entities should reveal and share information on the low-carbon energy projects not only of successfully completed ones but also of suspended or frozen ones. And when they reveal the information on failed projects, the reason for failure should be clarified. Such information is quite useful to make an analysis that should be utilised in future low-carbon energy projects in Asian countries.

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Appendix

In March 2024, The Institute of Energy Economics, Japan (IEEJ) organised a workshop to gain a better understanding of investment opportunities to low-carbon, cutting-edge technology deployment in Asia. The workshop participants included an expert on risk analysis from Australia and energy-related policymakers, government officials, and researchers from China, the Republic of Korea, Malaysia, Myanmar, the Philippines, Singapore, and Thailand.

The workshop included a presentation of the draft result of this study by IEEJ, keynote speech by expert on risk analysis from Australia, and inputs from three ASEAN member states.

Keynote Speech by Kevin J. Foster

Dr Foster explained contemporary risk and resilience management principles and processes that might be applied in decision-making for the selection and development of low-carbon energy facilities. His explanation is outlined as follows:

- Low-carbon projects and resilient energy supply chains should not be limited to nationally prioritised energy infrastructure. National and sub-national policies need to improve energy resilience for all communities.
- Thinking about resilience not only helps us prepare for uncertain significant or catastrophic events but also for potentially disastrous events that we might not even have considered or thought of yet.
- When assessing risks and resilience, it is important to consider different contextual scales that usually need to be balanced. However, in many cases, project managers limit their risk assessments to events they can control. This is usually fine for simple routine projects. But a more robust approach to risk information sharing is required where project failures could have cascading impacts on a community or a supply chain.
- The risk management system needs to be dynamic, using the best information available. And new information should always be considered as it becomes available. Also, risk management information must be structured, comprehensive, and considered integrally for all stakeholders affected by risk event scenarios.

- Energy resilience principles need to be globally standardised, harmonised, and should be based on socio-technical systems thinking. The principles should be suitable for all contexts and all scales of systems, and all elements of systems.

Input by Michael Sinocruz (Philippines)

Mr Sinocruz explained the overview of the draft Philippine Energy Plan 2023–2025 (PEP2023–2025). His explanation is outlined as follows:

- In the reference scenario, the Philippines aims to increase the share of renewables to 30% by 2030, and to 50% by 2050. In Clean Energy Scenario (CES) 1 and 2, renewables will be 40% by 2040 and 50% by 2050.
- The target capacity of the offshore wind is 19 GW by 2050 in CES 1, and that in CES 2 is 50 GW by 2050. Nuclear is targeted to be introduced in both CESs to 1.2 GW in 2032, 2.4 GW in 2035. and 4.8 GW in 2050.
- We have a programme of voluntary coal retirement but are also looking at repurposing coal power plants. By using the existing facilities of the plants, we can reduce the cost of putting up the support facilities. And there are several alternatives like the development of hydrogen and its derivatives and even a small modular reactor.
- Regarding the renewable energy (RE) plan and programme, we eased the restriction on foreign ownership specifically for RE and now allow 100% foreign ownership for a development except for hydro. Also, Executive Order No. 21 was issued to accelerate the development of offshore wind. Many government agencies are involved.
- Delays in transmission projects that hamper the attainment of RE targets can be a major challenge. In addition, access to project financing for transition and resiliency can be another big challenge.

Input by Yaowateera Achawangkul (Thailand)

Dr Achawangkul explained key challenges for clean and low-carbon investments in Thailand. His explanation is outlined as follows:

- Thailand is developing and finalising energy sub-plans under the National Energy Plan, with the target of reaching carbon neutrality by 2050 and achieving net-zero emission by 2065.
- RE promotion measures in Thailand include considering adequate

environmental policies (e.g. biomass and biogas for thermal generation), announcing the proper power purchasing scheme, considering the biofuels blending ratio (Gasohol E20 and Biodiesel B10), and promoting other alternative fuel (SAF/hydrogen).

- We also think that CCS/CCUS is essential to accelerating our carbon neutrality. In the electricity sector are three major activities: Mae Moh and Lampang Projects, North Gulf of Thailand, and CCS Regulation.
- Key considerations to promote renewable energy and clean energy include regional and international cooperation on clean energy initiatives and sharing resources, increasing the use of underutilised RE resources (e.g. biomass, waste-to-energy), and guidance for the transitioning away from fossil fuel reliance.

Input by Ivy Yap Lee Lian (Malaysia)

Dr Ivy explained renewable energy development in Malaysia. Her explanation is outlined as follows:

- The National Energy Policy (1979), which is the first national energy policy, National Depletion Policy (1980), and Four Fuel Diversification Policy (1981) shared some commonalities: they were introduced very closely to each other and all of them were very oil centred as it was the prime mover back then.
- The Fifth Fuel Policy (2000) introduced RE as a fifth fuel into the energy mix and played a significant role as it marked the beginning of RE development in Malaysia. Almost a decade later, the Renewable Energy Policy (2011) was introduced to develop RE more systematically.
- Malaysia targets to achieve 31% of RE installed capacity in 2025, 40% in 2035, and ultimately 70% in 2035. Based on the 2022 official data, we have 24% RE share in our installed capacity mix, which is about 7% less than the target of 31% in 2035, so we are quite confident in achieving our target.
- Major RE programmes include Feed-in Tariff (FiT), Large-Scale Solar, Net Energy Metering, Self-consumption, Corporate Green Power Programme, and Low-carbon Energy Generation Programme.
- In January 2024, the government announced a 2,800 MW additional quota for RE. It consists of 2,000 MW of large-scale solar (LSS), 400 MW of net energy metering, and 400 MW of low-carbon energy generation programme. Alongside this quota, a new category was created for floating solar. The

participation limit for LSS for each company increased to 500 MW.

Discussion by all participants moderated by MURAKAMI Tomoko

Finally, discussions took place mainly on how to correctly be informed of the various projects in various countries and how to establish a proper way of sharing publishable information. The participants' comments are outlined as follows:

- Some countries use the concept of trusted sharing, which is a trust information sharing network where a group of people come together and share their experience on particular risk issues. There should be a formal network where information sharing is done regularly.
- Aside from the network, it is important to produce a template of what information should be shared because some information cannot be disclosed in terms of privacy and competition. It may be useful to conduct a group discussion amongst ASEAN countries to identify the scope of information disclosure.
- Investors, operators, researchers, and policymakers cannot do anything without correct information, so we should pursue the best way of sharing information.

Agenda

Date: 21 March 2024

Venue: Virtual Meeting (by Zoom Meeting)

Timetable (Time is shown by the time zone ICT [UTC +0700]):

8:30–9:00	Registration, Dry-run for Zoom connection
9:00–9:20	Welcome and Opening Address *by **Dr Han Phoumin**, Senior Energy Economist, Energy Unit, Research Department, Economic Research Institute for ASEAN and East Asia (ERIA)* Adoption of Agenda Self-introduction of the participants
9:20–9:55	Presentation of the Draft Study Result

	*by **Dr Kimura Kenji**, Senior Researcher, Nuclear Energy Group, Electric Power Industry Unit|Research Strategy Group, Research Strategy Unit, The Institute of Energy Economics, Japan (IEEJ), Japan*
9:55–10:30	Keynote Speech *by **Dr Kevin J. Foster**, Chairman (Western Australia), Institute of Strategic Risk Management (ISRM), Australia* ✓ What kind of risks could be assumed in carrying out the development project of low-carbon technology facilities? ✓ What measures can be taken to predict risks and mitigate the impacts?
10:30–10:40	Break
10:40–11:55	Input from ASEAN Member States *by **Mr Michael Sinocruz**, Director of Energy Policy and Planning Bureau, Department of Energy (DOE), Philippines* *by **Dr Yaowateera Achawangkul**, Engineer, Senior Professional Level, Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy (MOEN), Thailand* *by **Dr Ivy Yap Lee Lian**, Ministry of Energy Transition and Water Transformation (PETRA), Malaysia*
11:55–12:10	Wrap-up and Way Forward *by **Ms Murakami Tomoko**, Senior Fellow, Electric Power Industry Unit, IEEJ, Japan*