Chapter 3

By-Country Situation and Perspectives

May 2022

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Chapter 3
By-Country Situation and Perspectives

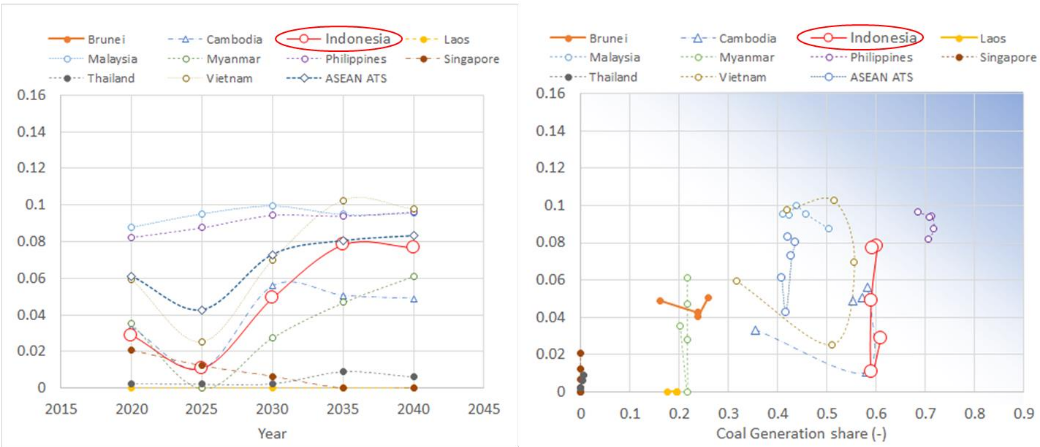
1. Indonesia

1.1. Grid fluctuation of Indonesia

Figure 3.1 shows Indonesia's future grid fluctuation analysis by GFI based on AEO6 data.

Indonesia is projected to see GFI surging after 2035. Flexibilisation with the CFPPs would be one of the major options to address the possible fluctuation of the national grid system.

Figure 3.1. Future Grid Fluctuation of Indonesia by GFI

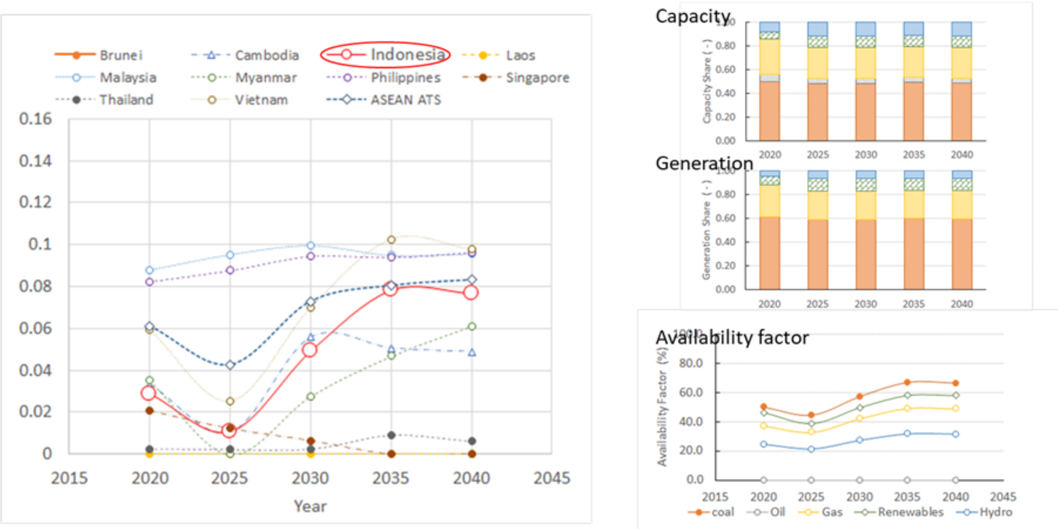


Source: Authors' calculation.

Figure 3.2 shows the GFI analysis and capacity, generation, and availability factor.

Towards 2040, Indonesia will not experience a major change in electricity mix for both installed capacity and generated capacity. The availability factor of all fuels will rise as years go by. Coal is projected to be over 80%.

Figure 3.2. GFI Analysis and Capacity, Generation, and Availability Factor



Source: Authors' calculation.

1.2. Power generation development plan

1) Power plant capacity

Indonesia's electricity supply business plan, known as RUPTL (*Rencana Usaha Penyediaan Tenaga Listrik*), is prepared by the Perusahaan Listrik Negara (PLN), the state-owned power company. The RUPTL is published annually to review the detailed electricity supply plan for 10 years.

It took more than one year since the issuance of the RUPTL in 2019[1] until the RUPTL in 2020 was released, because they had to take time to observe the unusually slugging electricity demand growth due to the COVID-19 pandemic and were trying to identify how and to what extent they would have to reflect the impact of the pandemic and energy transition requirements to formulate the new RUPTL. The Government of Indonesia also shifted to renewable energy due to Indonesia's commitments under the Paris Agreement and its recently declared carbon neutrality objectives. The new RUPTL was released on 5 October 2021 after reviewing and revising the power supply configuration as follows:

- Maintaining demand–supply balance for each electricity grid to ensure the adequacy of electricity supply,
- No additional CFPP and sequential reduction of existing plants, and
- Increase new and renewable energy (NRE) to achieve the minimum target of 23% NRE mix starting in 2025.

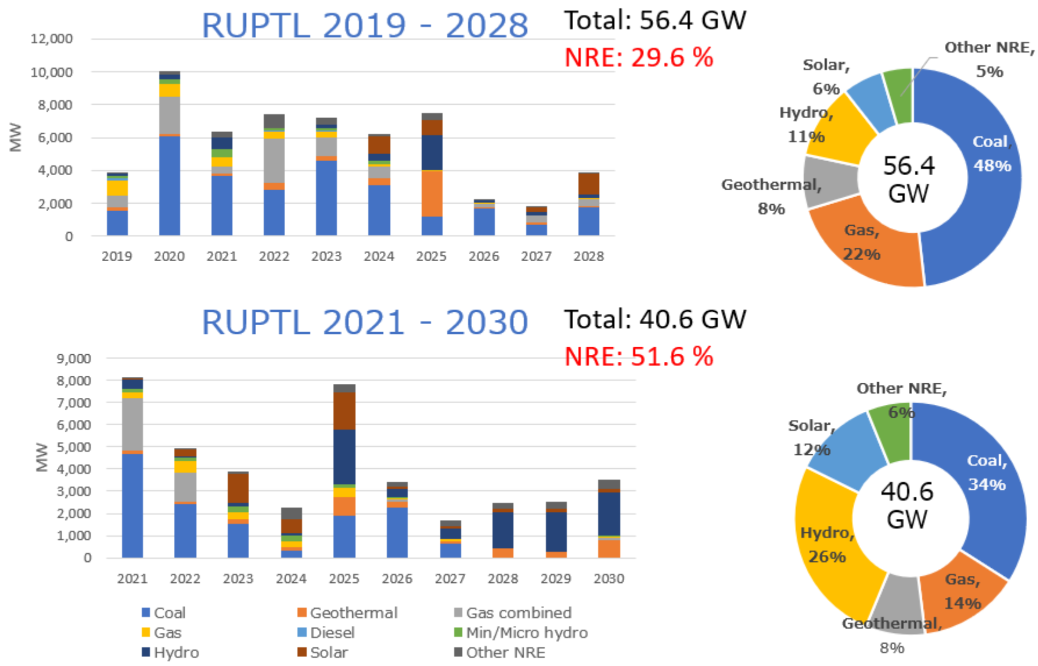
[1] RUPTL 2019, https://web.pln.co.id/statics/uploads/2021/08/5b16d-kepmen-esdm-no-39-k-20-mem-2019-tentang-pengesahan-ruptl-pt-pln-2019-2028.pdf (accessed 13 September 2021).

Figure 3.3 compares the power plant capacity plan in RUPTL 2021 and RUPTL 2019.

In RUPTL 2019, the total power plant installed capacity is 56.4 GW; CFPP share is 48%.

In RUPTL 2021, the capacity is 40.6 GW, 15 GW less than RUPTL 2019. In addition, coal accounts for 34% of the total capacity, while NRE accounts for more than 50%.

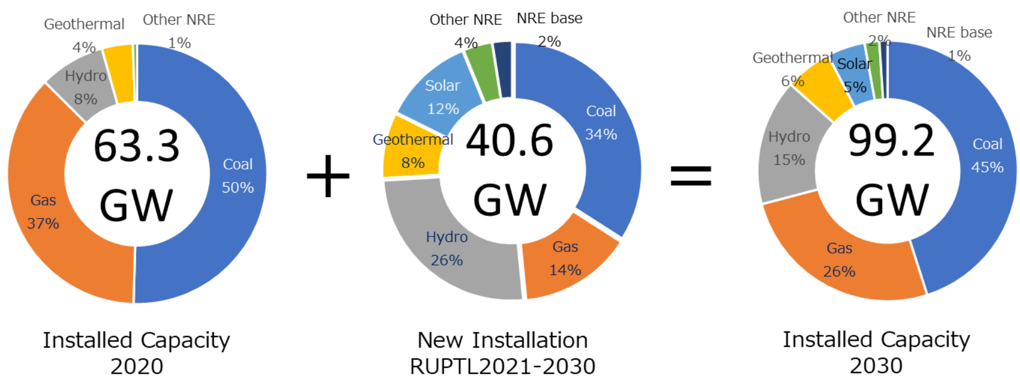
Figure 3.3. New Power Plant Capacity Plan Compared with RUPTL 2019



Source: RUPTL 2021, https://web.pln.co.id/statics/uploads/2021/10/ruptl-2021-2030.pdf (accessed 15 October 2021).

Figure 3.4 shows installed generation capacity of Indonesia in 2020 and 2030. The installed capacity in 2020 is 63.3 GW, and the expansion in RUPTL 2021–2030 is 40.6 GW. The total power plant capacity will be 99.2 GW in 2030. By substituting CFPPs with NRE power plants, the share of coal power in the projected installed capacity mix in 2030 will be less than half, and the NRE share will be 29%.

Figure 3.4. Power Plant Capacity Installed by 2030

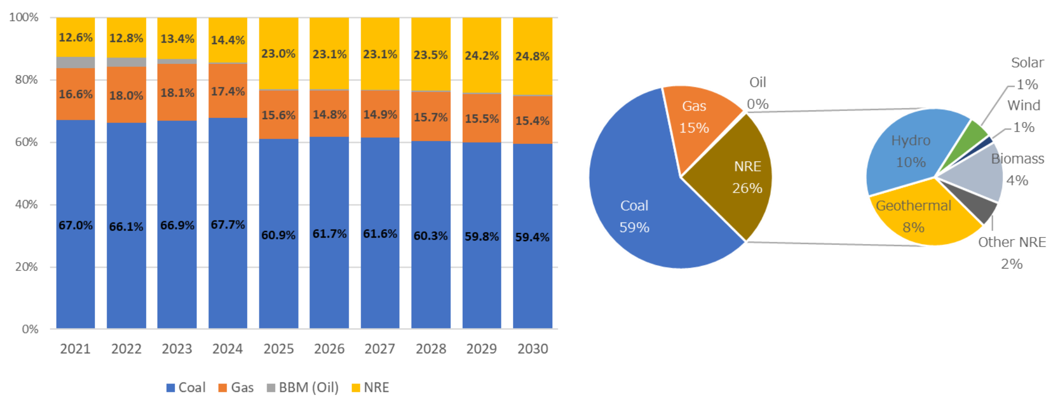


Source: RUPTL 2021, https://web.pln.co.id/statics/uploads/2021/10/ruptl-2021-2030.pdf accessed 15 October 2021).

2) Power generation energy mix

Figure 3.5 shows the electricity production and energy mix of power generation in 2030 based on RUPTL 2021. Total electricity production in 2030 will be 445 TWh. In 2025, NRE will significantly increase due to a policy response of 23% NRE generation. The main NRE are hydro, geothermal, and biomass, which are baseload power sources. But coal still accounts for 60% of electricity generation.

Figure 3.5. Electricity Production and Power Generation Energy Mix in 2030



Source: RUPTL 2021, https://web.pln.co.id/statics/uploads/2021/10/ruptl-2021-2030.pdf (accessed 15 October 2021).

Biomass cofiring in CFPPs is promoted as an effective and easy way to increase NRE share and manage municipal waste disposal. Table 3.1 shows PLN's biomass cofiring plan. The PLN has conducted cofiring tests with a 5% biomass addition rate at 32 out of 52 power plants. The PLN will increase renewable energy to 23% by 2025; therefore, the biomass cofiring rate will increase to 20%–30%. Finally, biomass will be consumed at a rate of 8–14 million tons.

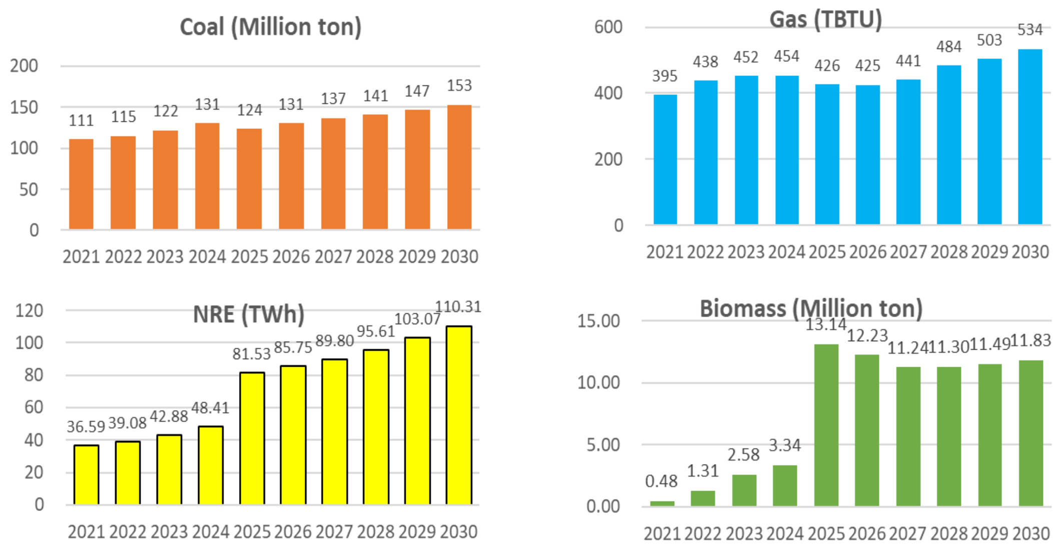
Table 3.1. Plan of Biomass Cofiring with Coal

	CFPP		Biomass	Waste Pellet
	No.	MW	(Million ton/year)	
Sumatra	13	2,315	2.82	0.122
Jawa	16	14,845	2.73	0.693
Kalimantan	10	979	1.16	0.053
Sulawesi	6	478	0.77	0.026
Papua & Maluku	3	41	0.17	0.002
Nusa Tenggara	4	237	0.40	0.0136
Total	52	18,895	8.05	0.9096

Source: RUPTL 2021–2030 (accessed 15 October 2021).

Figure 3.6 shows the fuel consumption based on the new RUPTL. Coal and gas consumption will slightly increase. NRE and biomass will be increased rapidly in 2025 to achieve the target of 23% NRE share. In particular, biomass consumption is increasing rapidly, therefore it is important to ensure its procurement.

Figure 3.6. Fuel and Energy Consumption in Power Generation



Source: RUPTL 2021–2030 (accessed 15 October 2021).

1.3. Electricity policy towards carbon neutrality

GHG emissions also affect the power generation plan. Indonesia had announced that it would reduce GHG emissions and make the country carbon neutral by 2060.

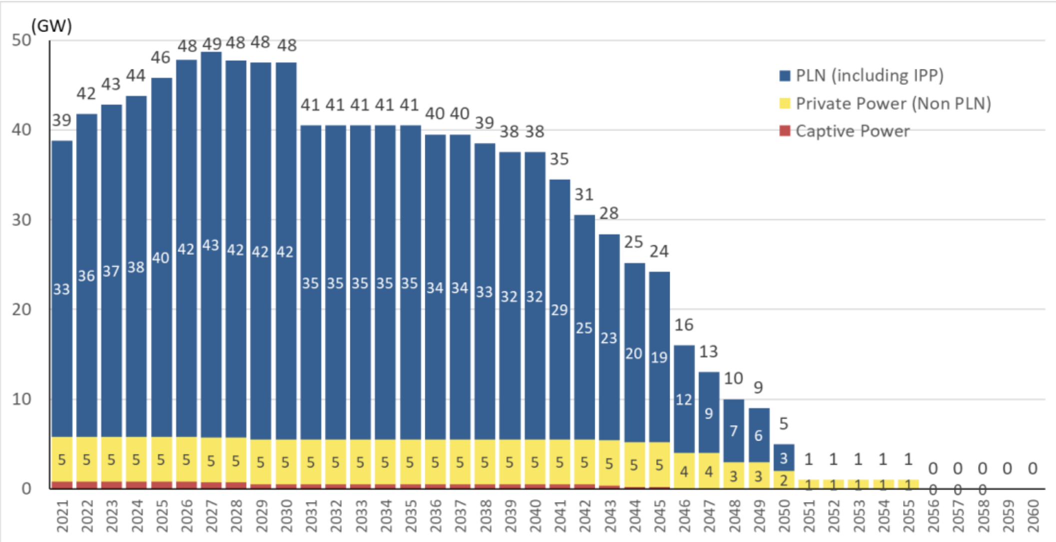
As shown in Figure 3.1-5, even in 2030, 59% of electricity will be generated from CFPPs, which emit the most GHGs in power generation. Therefore, reducing CFPPs and replacing them with renewable energy for carbon neutrality is necessary.

Figure 3.7 shows the phase-out plan of the CFPPs, which will be gradually reduced from 2031 and abolished by 2056.

The basic principles are as follows:

- CFPP capacity will increase until 2027, coming from ongoing projects. There will be no new plants other than those contracted or being constructed
- The CFPPs of independent power producers will operate until the power purchase agreement has ended; it cannot be extended.
- A retirement programme is applied to all CFPPs, including those for non-PLN and own use.
  - 2031: First stage retirement of CFPPs with sub-critical technology
  - 2037: Second stage retirement of sub-critical and some super-critical CFPPs
  - 2054: The last group of combined cycle power plants are retired.
  - 2055: CFPPs are completely retired.
- Action is needed to accelerate the retirement plan:
  - Study further the retirement of PLN's CFPPs before 2030 because of revaluation issues of PLN's assets.
  - Prepare the CFPP regulation to support the implementation of retirement.
  - Ban new CFPP permits.

Figure 3.7. Phase-out Plan of Coal-fired Power Plants



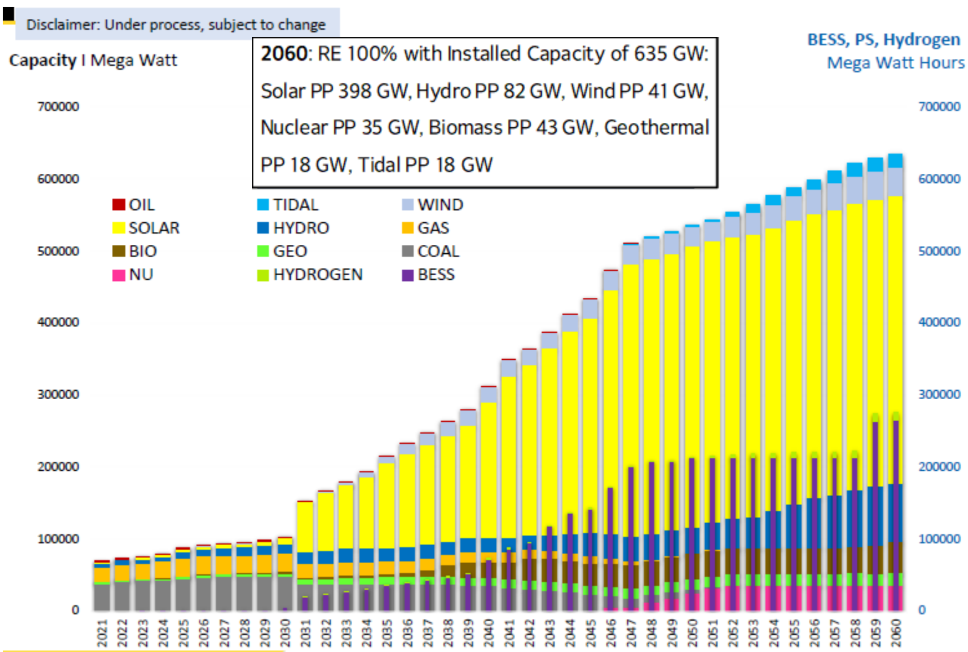
Source: Mulyana (2021).

Figure 3.8 shows the power supply plan until 2060 that was considered based on this CFPP phase-out plan.

For the years 2021 to 2030 of this plan, the RUPTL is applied; for 2031 to 2060 of the plan, the following conditions are considered:

1. CFPP/CCPP (combined cycle power plant): No new CFPP unless it has been contracted and constructed. The CFPP and CCPP will be retired according to age and/or contract (remaining < 1 GW: CFPP 2052, CCPP: 2050).
2. NRE: Additional power plant after 2030 only from NRE. It will be dominated by VRE, such as solar power plants, starting in 2035 and, in the following year, by wind and tidal power plants.
3. Geothermal: maximised up to 75% from total potency
4. Hydropower: maximised, and the electricity is sent to load centres on other islands; hydropower also provides balancing for VRE plants.
5. Storage: pump storage, BESS, and hydrogen fuel cells will be massively used after 2035. Hydrogen is used gradually, starting in 2031 and massively in 2051.
6. Nuclear power plant: to maintain system reliability, nuclear power plants will operate around 2045; in 2060, the total installed capacity of nuclear power will reach 35 GW.

Figure 3.8. Power Plant Capacity and Electricity Production by 2060



Source: Mulyana (2021).

With the retirement of CFPPs starting in 2031, solar power will increase, followed by wind and tidal power. Since solar, wind, and tidal power are VRE, it is necessary to balance these VRE plants with hydropower, which is the baseload power source.

1.4. Policy recommendations

Due to the COVID-19 pandemic, electricity growth in 2020 was below the target initially set out in RUPTL 2019-2028. In the new RUPTL, the national generation mix is revised to maintain demand–supply balance as follows:

- No additional CFPPs and sequential reduction of existing plants
- Increase NRE to achieve the minimum target of 23% NRE mix starting in 2025.

Additionally, towards carbon neutrality in 2060, only NRE power plants will be added after 2031, and CFPPs will be phased out. Therefore, reducing CFPPs and increasing NRE by reviewing oversupply are also effective from the carbon neutrality perspective.

As mentioned earlier, the Indonesian government is considering the new electricity development plan:

1) Rapid increase in NRE from 2025, especially biomass, will enhance procurement in terms of fuel availability. In addition, due to its high cost, it is necessary to consider efficiency improvement and economic efficiency.

2) NRE will increase as a substitute for coal. Since hydropower, geothermal, and biomass are the main sources for the time being, grid stabilisation and load adjustment are not necessary. However, in response to the abolition of CFPPs and the increase in NRE, especially solar power, towards carbon neutrality in 2060, a detailed study on securing base power sources, battery development, and grid stabilisation is needed.

2. Malaysia

2.1. Energy policy and power sector overview

1) Energy power sector overview

While Malaysia holds a large share of Southeast Asia's fossil fuel resources, the country has always been conscious of the importance of sustainable energy supply and has had very clear energy policies addressing various important elements of energy utilisation. The country's energy policy has been evolving to facilitate energy security and clean energy. Table 3.2 outlines the major relevant energy policies to date.

Table 3.2. Major National Energy and Electricity Policies of Malaysia

Year	Title of Policy/Act	Outline
1979	National Energy Policy	- Adequate, secure, and cost-effective energy supply - Efficient utilisation of energy - Minimise negative impacts to the environment
1980	National Depletion Policy	- Prolong the life span of national gas and oil reserves
1981	Four Fuel Policy/National Diversification Policy	- Ensure reliability and security of supply through diversification of fuel (oil, gas, hydro, and coal)
1990	Electricity Supply Act	- Stipulate how electricity supply is ensured and implemented
2001	Five Fuel Policy	- Encourage utilisation of renewable resources such as biomass, solar, mini-hydro, etc. - Efficient utilisation of energy
2001	Energy Commission Act	- Establish the Energy Commission
2011	Renewable Energy Act	- Establish a system of feed-in tariffs for renewables
	Sustainable Energy Development Authority Act	- Establish the Sustainable Energy Development Authority (SEDA)
Forthcoming	Renewable Energy Transition Roadmap (RETR)	- Establish the national energy roadmap with a focus on renewables

Source: Country Presentation at the 1st Working Group Meeting (June 2021) and Energy Commission (2021a).

The federal government established the Sustainable Energy Development Authority (SEDA), a new wing for renewable energy development, in 2011. As of November 2021, under SEDA's initiative, the Renewable Energy Transition Roadmap (RETR) is being formulated with the target year revised to be 2050 from the initially set 2040. The RETR is anticipated to constitute the new backbone of the country's energy policy and policy implementation in the ongoing energy transition as renewable energy gradually takes the central position in the country's power sector.

2) Organisation of the power sector in Malaysia

The Ministry of Energy and Natural Resources (Ketsa), as the line ministry that took over from the then Ministry of Energy, Science, Technology, Environment and Climate Change in March 2020, currently oversees the energy and electricity sector. The Economic Planning Unit also oversees the sector as the government institution in charge of national development policy. SEDA implements the renewable energy policy, while the Energy Commission regulates and facilitates clean and sustainable energy utilisation at the national level.

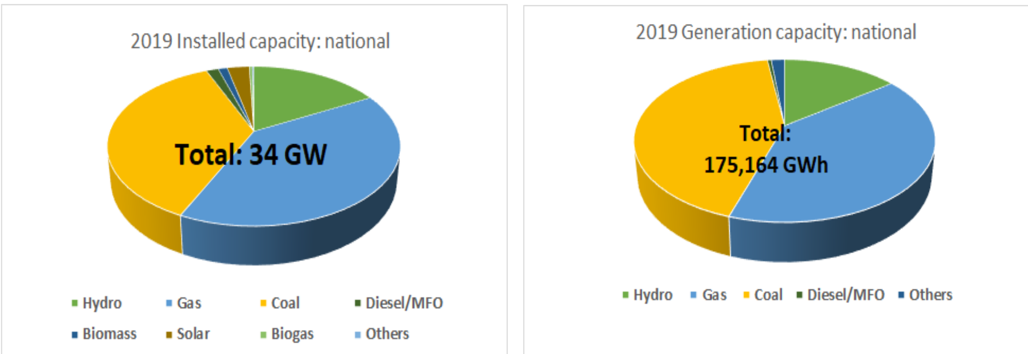
While the federal government formulates national policy, different institutions handle the day-to-day power sector management of each of the three regions. Power generation, transmission, and distribution in Peninsular Malaysia are under the Tenaga Nasional Berhad (TNB) and the Grid System Operator (GSO); the same for Sabah is handled by the Sabah Electricity Corporation under the provincial government. The Electrical Inspectorate Unit under the Ministry of Utility Sarawak oversees the power sector in Sarawak. The fully privatised Sarawak Energy is in charge of generation, transmission, and distribution.

3) Diverse generation portfolio in the three regions

Figure 3.9 shows the national installed capacity mix and generation mix in 2019.

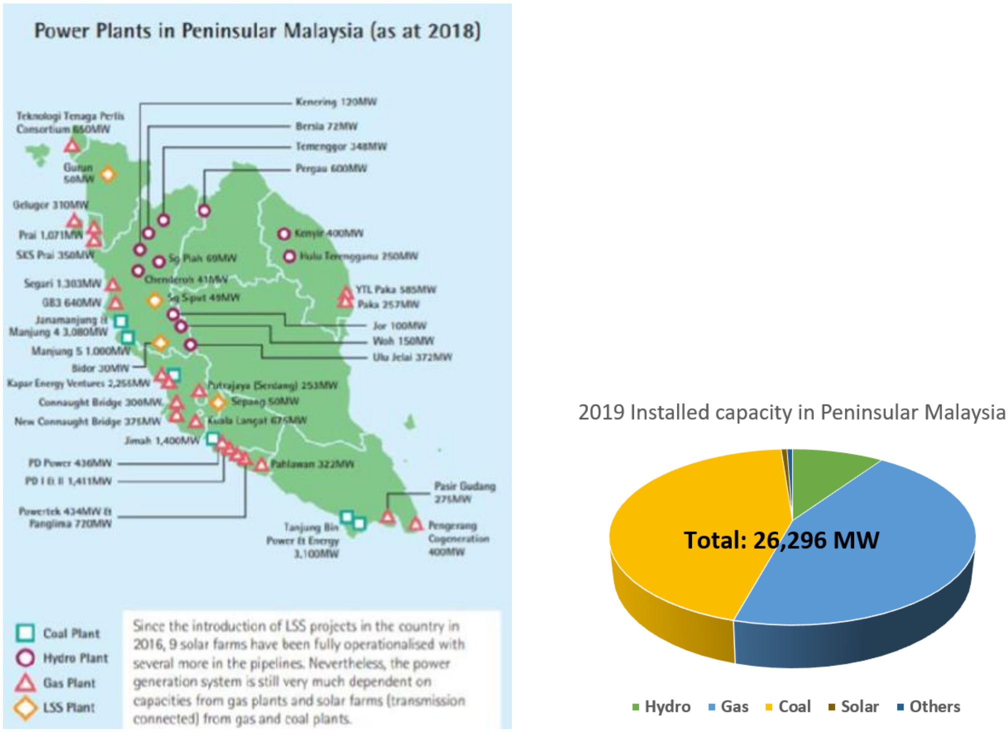
Coal and gas respectively account for 36.7% and 39.8% of the national installed capacity and 42.8% and 40.2% of the national generation capacity in 2019, indicating that Malaysia is still fossil fuel dependent.

Figure 3.9 Malaysia National Installed Capacity and Generation Capacity



Source: Energy Commission (2020).

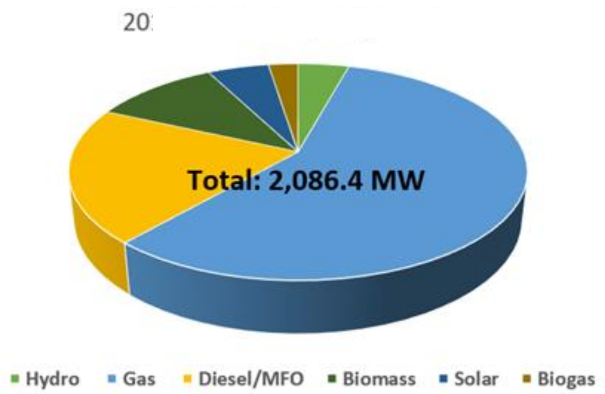
Figure 3.10 Power Plants and Installed Capacity in Peninsular Malaysia



Source: Country presentation at the 1st Working Group (2021).

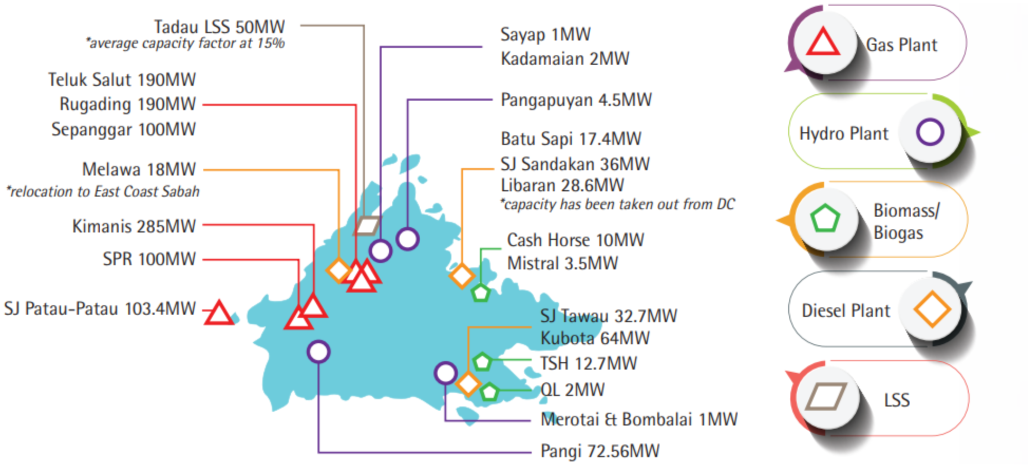
Figure 3.10 shows power plants in Peninsular Malaysia and the installed capacity mix. The region has over 83% of the national population and holds over 73% of the national power capacity, including several large-scale CFPPs. The peninsula is heavily dependent on fossil fuels, i.e. gas and coal.

Figure 3.11. Installed Capacity in Sabah, 2019



Source: Energy Commission (2019).

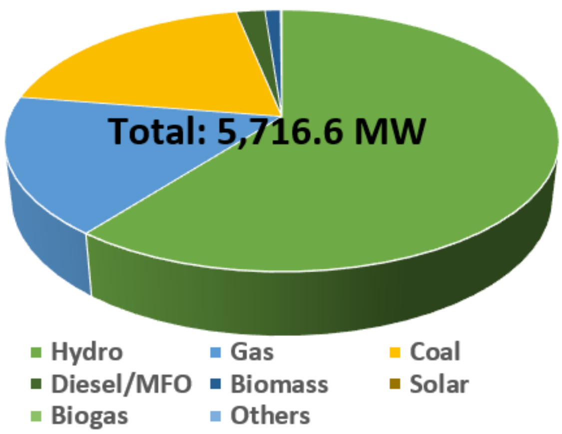
Figure 3.12. Power Plants in Sabah



LSS = large-scale solar.
Source: Energy Commission (2019).

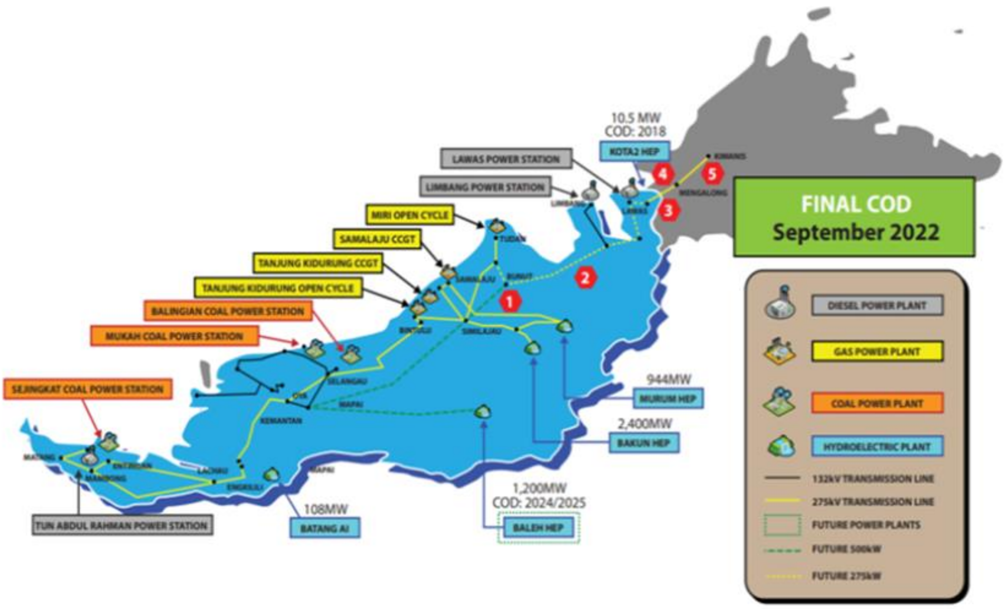
Sabah has several micro- to mid-scale power plants, mostly located on the west side of the region (Figure 3.11). It also heavily depends on fossil fuels (Figure 3.12), but has no coal power and is mostly dependent on gas and diesel. The authorities think about electricity import from Sarawak that has less population and has surplus power to export.

Figure 3.13. Installed Capacity in Sarawak, 2019



Source: Energy Commission (2019).

Figure 3.14. Power Plants in Sarawak



Source: Energy Commission (2019).

In Sarawak, the Electrical Inspectorate Unit under the Ministry of Utility Sarawak government oversees the entire power sector. Sarawak Energy is the sole implementer from generation, transmission, and distribution to retail.

Endowed with abundant natural resources, Sarawak has a well-balanced electricity mix (Figure 3.13). Thanks to its large- and mid-scale hydro projects (Figure 3.14), which are boosting the total supply capacity of the region with the smallest population of all three regions in Malaysia.

Sarawak began to export electricity to West Kalimantan, Indonesia, in January 2016 through a 275 kV interconnection operated by Sarawak Energy. This project is the first successful power trading project for Malaysia.

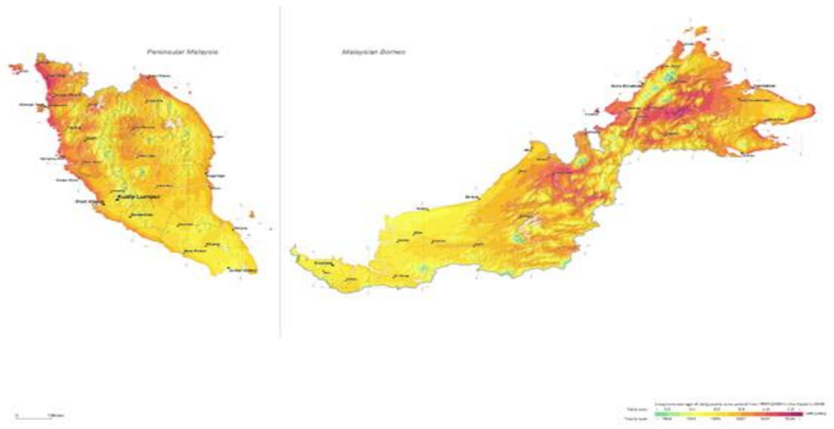
Given the above situation of the three regions of such a variety and difference and the quantitative dominance of Peninsular Malaysia in the national power capacity, the measures to address the possible future grid fluctuation and subsequent issues should be pursued by observing the case of the peninsula.

2.2. Mid- to long-term grid fluctuation potential of Malaysia

1) Major renewable potential

Figure 3.15 shows the solar power potential of Malaysia. SEDA sees huge potential, especially in the rooftop solar PV – 37,429 MW in Peninsular Malaysia alone, exceeding that of the current overall national power demand.

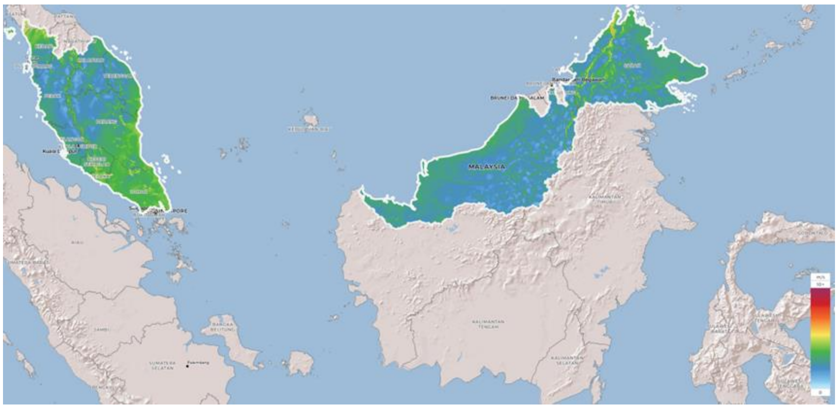
Figure 3.15. Map of Solar PV Potential in Malaysia



Source: World Bank (2020).

Malaysia has wind power potential as well (Figure 3.16). However, geographical location around the equator naturally limits the scale and availability of the country's wind power potential. Wind power, being quite seasonable and at times unreliable in equatorial areas, is deemed to comprise a relatively minor share of the future electricity mix of the country.

Figure 3.16. Wind Power Potential in Malaysia

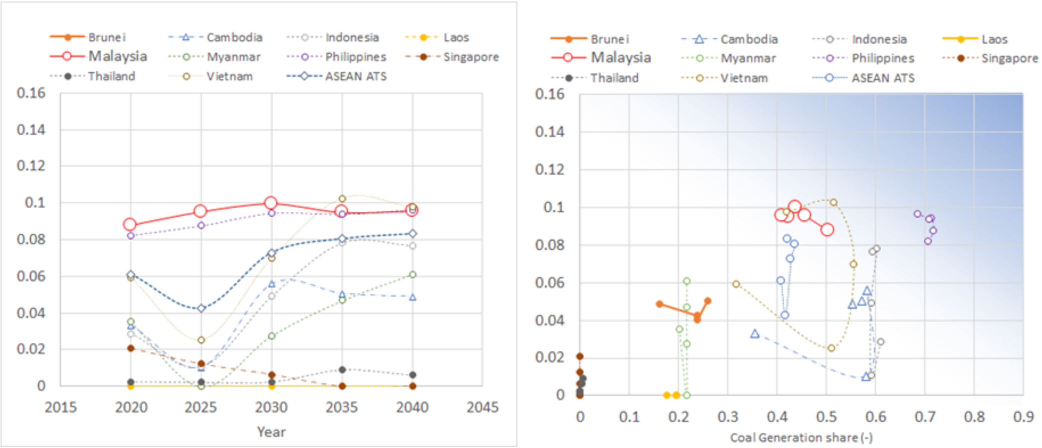


Source: Denmark Technical University (2019), 'Global Wind Atlas'. (Global Wind Atlas 3.0 is a free, web-based application developed, owned, and operated by the Technical University of Denmark (DTU). The Global Wind Atlas 3.0 is released in partnership with the World Bank Group, utilising data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program. For additional information: https://globalwindatlas.info.

2) Future grid fluctuation potential by GFI

Figure 3.17 shows the year-by-year GFI projection of the AMS (left) and the same against coal generation share in the generation mix. In AEO6, which provides the data of the GFI projections, the generation mix in 2040 consists of 20% renewables, 39% gas, and 22% coal.

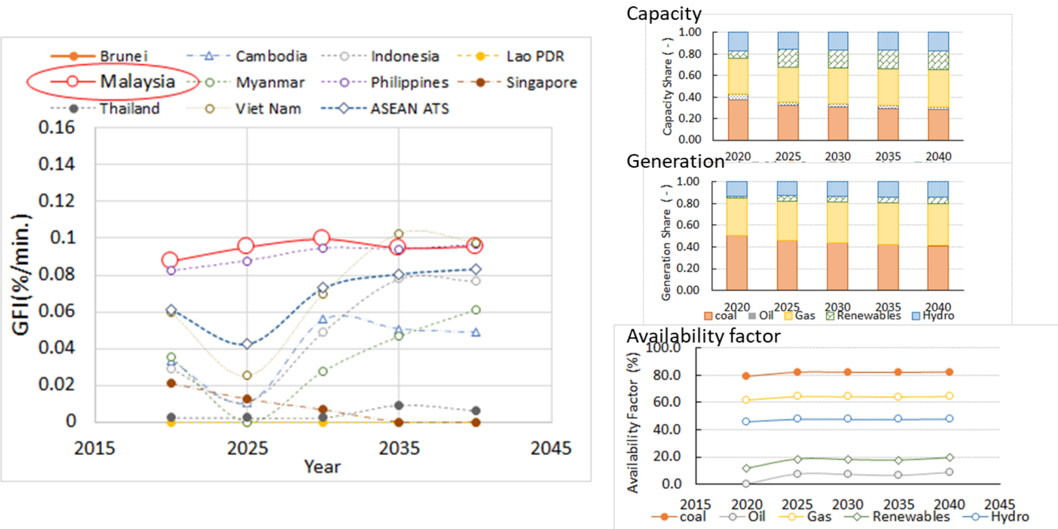
Figure 3.17. Future Grid Fluctuation of Malaysia by GFI



Source: Authors' calculation.

Malaysia is envisaged to have increased grid fluctuation, especially after 2030, if the country's generation mix remains as forecasted and no particular measures are taken.

Figure 3.18. GFI Analysis and Capacity, Generation, and Availability Factor



Source: Authors' calculation.

2.3. Energy transition and coal phasing-out scenario of the power sector in Malaysia

1) Generation development plan of Peninsular Malaysia

As mentioned, under this plan published in March 2021, Malaysia was committed to not having new greenfield CFPPs. The plan retires 7,044 MW of coal power from 2021 to 2039. The same plan refers to 2,800 MW of coal power that will replace the retiring ones. However, recently, Malaysia's Prime Minister announced no more new coal power capacity to speed up coal phasing out given the outcomes of COP26. The government will have to wait for some time – probably until the RETR is finalised – to know the exact policy direction and power development Malaysia will follow and implement along with the energy transition.

Table 3.3 shows the generation development plan of Peninsular Malaysia for 2021–2039. As mentioned, under this plan published in March 2021, Malaysia was committed to not having new greenfield CFPPs. The plan retires 7,044 MW of coal power from 2021 to 2039. The same plan refers to 2,800 MW of coal power that will replace the retiring ones. However, recently, Malaysia's Prime Minister announced no more new coal power capacity to speed up coal phasing out given the outcomes of COP26. The government will have to wait for some time – probably until the RETR is finalised – to know the exact policy direction and power development plan Malaysia will follow and implement along with the energy transition.

Table 3.3. Peninsular Generation Development Plan 2031–2039

Year	Generation Capacity (31% RE Capacity Mix for Malaysia)	Retiring Plants
2021	Edra Energy (CCGT) (3X747 MW) RE (860 MW)	YTL Power (CCGT) (585 MW)
2022	RE (652 MW)	TNB Pasir Gudang (CCGT) (275 MW) GB3 (CCGT) (640 MW)
2023	RE (663 MW)	Panglima (CCGT) (720 MW)
2024	TADMAX (CCGT) (2x600 MW) RE (855 MW)	SKS Prai CCGT (341 MW) TTPC (CCGT) (650 MW) TNB Gelugor (CCGT) (310 MW)
2025	RE (818 MW)	TNB Putrajaya GT4 & GT5 (OCGT) (249 MW)
2026	THB (CCGT) (2x600 MW) RE (117 MW)	KLPP (CCGT) (675 MW)
2027	Nenggiri (Hydro) (300 MW) RE (184 MW)	Segari Energy Ventures (CCGT) (1,303 MW)
2028	RE (192 MW)	TNB Tuanku Jaafar PD1 (CCGT) (703 MW)
2029	CCGT (1x700 MW) CCGT (1X500 MW) RE (199 MW)	KEV Gas U1 & U2 (Thermal Gas) (578 MW) KEV Coal U3-U6 (Coal) (1,474 MW)

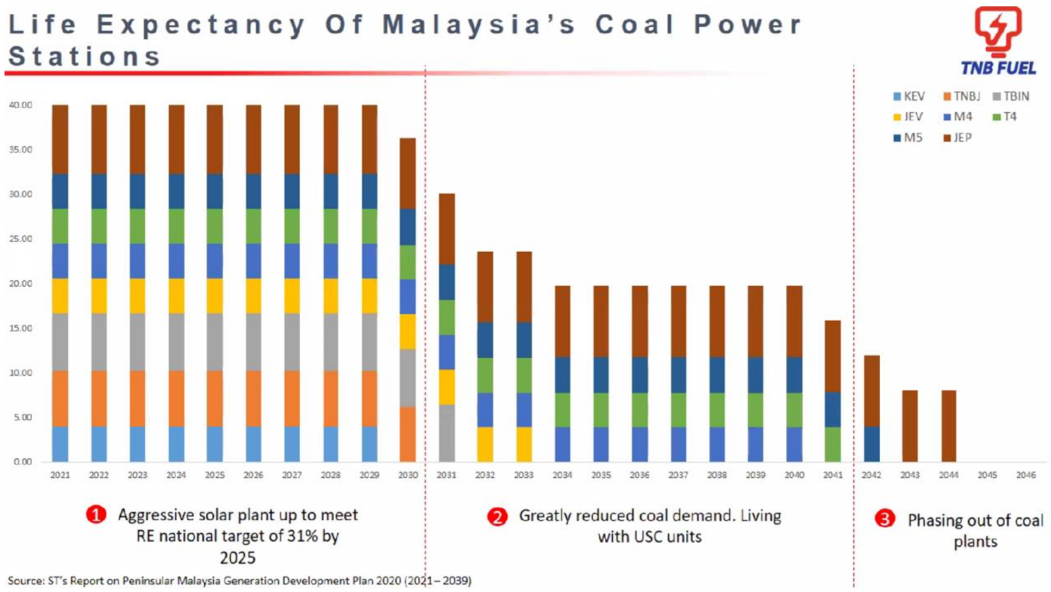
2030	CCGT (4x700 MW) RE (207 MW) BESS (1x100 MW)	TNB Tuanku Jaafar PD2 (CCGT) (708 MW) TNB Janamanjung (Coal) (2,070 MW)
2031	CCGT (1x700 MW) Coal (2X700 MW) BESS (1x100 MW) RE (215 MW)	Tanjung Bin Power (Coal) (2,100 MW)
2032	CCGT (1x700 MW) BESS (1x100 MW) RE (224MW)	
2033	CCGT (2x700 MW) BESS (1x100 MW) RE (232MW)	Jimah Energy Venture (Coal) (1,400 MW)
2034	Coal (1X700 MW) BESS (1x100 MW) RE (242 MW)	
2035	RE (278 MW)	
2036	CCGT (1x700 MW) RE (80 MW)	
2037	CCGT (1x700 MW) Coal (1X700 MW) OCGT (1x100 MW) RE (77 MW)	TNB Prai (CCGT) (1,071 MW) TNB CBPS (CCGT) (375 MW)
2038	CCGT (1x700 MW) RE (76 MW)	Pengerang Power (Co-Gen) (600 MW)
2039	CCGT (1x700 MW)	

Source: Energy Commission (2021b).

2) Malaysia's coal phasing-out scenario

Malaysia will continue utilising CFPPs in the cleanest possible manner in the foreseeable future. At the same time, it is committed to gradually reducing CFPPs, as shown in its phasing-out plan (Figure 3.19). The government and the TNB are meticulously planning the phasing out by targeting approximately 50% of CFPPs from the first phase (2021–2030) to the second phase (2031–2041). The third and final phase (2042–) will see the total abolition only in 3 years. Even if the phasing out plan proceeds accordingly, the fluctuation potential after 2030 remains.

Figure 3.19. Utilisation and Phasing Out of Coal-fired Power Plants in Malaysia



Source: TNB presentation at the 1st International Seminar on Mineral and Coal Technology (ISMCT) (virtual), 23 June 2021.

We should note that Malaysia started utilising coal in the power sector because of the economic advantages of coal utilisation for power generation. How and to what extent a country will reduce coal and increase gas would impact the grid flexibility and the economy and affordability of electricity utilisation. While using more gas will better address the possible issue of fluctuation expected from 2030 onwards, the government will possibly have a dilemma, as switching to more gas will offset such economic advantages. Such an offset may be felt more in Malaysia as CFPPs are well maintained and have a longer life than such power plants in other ASEAN countries.

2.3. Policy recommendations

Malaysia is steps ahead of other AMS in considering its energy transition pathway, as we understand from the past policies and legal frameworks in the power sector. According to the GSO, in expectation of the possible grid fluctuation, a study on renewable energy penetration is in progress. They envisage that CFPPs will be cycled to minimum loading during solar peak time, possibly 50% to 70% during weekdays, and the technical and power purchase agreement minimum during weekends or public holidays. In the case of high solar penetration, whose variation is considered higher, the range will be 30% to 70%. They also envisage the possible challenges in managing the three cycles of load variation in a day.

As we have seen, Malaysia is expected to experience grid fluctuations after 2030 even if the government will go for the new scenario, i.e. no more new CFPPs, regardless of greenfield or brownfield. Therefore, in the medium term, flexibilisation measures with thermal power, including coal-fired power and hydropower, will address the requirements of the grid while renewable energy penetration proceeds. Storage technology will help ensure a non-intermittent power supply in the medium to long term. The government is already planning to introduce energy storage facilities in power development.

Recommendations for ensuring grid stability in the period of energy transition

In the medium term, flexibilisation measures with thermal power, including coal-fired power and hydropower, will address the grid's requirements while renewable energy penetration proceeds.

Storage technology will help ensure a non-intermittent power supply in the medium to long term. Consideration of policy initiatives from this stage to enable local manufacturing in the near future is recommended. It is also possible for Malaysia to make a hub supplying made-in-Malaysia storage facilities.

Consideration of policy initiatives by the federal government to enable local manufacturing in the near future is recommended.

According to the 12th Malaysia Plan [2], the federal government encourages local manufacturing in emerging industries, so such direction is in line with the government policy.

Enabling policy for battery and other key products local manufacturing is crucial, as it will enable Malaysia to maintain growth and development while maintaining system stability. It is important in terms of energy economy and energy security through sustainable supply. Also, such an arrangement will benefit neighbouring countries and contribute to ensuring ASEAN's energy security.

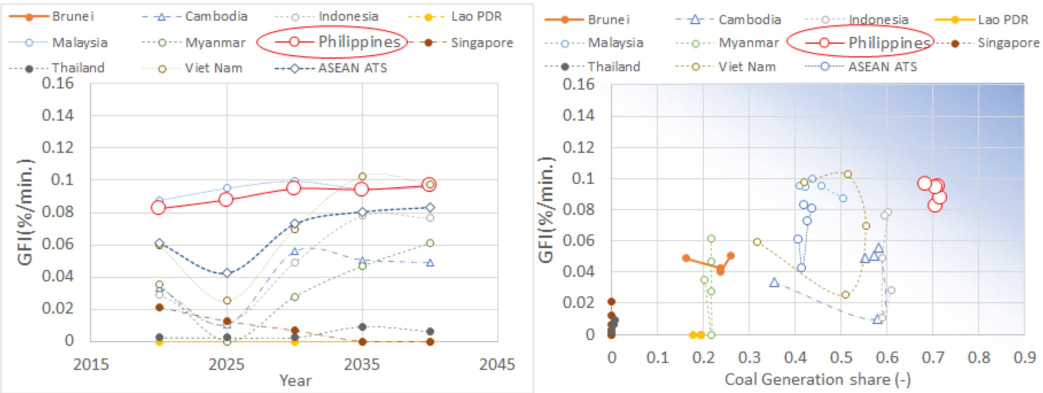
[2] 12th Malaysia Plan, https://rmke12.epu.gov.my/en (accessed 15 October 2021).

3. Philippines

3.1. Preliminary grid analysis by GFI

Figure 3.20 presents the future grid fluctuation analysis of the Philippines using the GFI method based on the data from AEO6. The GFI will remain at a relatively high level at approximately 0.08–0.1, which would require flexibilisation measures. High dependence on coal-fired power generation is deemed a major factor to expedite it. The local grid system fluctuation might occur more severely if the more flexible power supply sources such as gas and/or hydro are less available.

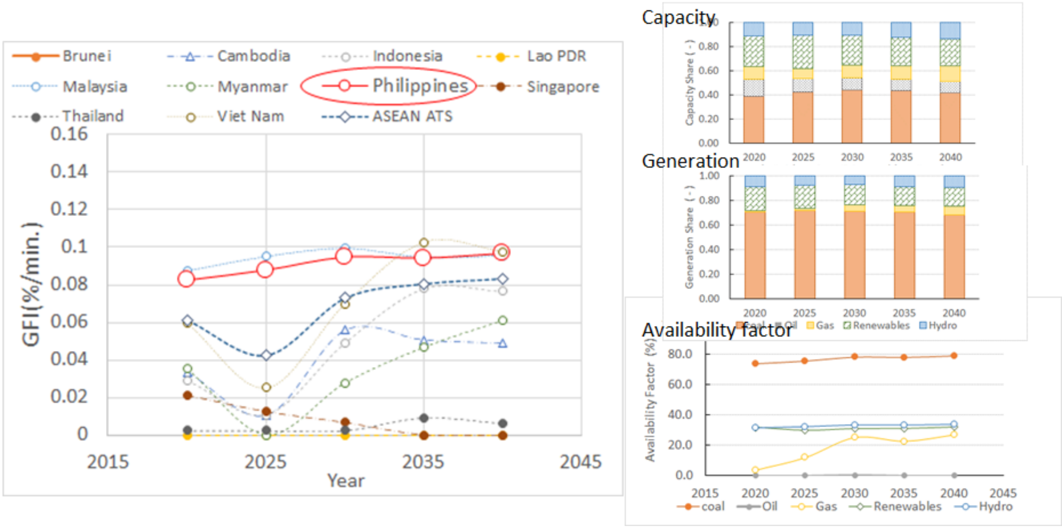
Figure 3.20. Future Grid Fluctuation of the Philippines by GFI



Source: JCOAL.

Diversification is sustained in the well-balanced installed capacity from 2020 to 2040. However, overdependence on coal will continue to be observed in the generation mix. As shown in Figure 3.21, the availability factor of coal-fired power is much higher than that of other sources. The foregoing will constitute the major cause to push up the level of the GFI from 2030 to 2040.

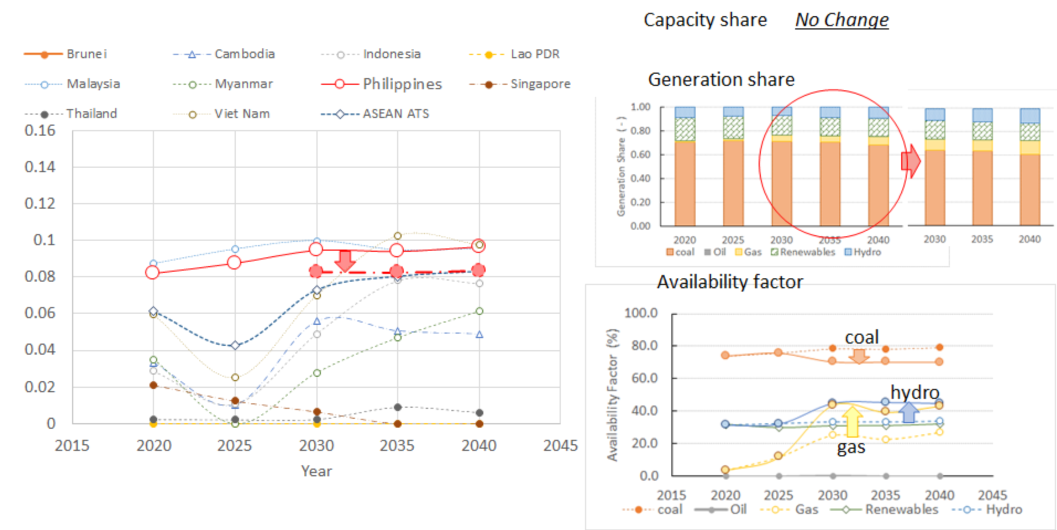
Figure 3.21. GFI Analysis and Capacity, Generation, and Availability Factor



Source: JCOAL.

The generation shift from coal to gas and hydro may contribute to a levelling of the availability factor amongst coal, hydro, and gas. In this case, if the availability factor of hydro and gas in 2030–2040 increases by 10% to 17%, the availability factor of coal-fired power can be reduced by 8% to 9%. As a result, the GFI is expected to become milder to the ASEAN average level (Figure 3.22).

Figure 3.22. Tentative Recommendations of Flexibilisation Measures



Source: JCOAL.

3.2. Clean energy scenario (CES), input by the Department of Energy (DOE)

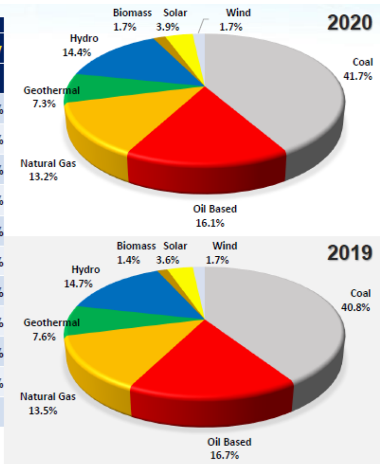
The Philippine power sector set up four sectors: generation, transmission, distribution, and supply. The generation sector, a business affecting the public interest, shall be competitive and open. Generation companies only need to secure from the energy regulatory commission a certificate of compliance and health, safety, and environmental clearances from appropriate government agencies under existing law and comply with gross ownership provisions.

Energy dispatch, scheduling, and pricing are made through the electricity market, called the wholesale electricity spot market. It is a real-time market where prices and schedules are determined 24/7. But now, the Philippines is ready to transition into a 5-minute market. Hopefully, by the end of October 2022, the DOE will commercially launch the 5-minute market.

Focusing on the installed capacity (Figure 3.23), the country has 26 GW of capacity from coal, oil, diesel, natural gas, and various renewable energy resources from geothermal, hydro, biomass, or solar wind. In terms of capacity or MW, the highest percentage share for this capacity mixes that of coal, which accounts for 41.7% of the total installed capacity of the Philippines. It is followed by oil at 16.1%, natural gas at 13.2%, and the others at 29% in terms of MW installed capacity or from renewable energy source technologies.

Figure 3.23. Installed and Dependable Capacity

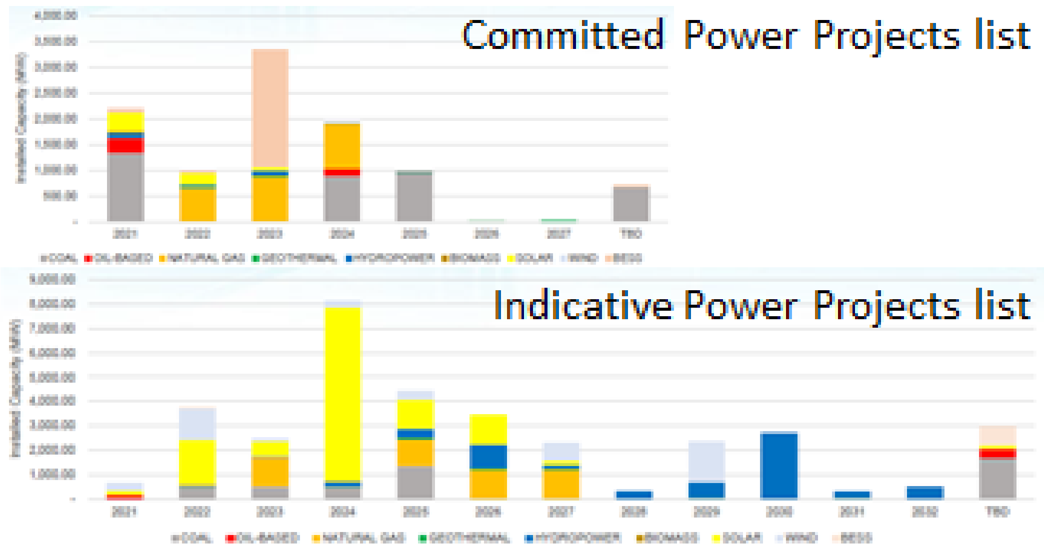
FUEL TYPE	2020				2019			
	Installed Capacity		Dependable Capacity		Installed Capacity		Dependable Capacity	
	in MW	% Share	in MW	% Share	in MW	% Share	in MW	% Share
Coal	10,943.9	41.7%	10,245.3	43.8%	10,417.2	40.8%	9,743.3	42.9%
Oil Based	4,236.6	16.1%	3,053.6	13.0%	4,262.4	16.7%	3,015.3	13.3%
Natural Gas	3,452.5	13.2%	3,286.1	14.0%	3,452.5	13.5%	3,286.1	14.5%
Renewable Energy (RE)	7,616.9	29.0%	6,824.9	29.2%	7,399.3	29.0%	6,691.2	29.4%
Geothermal	1,928.1	7.3%	1,753.1	7.5%	1,928.1	7.6%	1,792.3	7.9%
Hydro	3,779.3	14.4%	3,526.6	15.1%	3,759.8	14.7%	3,508.1	15.4%
Biomass	447.4	1.7%	285.4	1.2%	363.4	1.4%	227.0	1.0%
Solar	1,019.3	3.9%	816.9	3.5%	921.1	3.6%	736.9	3.2%
Wind	442.9	1.7%	442.9	1.9%	426.9	1.7%	426.9	1.9%
TOTAL	26,249.9	100.0%	23,409.9	100.0%	25,531.4	100.0%	22,736.0	100.0%
BESS	11.0		11.0		11.0		11.0	



Source: Presentation by DOE, Philippines, at the 1st Working Group meeting, July 2021.

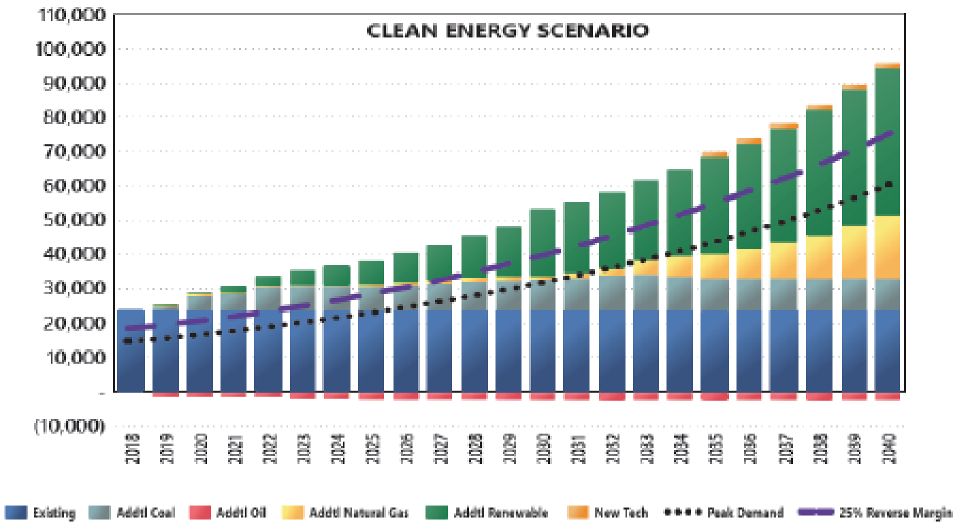
Figure 3.24 summarises the line-up of power plant capacities for committed projects granted in the pipeline, which is estimated to be online by specific years. These are projects that have secured financial closing or are already being constructed. The majority or a big chunk of these capacities will come from the pool for 2021. There are also natural gas power plants, renewable energy capacities, and the inclusion of BESSs. The indicative project list is also illustrated in Figure 3.24. The difference with the committed power project is that the indicative project list refers to power-generating companies that already signified to the DOE their intent to pursue building a generating facility. However, these projects are still fulfilling various permitting requirements and are in their pre-development stages.

Figure 3.24. Capacity Addition Plan up to 2032



Source: Presentation by DOE, Philippines, at the 1st Working Group meeting, July 2021.

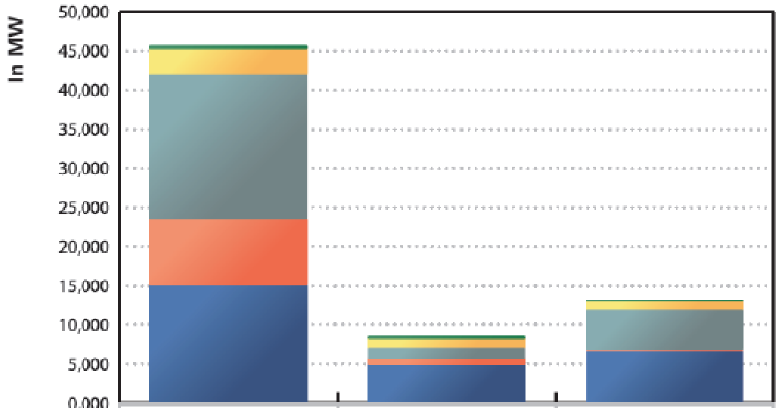
Figure 3.25. Clean Energy Scenario under the Philippines' Energy Plan 2018–2040



Source: Presentation by DOE Philippines at the 1st Working Group meeting, July 2021.

From the Philippines' energy plan 2018–2040, DOE has incorporated a reference and a CES to highlight the country's commitment in its nationally determined contributions and find a way on the side of the energy sector on what is the possible mix (Figure 3.25). Considering the demand level the Philippines needs to meet in terms of capacity or outlook, Figure 3.26 shows the additional capacities projected for each grid for the whole Philippines.

Figure 3.26. 2040 Additional Capacities per Grid (MW)



	Luzon	Visayas	Mindanao
Peaking	420	200	40
Flexible	3,200	1,340	1,100
Variable	18,500	1,324	5,148
Intermediate	8,400	700	200
Baseload	15,220	5,000	6,553

**net capacity addition (less retiring plants between 2018-2040)*

Source: Presentation by DOE Philippines at the 1st Working Group meeting, July 2021.

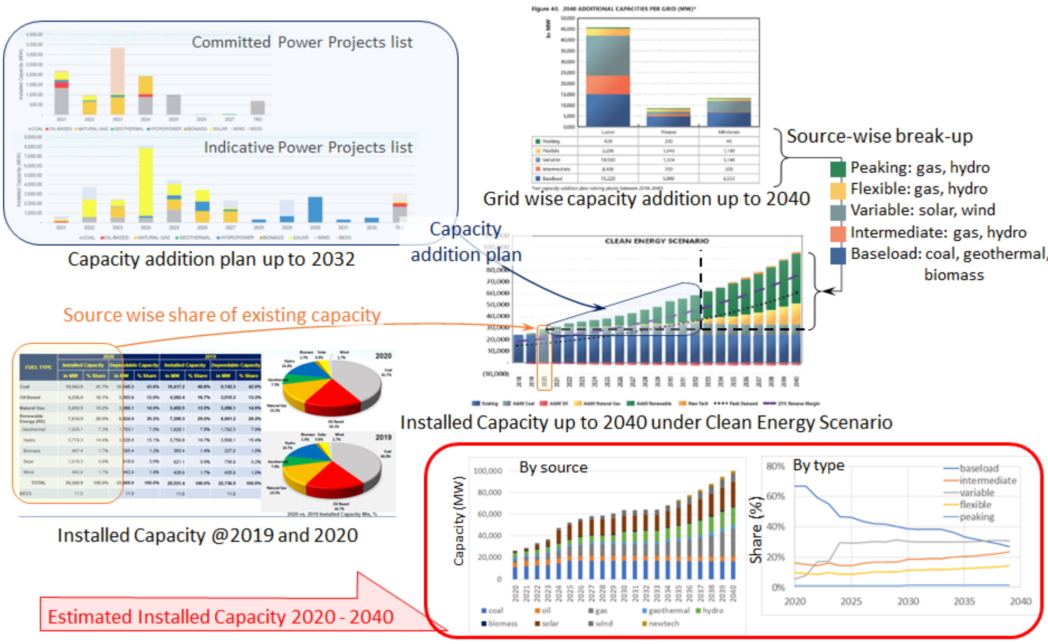
In 2020, a coal-fired power project moratorium or a moratorium on new coal-fired power facilities was implemented. Based on this policy, the Philippines will not be providing approvals for new coal-fired power facilities except for those already committed and all power projects already having significant development in terms of the projects before the moratorium. So, the Energy Secretary had signed this moratorium, and the DOE will not be entertaining new coal-fired power facilities in the near future.

These are also in preparation for the reserve market currently being finalised by DOE to encourage additional investment in those generating facilities that project owners are exploring possibilities of reserve provisions to the grid. For the distribution sector, DOE has a competitive selection process to facilitate the procurement process of distribution companies with the generating companies to ensure that their rates will be at the least cost per the end users.

3.3. Source and grid-wise breakdown of clean energy scenario (CES)

Based on DOE data, a detailed analysis of CES was conducted. The process of breakdown of CES by the power source is shown in Figure 3.27. The existing capacity shown in Figure 3.25 is divided by the data in Figure 3.23. Source-wise capacity addition can be accumulated using the data in Figure 3.24. The source-wise capacity from 2032 to 2040 is predicted from the additional capacity for each grid in 2040 in Figure 3.26. Integrating these data conversions, the installed capacity by a power source from 2020 to 2040 was estimated (Figure 3.27). Based on the information from DOE, the operation type of each power supply can also be categorised (Table 3.4). By converting the capacity for each power source to the one for each operation type, the relation between the grid fluctuation and the capacity sufficiency or insufficiency can be clarified. Since gas and hydro are operated in various modes such as peaking, flexible, and intermediate, their distribution to each type was considered using the data in Figure 3.23 and Figure 3.26.

Figure 3.27. Process of Source-wise Breakdown



Source: Edited by JCOAL, data: Presentation by DOE Philippines at the 1st Working Group meeting, July 2021.

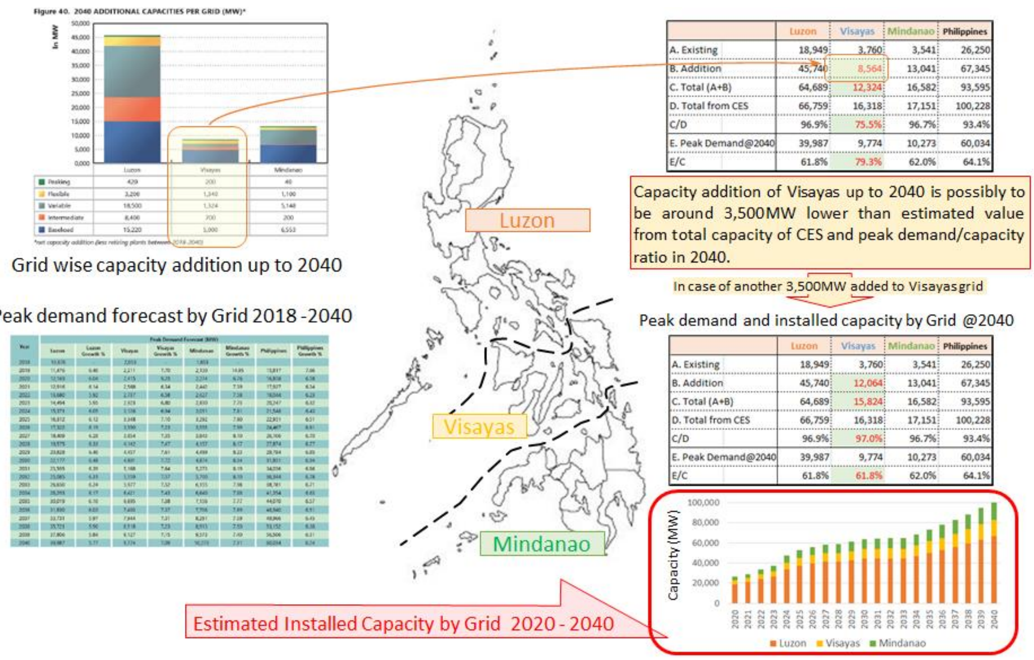
Table 3.4. Type of Operation, by Source

Type of Operation	Source
Peaking	Gas, Hydro
Flexible	Gas, Hydro
Variable	Solar, Wind
Intermediate	Gas, Hydro
Baseload	Coal, Geothermal, Biomass

Source: Email communication with DOE Philippines.

From the growth of peak demand forecast for each grid in Luzon, Visayas, and Mindanao, the installed capacity for each grid was assumed, and the installed capacity was further divided by power source and operation type. The process is shown in Figure 3.28. In the installed capacity forecast from the peak demand for each grid, only Visayas showed a result of about 3.5 GW less than the capacity of CES. Still, Luzon and Mindanao showed a good agreement. Although the details are unknown, they do not affect the data of the ratio by the power source and operation type, so the analysis was continued as it is.

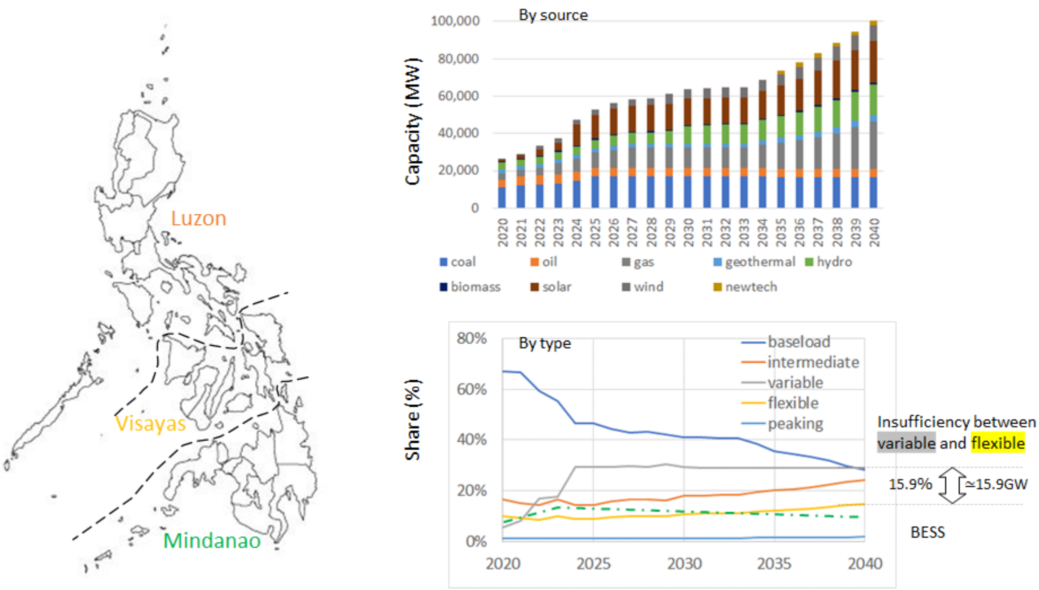
Figure 3.28. Process of Grid-wise Breakdown



Source: Edited by JCOAL, original data: Presentation by DOE Philippines at the 1st Working Group meeting, July 2021.

These analyses provided capacity predictions for each grid up to 2040 (Figure 3.28). Per the analysis results in this study, Figure 3.29 shows the changes in the source-wise capacity and operation type share of the entire Philippines up to 2040. The ratio of baseload operation will decrease due to the decrease in coal-fired power and the increase in renewable energy. This trend will be remarkable from now to 2024 and will gradually decrease after that. On the other hand, solar and wind power, which will be in variable operation, will increase in terms of installed capacity while maintaining a certain share after 2024. As for flexibilisation, it is possible to judge the surplus or insufficiency of correspondence from the share of variable and flexible operation. In the Philippines, the difference in installed capacity between variable and flexible is about 16 GW as of 2040. But it can be accommodated by the gas-fired and hydropower of Intermediate operation and BESS, which are expected to increase. To address flexibilisation, it is recommended for the policy to divert the gas and hydropower of intermediate operation to flexible operation as needed.

Figure 3.29. Source-wise Breakdown of the Whole Philippines



Source: Edited by JCOAL, original data: Presentation by DOE Philippines at the 1st Working Group meeting, July 2021.

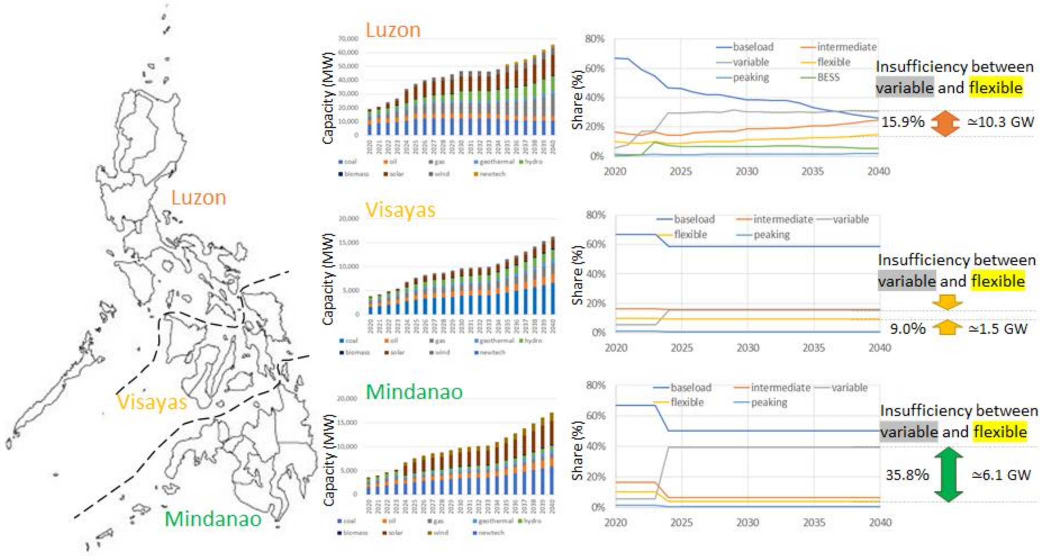
Figure 3.30 shows the Luzon, Visayas, and Mindanao grid forecasts of installed capacity by the power source and share by operation type by 2040. The data on the share by driving type is limited. There are two data: the current and the one as of 2040.

However, Luzon has the largest grid, which occupies 70% of the country. It is calculated approximately by the ratio from the data of the whole country. The difference in installed capacity between 'variable' and 'intermediate' in 2040 on the Luzon grid was 10.3 GW. Therefore, the countermeasure is to maximise the operation shift from intermediate to flexible, as shown in the Philippines.

For the Visayas grid, the insufficiency between variable and flexible is as small as 1.5 GW. Therefore, it is expected that operation shift of some part of intermediate or the installation of BESS, etc., can address it.

In contrast to the Visayas, the Mindanao grid has a large insufficiency between variable and flexible, 6.1 GW. This difference is still insufficient even if all the intermediate capacities are shifted to flexible operation. Even with BESS, etc., it is necessary to take measures so that part of the coal-fired power of baseload operation can be operated flexibly. Drastic measures such as renovating coal mills, enhancing the operation mode, and introducing software associated with them are required to improve the flexible capability of coal-fired power, as described in section 2.1.

Figure 3.30. Source-wise Breakdown of Luzon, Visayas, and Mindanao Grids



Source: Edited by JCOAL, original data: Presentation by DOE Philippines at the 1st Working Group meeting, July 2021.

The results of future prediction analysis of grid fluctuations in this study and their flexibilisation measures are summarised in Table 3.5 for the whole Philippines and each island group: Luzon, Visayas, and Mindanao.

Table 3.5. Summary of the Grid Analysis and Measures

Grid	Grid Analysis	Measures
Philippines	・The renewable energy capacity will increase by 2024; the capacity to cope with fluctuations by gas and hydropower is secured. ・After 2024, the increase in flexible capacity is lower than the increase in renewable capacity. ・Insufficiency of variability/flexibility in 2040; 15.9 GW	Intermediate gas and hydro => Flexible operation Introduction of large energy storage such as BESS and pumped hydro
Luzon	・The situation is mostly the same as the whole Philippines since around 70% of the capacity belongs to the Luzon grid. ・Insufficiency of variability/flexibility in 2040; 10.3 GW	As described above
Visayas	・The Visayas grid has a flexible capacity of comparable scale as the fluctuation. ・A small part of the intermediate capacity is to be operated as flexible.	・Intermediate gas and hydro => Flexible operation

	・Insufficiency of variability/flexibility in 2040; 1.5 GW	
Mindanao	・Due to the large variable capacity in the Mindanao grid, a part of the coal-fired power should be operated flexibly. ・Insufficiency of variability/flexibility in 2040; 6.1 GW	Maximise the flexible operation by gas and hydro. Introduction of large energy storage such as BESS and pumped hydro Flexible operation by coal-fired power

Source: JCOAL.

3.4. Policy recommendations

Based on DOE data, a detailed analysis was conducted to find the measures to be taken in the three grids, mainly from the viewpoint of balance of the generation type. The flexibilisation measures to be taken in the power grid are as follows:

- Maximise the flexible operation by gas and hydro, which is normally operated as an intermediate mode;
- Install large-scale energy storage such as BESS and pumped hydro;
- Operate a part of the coal-fired power flexibly like partial load and/or 'daily start and stop' mode.

Implementation of the above-mentioned flexibilisation measures is recommended.

Especially, tariff incentives for non-baseload operation by private utilities are the key to maximising the flexible capacity.

Large-scale energy storage technologies are to be selected appropriately for grid situations. Commercially available pumped storage might have a cost advantage than BESS if local site condition suits.

In the case of flexible operation by a CFPP, additional investment for modification of mill, steam bypass, and operating software may be required. In this regard, a supporting program under the Resiliency Compliance Plan (DOE, 2018) or other suitable national plan is recommended.

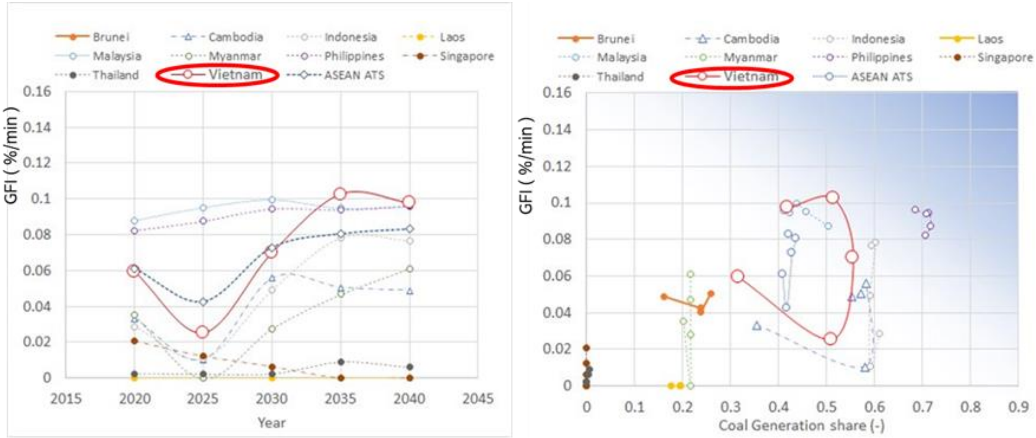
As facilitation of demand-side management, daytime operations are recommended for the power-intensive industry like electric arc furnace steel and electrolytic smelting. A necessary tariff mechanism to specify such daytime operation is also recommended.

4. Viet Nam

4.1. GFI of Viet Nam

The GFI of Viet Nam will stay relatively at a low level up to 2025, following which a sharp increase will be observed towards 2035. Installed capacity will continue to increase for the long term.

Figure 3.31. Future Grid Fluctuation of Viet Nam by GFI

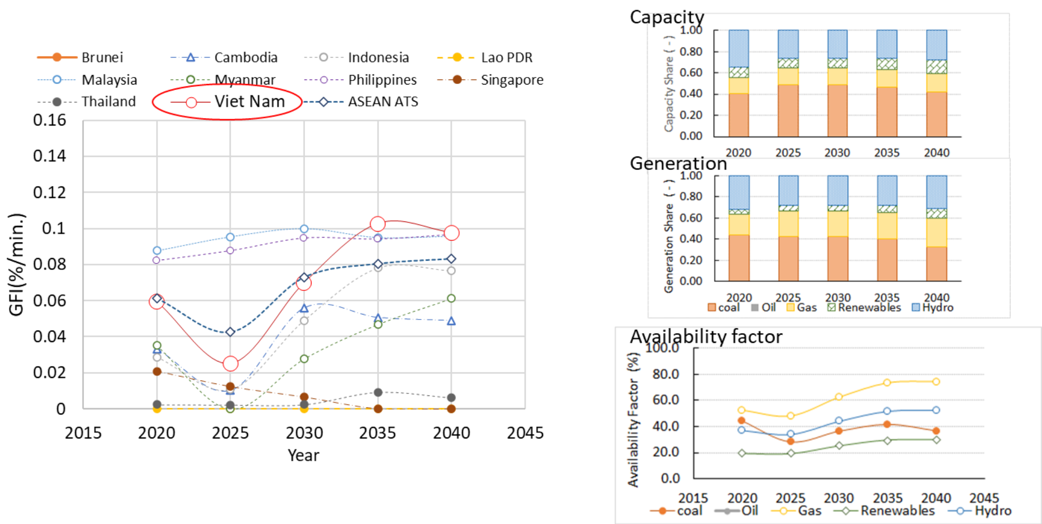


Source: Authors' calculation.

As of 2040, coal will account for less than 40% of the generation mix. The share of gas and hydro will increase, and so will the availability factor of these sources. As of 2040, renewable energy and coal will have an equal share of 40%.

Since domestic anthracite is not suitable for flexible operation, flexibilisation with imported coal will be a crucial key to successful grid stability.

Figure 3.32. GFI Analysis and Capacity, Generation, and Availability Factor of Viet Nam

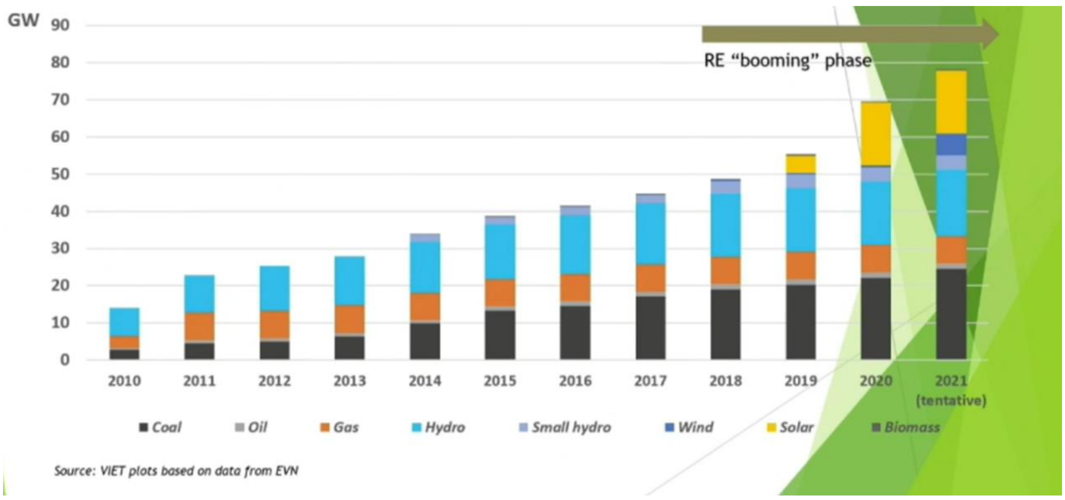


Source: Authors' calculation.

4.2. Power mix of Viet Nam's installed capacity

From here, we will explain the current situation of Viet Nam's power mix, the draft Power Development Plan 8, etc. Viet Nam has continued its economic growth steadily. Domestic energy sources are at their limits, and imported energy is increasing. Coal, gas, and hydro were the main power sources. But since 2018, renewable energy booms have led to increased small-scale hydro-, solar, and wind power.

Figure 3.33. Power Mix of Viet Nam's Installed Capacity

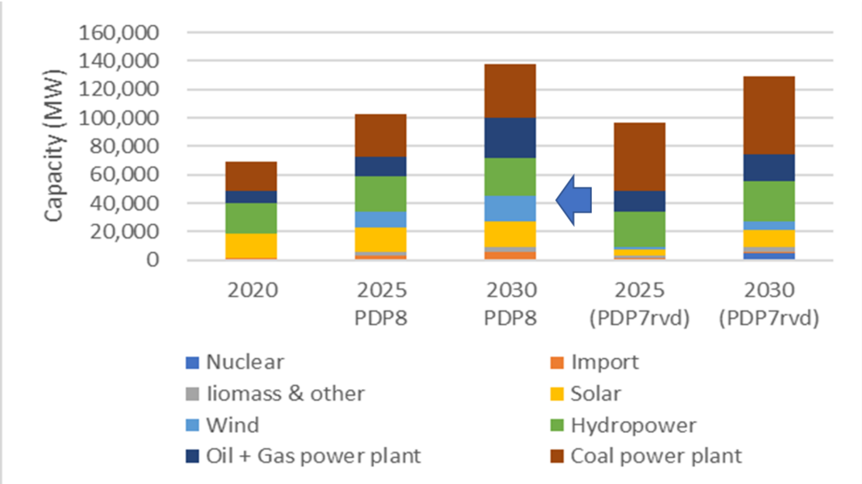


Source: MOIT (2021).

4.3. Power mix of Viet Nam's PDP8[3] draft up to 2030

A draft of PDP8 was published, indicating the direction of the energy transition. Figure 3.34 compares the present and the future power mix by the revised PDP7 and the draft PDP8, respectively. The important points of the PDP8 draft are as follows. The power supply configuration has been revised: conversion to clean energy, reduction of environmental impact, and suspension of new CFPPs.

Figure 3.34. PDP8: Power Mix up to 2030

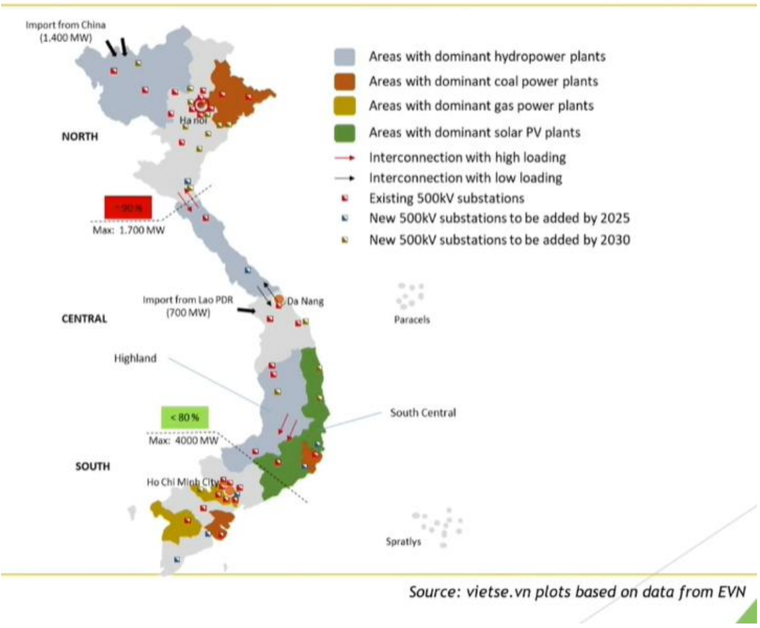


Source: MOIT (2021).

Figure 3.35 shows the grid system of Viet Nam up to 2030. High load demand is in the north and the south. Solar and wind projects are concentrated in south-central. It is essential to strengthen the power grid to support the transmission between north, central, and south.

[3] Draft PDP8, https://www.globalcompliancenews.com/2021/03/09/Viet Nam-key-highlights-of-new-draft-of-national-power-development-plan-draft-pdp8-04032021/ (accessed 7 June 2021); https://onevalue.jp/insight/Viet Nam-re/ (accessed15 October 2021).

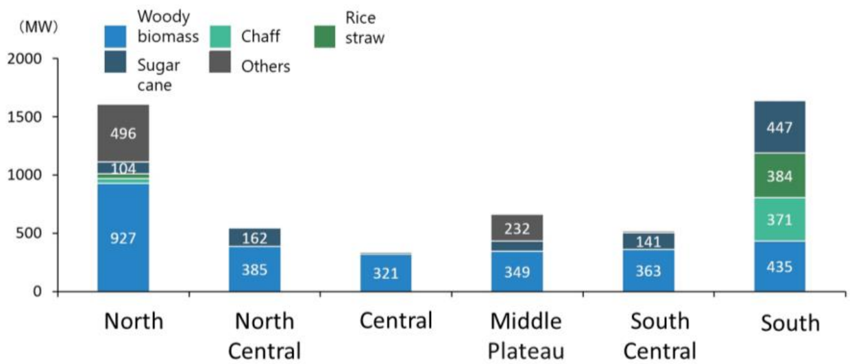
Figure 3.35. Grid System of Viet Nam up to 2030



Source: MOIT (2021).

The PDP8 draft shows the development potential of biomass power generation in 2030 (Figure 3.36). Since the distribution of plants as fuel is different, it is important to stably procure fuel according to the region in biomass power generation.

Figure 3.36. Development Potential of Biomass Power Generation, 2030



Source: Edited by JCOAL, original data: Onevalue.JP, October 2021. https://onevalue.jp/insight/Viet Nam-re/ (accessed 15 October 2021).

Strong incentives and mechanisms are needed to develop and strengthen renewable energy. Laws and regulations are also important. Feed-in-tariff mechanisms for renewable energy development are shown in Table 3.6. It is vital to continue and strengthen this mechanism.

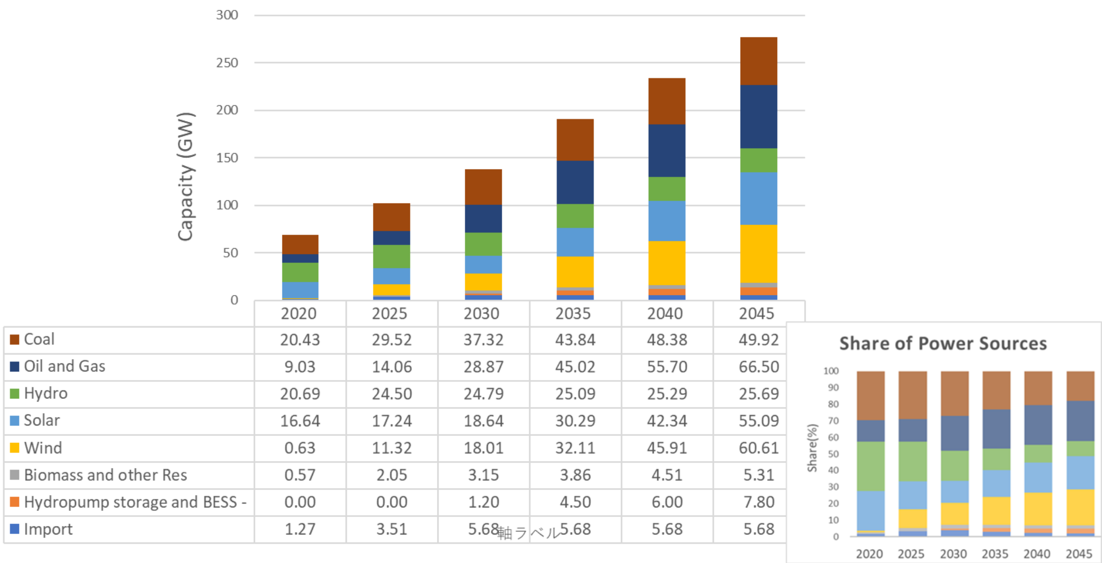
Table 3.6. Feed-in Tariff Mechanisms to Develop Renewable Energy

Type of RE	Status		FIT (US cent/kWh)	Note
	Current	On proposal		
Wind	FIT		Onshore wind projects: 8.5 Offshore wind projects: 9.8	COD before 31/10/2021
Biomass	FIT (CHP)		Cogeneration of power: 7.03 Non-cogeneration of power: 8.47	Decision No. 24/2014/QD-TTg dated on 24/3/2014 & Decision No. 08/2020/QD-TTg dated on 05/3/2020
Waste	FIT		Digged waste: 7.28 Direct-burned waste: 10.05	Decision No. 31/2014/QD-TTg dated on 05/5/2014
Solar	FIT	Auction	Floating solar: 7.69 Ground mounted solar: 7.09 Rooftop solar: 8.38	COD before 31/12/2020 On-grid solar with decision investment before 23/11/2019

Source: MOIT (2021).

Figure 3.37 shows the power mix of Viet Nam's PDP8 draft up to 2045. Steady economic growth is planned in the PDP8 draft. The development of renewable energy is remarkable. Coal and hydropower will remain flat, and share will decline. Renewable energy, excluding hydropower, will increase to 44% in 2045.

Figure 3.37. Viet Nam's Power Mix to 2045 according to Draft PDP8



	2020	2025	2030	2035	2040	2045
Coal	20.43	29.52	37.32	43.84	48.38	49.92
Oil and Gas	9.03	14.06	28.87	45.02	55.70	66.50
Hydro	20.69	24.50	24.79	25.09	25.29	25.69
Solar	16.64	17.24	18.64	30.29	42.34	55.09
Wind	0.63	11.32	18.01	32.11	45.91	60.61
Biomass and other Res	0.57	2.05	3.15	3.86	4.51	5.31
Hydropump storage and BESS -	0.00	0.00	1.20	4.50	6.00	7.80
Import	1.27	3.51	5.68	5.68	5.68	5.68

Source: Edited by JCOAL, original data: Viet Nam Initiative for Energy Transition, March 2021.

Viet Nam continues to grow steadily, focusing on the development of renewable energy. Renewable energy will increase to 44% in 2045 (without hydro). The country will not build new CFPPs but will continue using existing ones. Promoting energy conservation and efficiency improvement is essential.

4.3. Policy recommendations

Viet Nam promotes a balanced energy mix to ensure energy security and stabilise grid fluctuations. The feed-in tariff mechanism for expediting renewable energy development is continuously applied. With the introduction of renewable energy based on the PDP8, the power system of Viet Nam will transmit large amounts of renewable energy from the central and south-central to the northern and southern regions where demand is high (Figure 3.4-7). Therefore, the measures should be taken by dividing the region into demand and supply regions.

In the north and south regions, where existing and under-construction coal-fired power generation is the main power, it is recommended to address the maximum flexibilisation performance of coal-fired power generation and enable flexible operation of gas-fired power generation. Especially for coal-fired power generation, it is essential to introduce power generation technology that uses imported coal and has excellent load response and environmental performance.

On the other hand, in the central and south-central regions, as electricity-supplied regions, it is recommended to renovate conventional hydropower to pumped hydropower. Additionally, it is recommended to consider a flexibilisation policy for intermittent renewable energy for stable energy transmission to demand areas.

Moreover, although a bit of energy loss in AD-DA should be considered, it might be efficient for grid management to concentrate BESS in the north and south regions where many substations are located.

As facilitation of demand-side management, daytime operations are recommended for the power-intensive industry like electric arc furnace steel and electrolytic smelting. A necessary tariff mechanism to specify such daytime operation is also recommended.