Chapter 2

Overview of the Energy and Power Situation in ASEAN

December 2019

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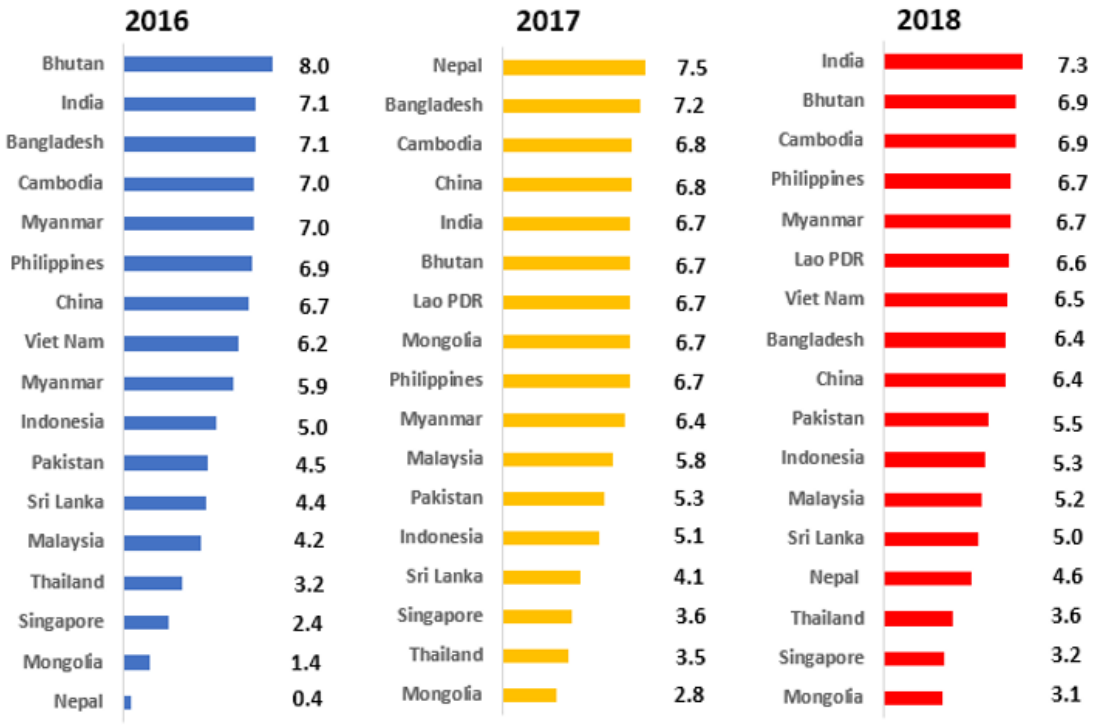
Chapter 2
Overview of the Energy and Power Situation in ASEAN

1. Energy, Power, and Environmental Situation in ASEAN

1.1. Economic growth in ASEAN

Having successfully weathered the 1997 Asian financial crisis and the 2008–2009 global economic crisis, ASEAN is now the fastest-growing and the sixth largest economy globally. Nine (9) out of 10 AMSs are in the list of 17 countries with highest growth in Asia for 2016–2018 (Figure 2.1).

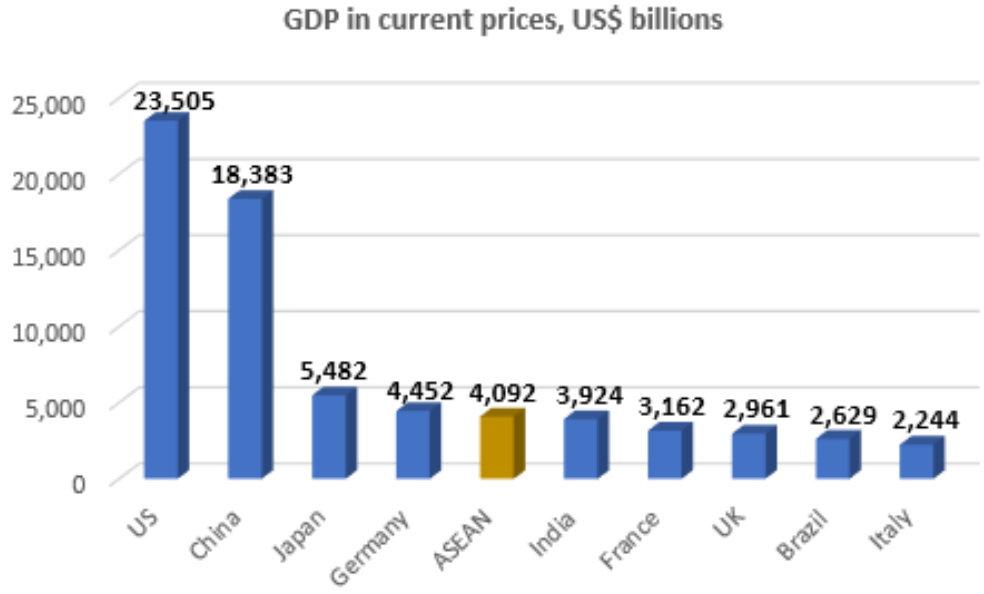
Figure 2.1. GDP Growth Projection for Asia, 2018



Source: The World Bank (2018).

ASEAN is forecasted to be the fifth-largest market by gross domestic product (GDP) size by 2022, when its GDP is expected to exceed US$4 trillion.

Figure 2.2. Top 10 Markets Worldwide in 2022, by GDP Size

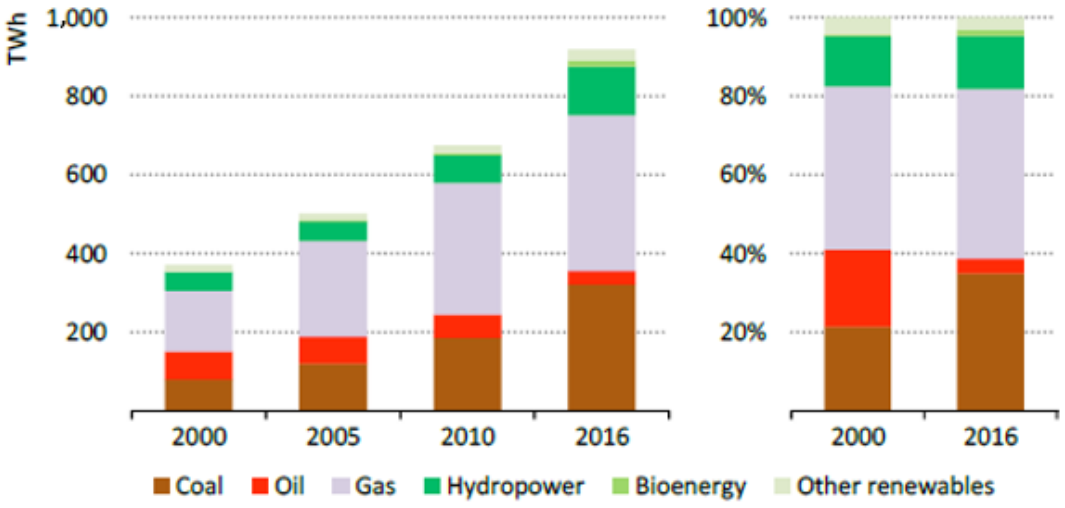


UK = United Kingdom, US = United States.
Source: PwC (2018).

1.2. Power demand growth and power generation mix

The electricity demand in the region, accordingly, has more than doubled in 2000–2016. Coal, as an abundant, affordable, and available electricity source, bolsters demand and economic growth.

Figure 2.3. Growth of Power Generation Mix in ASEAN



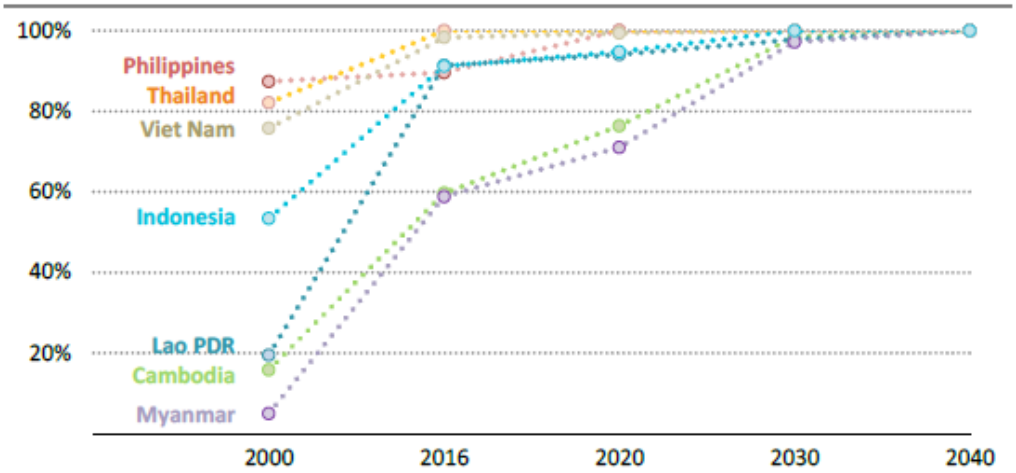
Source: IEA (2017).

Improvement of electricity access in the ASEAN region

While ASEAN as a collective group of states has made such outstanding progress during the past decades and is anticipated to continuously lead the economic path right on track, regional variations or even disparity remains in the socio-economic status of each member state, which affects national energy policy and planning.

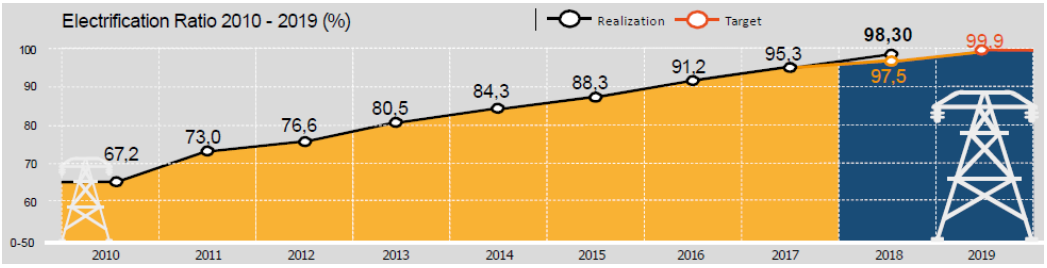
Especially in the past decade, the AMSs have been strenuously endeavouring to extend access to electricity. However, due to geographical and other country-specific reasons, the gap of electrification rate between each AMS used to be quite wide in 2000, but the gap had narrowed as of 2016. The Philippines and Thailand were getting close to 100% electrification following Brunei, Malaysia, and Singapore. Viet Nam was awarded by the World Bank as an emerging economy with the highest rural electrification ratio in the world of more than 99%.

Figure 2.4. Narrowing the Gap in Electricity Access



Source: IEA (2017).

Figure 2.5. Improvement of Electrification Access in Indonesia



Source: Indonesia Country Report Presentation at the ERIA Working Group Meeting.

Indonesia is another success story. An archipelagic country with 17,508 islands, it has also been struggling for years to increase electricity access towards 100% electrification. In 2015, the national electrification rate was 88.3% and was expected to reach 99.9% in 2019 (Figure 2.5).

Cambodia and Myanmar have seen an outstanding growth in their respective economies and their electrification ratio during the last decade. However, in Myanmar, a mere 34% of households have access to basic electricity services nationwide and 16% in rural areas. In Cambodia, a large part of households – about 6.62 million people – have yet to have access to electricity. They are continuously struggling to further boost the electrification ratio to catch up with the rest of the AMSs.

Towards full electrification: the issue of rural electrification and policy efforts to fill in the gap

While most AMSs appear to be on the same smooth path towards full electrification, they face a common issue – rural electrification – even after achieving over an 80%–90% electrification rate. Their respective governments are trying to enhance their policy efforts to fill in the gap between regions or between the urban and rural areas to expedite rural electrification.

The Government of Cambodia set a two-step target in rural electrification: (i) by the year 2020, all the villages would have electricity of some type; and (ii) by 2030, at least 70% of households would have access to grid-quality electricity (Department of Rural Electrification Fund, 2018). The government announced that Cambodia would push ahead with plans to use hydropower and coal to achieve these. These are the major power sources to electrify the entire country by 2020, while renewables are also expected to play some roles (Thomson Reuters Foundation News, 2018).

In the meantime, the Government of Myanmar approved in its National Electrification Plan an ambitious target of universal access to electricity (7.2 million new connections) by 2030. In off-grid areas (those not likely to be connected to the national grid before 2026), the plan predicts that as many as 2.4 million new household connections could be made through solar home systems and mini-grids by 2021, plus tens of thousands more community connections and public lighting connections.

Archipelagic Indonesia has more than 73,000 villages, out of which about 2,500 villages are targeted under the government's special electrification programme 'Indonesia Terang' supported by the Japan International Cooperation Agency. The programme, separate from the major electricity development plan of the Perusahaan Listrik Negara (PLN), focuses on three types of renewables: micro hydro, wind, and solar photovoltaic. The programme for 10,300 villages is more for the six provinces of Papua, West Papua, Maluku, Maluku Utara, East Nusa Tenggara, and West Nusa Tenggara, where 6,689 villages are awaiting electrification. It is unique and quite sustainable as it emphasises a shorter time to prepare and develop the project, including managing both local government and community.

As shown in the list of Philippines household electrification rates by region (Table 2.1), the Philippine government has mandated off-grid missionary electrification to the National Power Corporation and has been supporting Missionary Electrification through electricity subsidies. Recently, the Department of Energy (DOE) announced that the subsidies would be

removed and private sector participation in the field would be stimulated to further expedite rural electrification.

Table 2.1. Philippines Household Electrification Level, by Region (as of December 2016)

Region	Total HH	Served HH	Unserved HH	Electrification Level (%)
CAR	392,000	348,471	43,529	88.9
I	1,184,431	1,100,259	84,172	92.9
II	785,900	721,354	64,546	91.8
III	2,687,073	2,593,462	93,611	96.5
IV-A	3,506,353	3,376,855	129,498	96.3
IV-B	648,149	533,017	115,132	82.2
NCR	3,512,439	3,451,303	61,136	98.3
V	1,087,469	964,270	123,199	88.7
Luzon Total	**13,803,814**	**13,088,991**	**714,823**	94.8
VI	924,701	863,878	60,823	93.4
VII	1,430,541	1,371,853	58,688	95.9
VIII	889,968	776,180	113,788	87.2
NIR	831,100	755,480	75,620	90.9
Visayas Total	**4,076,309**	**3,767,391**	**308,918**	**92.4**
ARMM	514,592	199,373	315,219	38.7
CARAGA	607,700	570,025	37,675	93.8
IX	655,300	476,510	178,790	72.7
X	1,039,243	837,560	201,683	80.6
XI	1,076,655	771,250	305,405	71.6
XII	947,816	649,234	298,582	68.5
Mindanao Total	**4,841,306**	**3,503,952**	**1,337,354**	**72.4**
Philippines	**22,721,430**	**20,360,334**	**2,361,096**	**89.6**

ARMM = Autonomous Region of Muslim Mindanao, CARAGA = Caraga Administrative Region, HH = household, NCR = National Capital Region, NIR = Negros Island Region.
Source: DOE (2017).

This report deliberates on the roles and possibilities expected of biomass–coal combustion to accelerate the smooth implementation of rural electrification by AMS governments to immediately realise full electrification.

1.3. Commitment to climate change and environmental compliance

All AMSs had ratified the Paris Agreement and made voluntary commitments. Undoubtedly, it is important for them to develop power and further electrification while mitigating CO_2 emissions to the extent possible for both global and local communities. Their national target of climate change, electrification, renewables, and efficiency are indicated in Table 2.2.

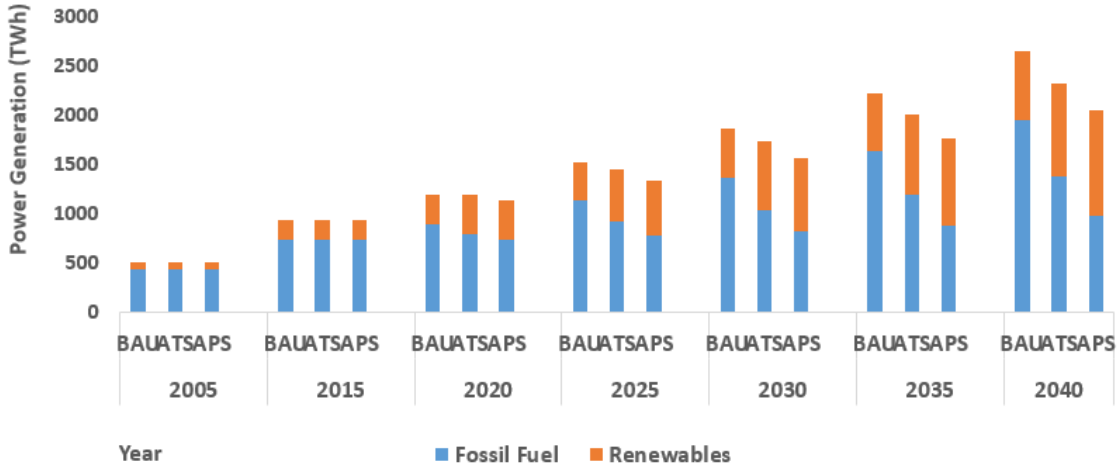
Table 2.2. National Energy and Climate Targets of ASEAN Member States

	Climate Change	Electrification	Renewables	Efficiency
Brunei	Reduce CO^2 emissions from morning peak-hour vehicle use by 40% from BAU level by 2035.		Increase share of new and renewable energy in generation mix to 10% in 2035.	Reduce total energy consumption by 63% from BAU levels by 2035.
Cambodia	Reduce GHG emissions by 27% from baseline emissions by 2030 with international support.	Universal electrification for all villages by 2020 and 70% electrification for households by 2030.	Increase share of new and renewable energy in generation mix to 25% in 2035	
Indonesia	Reduce GHG emission 29% from BAU and 41% with international support by 2030.	Achieve electrification ratio of 99.7% by 2025.	Increase share of new and renewable energy in primary energy supply to reach 23% by 2025 and 31% by 2050.	Reduce energy intensity by 1% per year to 2025.
Lao PDR		Achieve electrification rate of 98% by 2025.	Achieve 30% share of renewables in primary energy supply by 2025.	Reduce final energy consumption from BAU level by 10%.
Malaysia	Reduce GHG intensity of GDP by 35% by 2030 from 2005 level, increase to 45%reduction with enhanced international support.		Increase share of new and renewable energy in generation mix to 9% in 2020, 20% in 2030.	Promote energy efficiency in the industry, buildings and domestic sectors with methods of standard setting, labelling, energy audits and building design.
Myanmar		Achieve total electrification rate of 100% by 2030.	Increase share of new and renewable energy in generation mix to 15% in 2020.	Reduce primary energy demand by 8% by 2030 from 2035 level.
Philippines	Reduce GHG emissions by 70% from BAU level by 2030 with the condition of international support.	Achieve 100% electrification by 2022.	Increase of new and renewable energy in generation mix to 35% in 2030.	Reduce 40% energy intensity by 2030 from 2010 level. Decrease energy consumption by 1.6% per year against baseline forecasts by 2030.
Singapore	Reduce GHG emissions by 16% below BAU level by 2020, stabilize emissions with the aim of peaking around 2030.		Increase share of new and renewable energy in generation mix to 8%.	Improve energy intensity by 36% by 2030 from 2010 level.
Thailand	Reduce GHG emissions by 20% from BAU level by 2030, increase to 25% with enhanced interntional support.		Increase share of new and renewable energy in generation mix to 20.11%, and share of renewables in transport fuel consumption to 25.04% by 2036.	Reduce energy intensity by 30% by 2036 from 2010 level.

BAU = Business-As-Usual Scenario, CO_2 = carbon dioxide, GDP = gross domestic product, GHG = greenhouse gas.
Source: The Study Team, based on SEO 2017 and ASEAN Action Plan for Energy Cooperation 2016–2025.

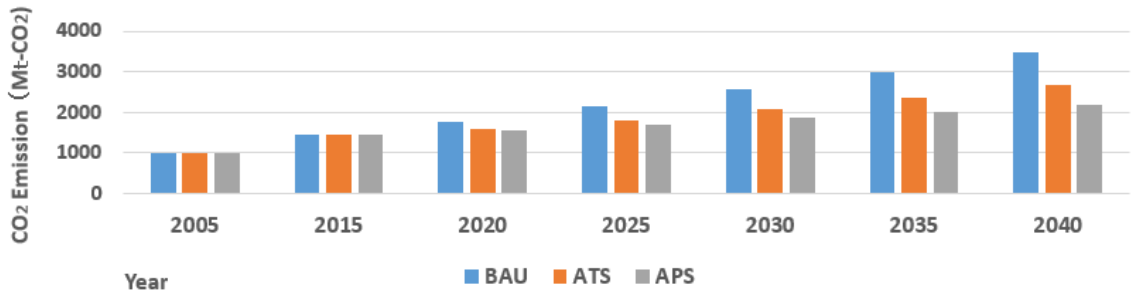
The 5th ASEAN Energy Outlook clearly shows how the AMSs have been firmly addressing the issue of CO_2 emissions in the power sector (Figure 2.7). ATS stands for data of the AMS Targets Scenario, while APS stands for data of the ASEAN Progressive Scenario. From 2005 to 2015, CO_2 emissions clearly did not increase as much as power generated in the same period. From 2015 to 2040, CO_2 emissions are predicted to be 2.4 times, while in the APS it will be 1.5 times only.

Figure 2.6. Growth of Power Generation in ASEAN



APS = ASEAN Progressive Scenario, ATS = AMS Targets Scenario, BAU = Business-as-Usual Scenario.
Source: ACE (2015).

Figure 2.7. CO_2 Emissions in ASEAN



ATS = AMS Targets Scenario, APS = ASEAN Progressive Scenario, BAU = Business-as-Usual Scenario.
Source: ACE (2015).

It is worthy to note that between 2005 and 2015, regardless of the scenario, the increased volume of CO_2 emissions is kept lower against the power generation growth, which has been realised through the efforts of the AMSs to improve efficiency.

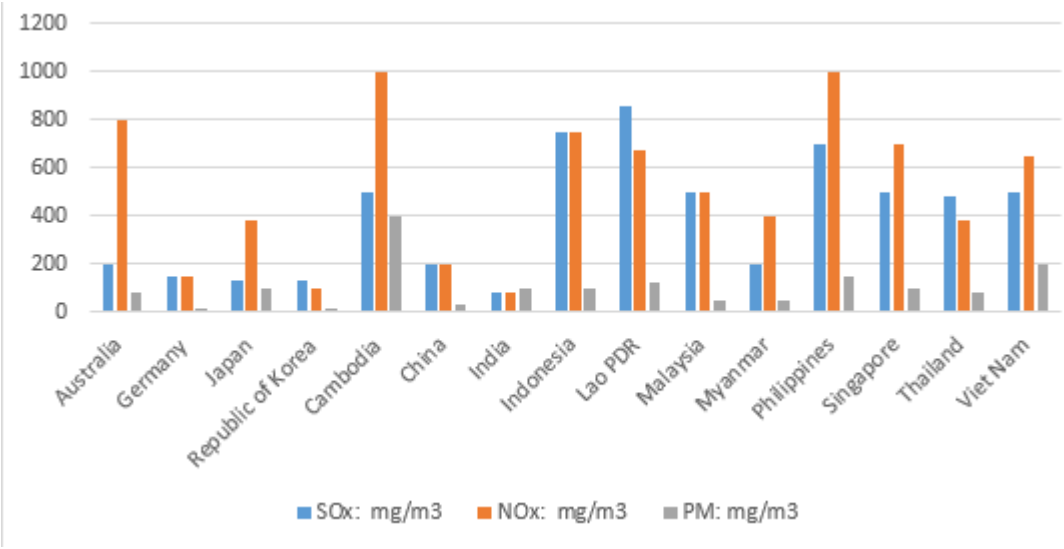
Issue of environmental compliance and public acceptance

When considering the global environment, it is important to reduce and control CO_2 emissions. However, on regional and living environments, other pollutants that affect the local and living environments such as sulphur oxide (SOx), nitrogen oxide (NOx), dust, etc. should be considered and significantly improved.

For this reason, environmental regulations in each country are gradually tightened. Figure 2.1-8 shows the environmental regulation values of recent coal-fired power plants in major countries. In Germany, Japan, and South Korea, each environmental regulation value is as low as 100–150 mg/m^3 for SOx, 50–200 mg/m^3 for NOx, and 10–100 mg/m^3 for vehicle dust. In China and India, environmental regulations have been greatly strengthened due to the

deterioration of the air quality for several years. Environmental efforts have been tightened with values of 100 mg/m^3 or less. On the other hand, in the ASEAN region, SOx is high at 200–850 mg/m^3, NOx at 380–1,000 mg/m^3, and medium dust at 80–400 mg/m^3.

Figure 2.8. Emission Standards for Newly Constructed Coal-fired Power Plants in Selected Countries (SOx, NOx, and PM)



NOx = nitrogen oxide, PM = particulate matter, SOx = sulphur oxide.
Source: *Myanmar Times* (2018).

In light of the above, promoting the policy improvement of the environment in the ASEAN region is deemed important.

It is technically possible to install and strengthen each countermeasure equipment for environmental improvement. However, increase in equipment costs leads to increased electricity prices. It is assumed that it will be difficult for countries and regions to respond and adopt this measure. Therefore, depending on the fuel used, a more optimal measure is desired.

Currently, the distribution of electricity is essential in improving the quality of life and the living standards of people. Achieving universal access to electricity is one important policy issue for ASEAN countries to continue to steadily grow even for those that still have non-electrified areas. Since coal is widely distributed worldwide, a stable and relatively inexpensive supply is possible. We have clearly stated that we will continue to use clean coal to generate power. ASEAN countries continue to use coal for their development, notwithstanding the adverse international public opinion on coal-fired power over global warming issues by environmental groups concerned about air pollution in each country/region. To do so, it is important that coal-fired plants are highly accepted publicly.

Specifically, while responding logically to the various criticisms mentioned above, environment-friendly technologies are being developed for coal-fired power plants already in operation and for those to be developed in the future. It is necessary to introduce

environment-friendly technologies.

In the past, environmental measures for coal-fired power plants in the ASEAN region were limited to the installation of dust collectors, which led to opposition to construct coal-fired power plants. However, in recent years, in addition to the improvement in the performance of dust collectors, the technological development of SOx and NOx measures have progressed, leading to significant environmental improvements.

Since the volume of emitted air pollutants change depending on the fuel, fuel pre-treatment may help save an excessive increase in environmental protection costs.

While the main thing is that the envisaged coal is practically available, it is also important to pay extra care to the amount of ash, flammability, ash properties, and water content by which unnecessary introduction of excessive equipment would be avoided. Thus, the introduction of biomass co-combustion is expected to provide appreciable advantages in terms of saving fuel and improving environmental compliance as well as enhancing public acceptance.

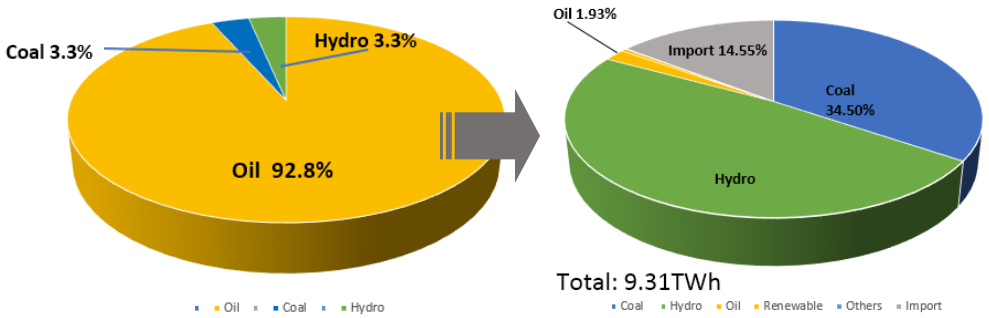
2. National Energy and Power Situation in ASEAN

2.1. Energy policy and generation mix of the AMSs

Cambodia

As of now, the major generation sources are hydro and coal. Generation mix in 2010 shows how the country was ever dependent on oil when it accounted for over 90% of the generation mix. It is admirable that the government has initiated diversification of generation sources, so the generation mix has been drastically changed to have two sources as the backbone of power generation (Figure 2.9).

Figure 2.9. Generation Mix of Cambodia, 2010 and 2015



Source: EAC (2018).

According to the transition of power generation from 2007 to 2017, power generation increased at 17.3% annually. If it increases at this ratio, power generation will be 23,774 GWh in 2025, 3.6 times of 6,634 GWh in 2017. Table 3 shows the construction plan for coal-fired power plants. Power generation from coal-fired power plants is planned to be expanded to 700 MW by the Sihanoukville Cambodia International Investment Development Group (CIIDG), which is currently at 405 MW. An additional 295 MW capacity will be constructed.

The Cambodia Energy Limited (CEL) is planning a 135 MW CEL Ⅱ in Sihanoukville in addition to the current 100 MW, totalling 235 MW. Toshiba already signed an EPC contract for CEL Ⅱ, whose scheduled commercial operation date is in late 2019 (Table 2.3).

Table 2.3. Construction Plan of Coal-fired Power Plants

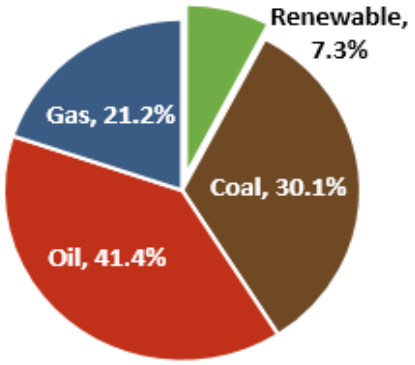
	Name of Power Plant	Condition	Capacity (MW)
Coal	Sihanoukville CIIDG Power Station (Phase 1)	Existing	405
	Sihanoukville CIIDG Power Station (Phase 2)	Expand	700
	Sihanoukville CEL Power Station	Existing (CEL)	100
		Expand (CEL Ⅱ)	135

CEL = Cambodia Energy Limited, CIIDG = Cambodia International Investment Development Group.
Source: EAC (2018).

Indonesia

Having been successful in getting out of oil dependency during the fuel crisis in the early 2000s, Indonesia remains highly dependent on fossil fuel. More than 90% of national energy consumption is sourced from fossil fuels – oil, gas, and coal – while fossil fuel reserves are declining gradually.

Figure 2.10. Primary Energy Mix of Indonesia, 2017

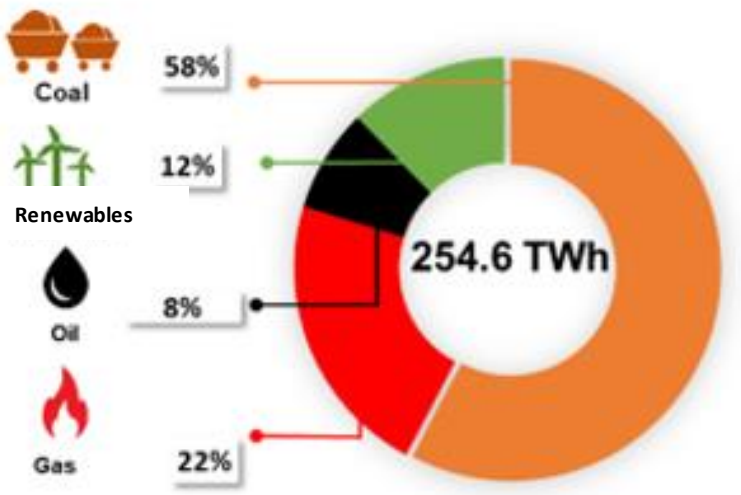


Source: MEMR (2018).

The government is now trying to ensure energy diversification by developing new and renewable energy, including bioenergy, waste-to-energy, etc.[2]

[2] According to presentations during the working group meeting, the total capacity of bioenergy power plants had reached 1,858.5 MW as of 2018. The government identified 12 waste-to-energy project sites with expected generated amount to be 207–242 MW.

Figure 2.11. Generation Mix of Indonesia, 2017



Source: MEMR (2018).

That said, coal remains the backbone of Indonesia's national electricity mix. The power generation in 2027 will be 501,917 GWh, which is about 2.5 times of the present capacity. The ratio of coal is 293,902 GWh, accounting for 59% of the total generation. In addition, the total capacity of power generation facilities to be built between 2018 and 2027 is 56 GW. Coal power is 27 GW, which is 48% of the total power capacity (Tables 2.4 and 2.5).

Table 2.4. Power Generation Plan of Indonesia, 2018–2027 (GWh)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Coal	169,632	176,517	194,250	220,081	234,455	248,560	264,618	236,841	264,429	293,902
Gas (LNG, etc.)	57,049	68,137	76,069	73,548	80,047	83,660	85,745	96,548	98,120	103,476
Geothermal	14,700	16,532	17,471	19,299	22,382	23,666	26,179	50,782	50,006	49,201
Hydro	18,944	17,594	18,051	19,784	20,028	23,749	27,967	43,135	44,385	46,700
Oil/diesel	11,634	11,429	7,053	3,639	1,679	1,713	1,834	1,826	1,893	2,007
Other renewables	419	2,494	2,906	3,180	3,204	3,260	3,545	6,319	6,591	6,631
Import	1,433	1,559	907	612						
Total	**273,811**	**294,262**	**316,707**	**340,143**	**361,795**	**384,608**	**409,888**	**435,451**	**465,424**	**501,917**

LNG = liquefied natural gas.
Source: PLN (2018).

Table 2.5. Power Plant Construction Plan, 2018–2027 (GW)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	合計
Coal	1,066	1,701	5,800	4,300	4,573	2,978	3,140	775	2,175	300	26,808
Geothermal	210	150	221	235	405	445	355	2,537	20	5	4,583
Gas	1,050	2,358	1,639	1,315	910	1,330	680	100	680	375	10,437
Gas engine	990	964	641	273	320	371	133	103	23	15	3,833
Diesel	30	5	0	0	0	0	0	0	0	0	35
Micro Hydro	109	203	365	103	31	0	0	0	0	0	811
Hydro	66	287	193	755	315	196	115	2,041	0	64	4,032
Solar	0	0	0	0	0	0	520	2,420	0	500	3,440
Others	128	160	261	335	245	240	309	300	0	70	2,048
Total	**3,649**	**5,828**	**9,120**	**7,316**	**6,799**	**5,560**	**5,252**	**8,276**	**2,898**	**1,329**	**56,027**

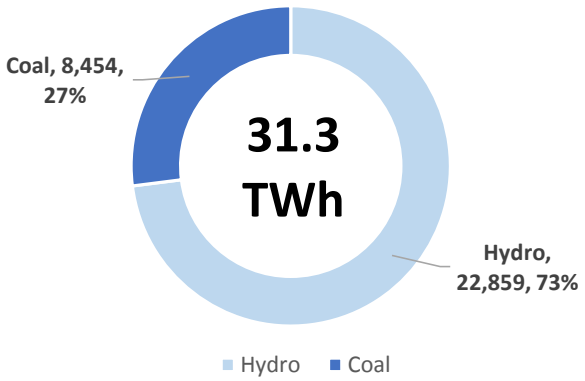
Source: PLN (2018).

Lao PDR

The Lao PDR has large hydropower potential varying from 18,000 MW to 26,000 MW, of which only 18% had been developed as of 2015.

The country has been engaging in electricity export for decades, as it is one of the major sources of state revenue. Total installed capacity is 6,308 MW, of which 2,100 MW is for domestic supply. In view of the supply situation and the relatively well-developed transmission lines, it looks as if the Lao PDR has no issues about national power supply. However, the country is not always a power exporter. The Electricité Du Laos (EDL), the national power company, indicates that it exports during the rainy season and imports during the dry season as most of its generation sources are run-off-river type hydro. The EDL considers diversifying its generation sources to others, including thermal power, to address the issue and ensure sustainable power supply. The policy direction might be the right choice for the government in light of the demand that is growing by 14% every year (EDL, 2017).

Figure 2.12. Power Generation Capacity and Power Generation of the Lao PDR, 2017



Source: EDL (2017).

Figure 2.12 shows that hydropower and coal will remain as the two pillars of power generation in the Lao PDR. The hydropower-installed capacity in 2030 is expected to be 17,486 MW, three times that of 2017. In the meantime, by the expansion of the current mine mouth Hongsa Power Plant and the other two new coal power plants, coal power–installed capacity will increase to 3,378 MW in 2025 – 1.8 times compared to that in 2017 – though the ratio of coal in the electricity mix will go down from 27% in 2017 to 15% in 2035.

Table 2.6. Future Power Generation Plan (MW）

	2017	2020	2025	2030
Coal	1,878	1,878	3,378	3,378
Hydro	5,172	8,735	13,580	17,486
Others	26	70	725	1,031
Total	7,076	10,683	17,683	21,895

Source: EDL (2017).

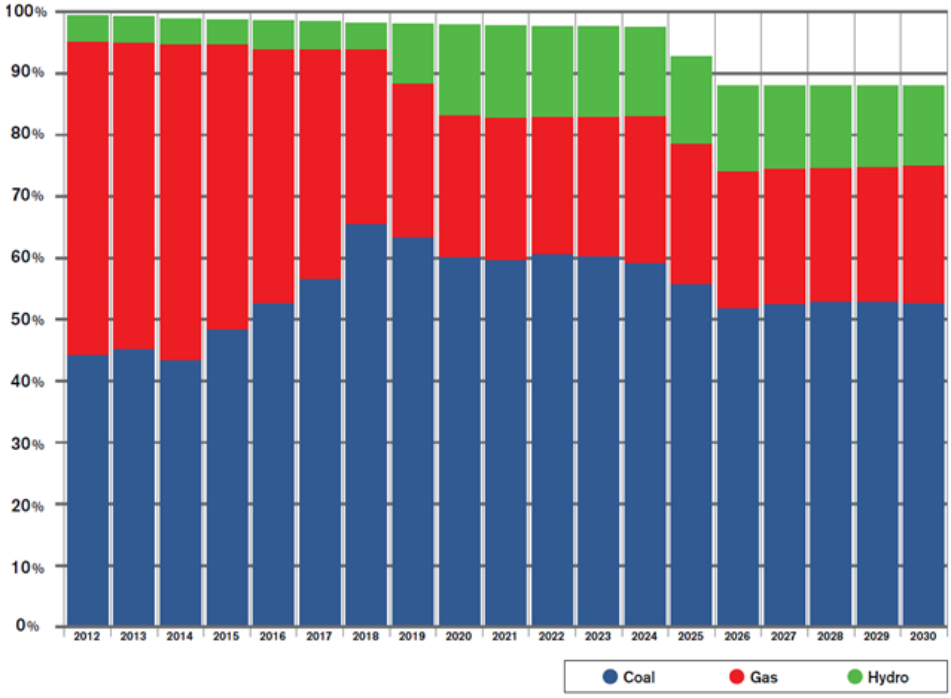
Malaysia

After the Asian financial crisis of 1997–1998, Malaysia's economy has been growing at an average of 5.4% since 2010. The country is expected to achieve its transition from an upper middle–income economy to a high-income economy by 2030 (Ministry of Economic Affairs, 2018).

As of now, about 56% of Malaysia's fuel mix is coal due to its price advantage and its ability to provide a balanced fuel mix in the system. Now the government is considering reducing dependence on fossil fuel, especially coal, and increase renewable energy instead. The target share of renewables in the national generation mix is 9% in 2020, 20% in 2030, which was revised after the new government came to power. The current share of renewable is 1%, but the government and other relevant institutions are ready to work on the plan to achieve the challenging target.

While Malaysia is keen to aggressively enhance renewable energy in its national energy mix, the government sticks to the balance of generation mix in view of the limited reliability of renewables in terms of supply stability, this being essentially intermittent.

Figure 2.13. Peninsular Malaysia and Sabah's Projected Generation Mix (%)



Source: Energy Commission (2017).

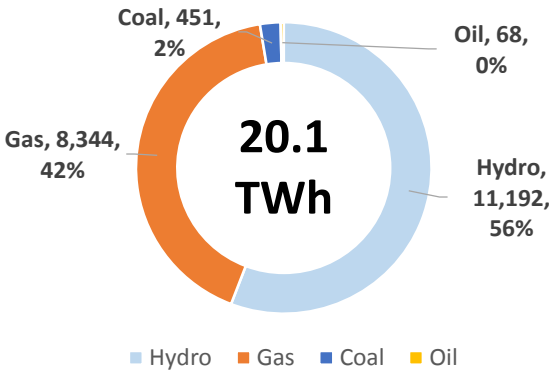
Myanmar

Having undergone political reforms in 2011–2015 followed by the transfer to the democratic government, Myanmar is naturally the least electrified and consumes the least of all AMSs. Myanmar stood at the beginning stages of a market economy only in 2014. Electricity consumption has increased rapidly since 2013 at an annual average growth rate of 15.8%.

In 2015, the National Energy Management Committee of the Government of Myanmar announced the Myanmar Energy Master Plan[3] to address all national energy issues including realisation of the universal access to electricity by 2030. Before the masterplan, the National Energy Policy was formulated in 2014. The policy indicates the national plan for coal-fired power plants with a total capacity of 2,785 MW to fulfil the surging demand. So far, Myanmar has an aged coal-fired power plant, Tigyit, at a rather inconvenient location; the plant is quite far from any of the seaport. Other plants are all small scale at 50–150 MW. Myanmar did not see much progress in new coal-fired power development since 2014 due to the anti-coal sentiment and campaigns in the country.

[3] The masterplan was financed under the Japan Fund for Poverty Reduction and administered by the Asian Development Bank.

Figure 2.14. Power Generation Capacity and Power Generation of Myanmar, 2018



Source: MOEE (Myanmar) (2019).

Philippines

Power generation output increased by 21.1% from 82.4 TWh in 2015 to 99.8 TWh in 2018. Being sourced from coal is 52.1% of the country's electricity, followed by gas (21.4%), and renewables (14.0%) (Figure 2.15).

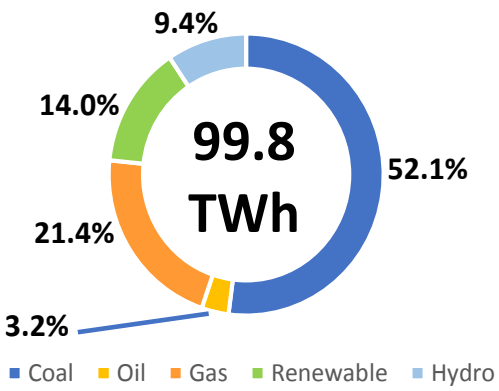
The future power demand in the Philippines is predicted to be 16,323 MW in 2020; 28,158 MW in 2030; and 49,287 MW in 2040. It will increase 1.3 times, 2.3 times, and 4.0 times, respectively, compared to 2015. However, it had already increased by 22,730 MW in 2017, and it would be 2.2 times in 2040 (Table 2.7, Figure 2.15).

Table 2.7. Prediction of Future Power Demand (MW)

	2015	2019	2020	2025	2030	2035	2040
Luzon	8,928	10,895	11,451	14,501	18,432	23,457	29,852
Visayas	1,768	2,298	2,465	3,427	4,765	6,624	9,210
Mindanao	1,517	2,229	2,407	3,456	4,961	7,122	10,225
Total	**12,213**	**15,422**	**16,323**	**21,384**	**28,158**	**37,203**	**49,287**

Source: Department of Energy (2016).

Figure 2.15. Generation Mix of the Philippines, 2018

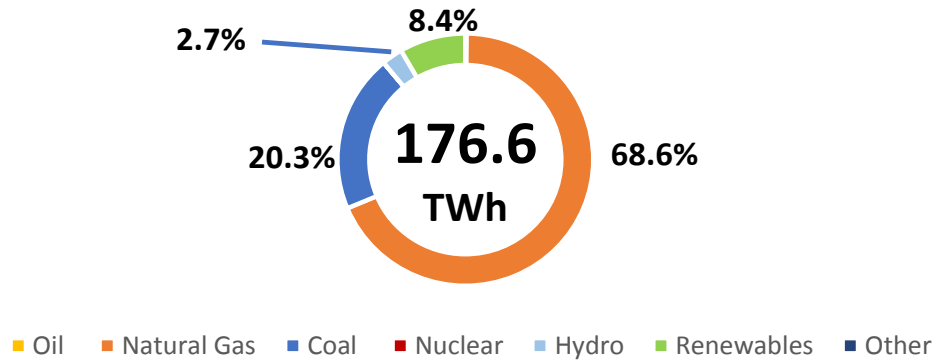


Source: Department of Energy (2018).

Thailand

Figure 2.16 shows the current generation mix of Thailand.

Figure 2.16. Generation Mix of Thailand, 2017



Source: BP (2018).

In January 2019, the Government of Thailand announced the revised Power Development Plan (PDP) 2018–2037. This clearly reflected a policy revision, if not a change of direction, in the then-forthcoming national power development planning and implementation reflecting Thailand's renewable energy policy, the Alternative Energy Development Plan 2018.

Table 2.8 compares the previous 2015 PDP and the amended PDP.

Table 2.8. Comparison of 2015 PDP and 2019 Amended PDP

Type of energy source	2036 Targets (%) under 2015 PDP	2037 Targets (%) under 2019 Amended PDP
Natural Gas	37	53
Coal	23	12
Hydropower from neighbouring country	15	9
Alternative Energy	20	20
Nuclear	5	-
Others	0.1	0.06
Energy efficiency	0	6

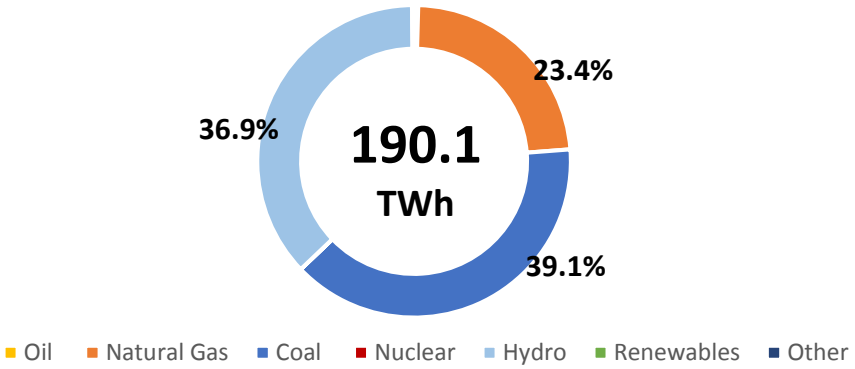
PDP = power development plan.
Source: EGAT (2015, 2019).

Having once shifted to increase coal-fired power generation in its generation mix to pull out from excessive dependency on gas, Thailand is now shifting again its policy direction to restructure its electricity mix by making an impressive 'comeback' to gas (from 37% to 53%). Coal's share has been reduced to 12% from 23%, and even hydropower will decrease to 9% from 15%.

The total installed capacity is 46,090 MW as of December 2017. The planned addition is 56,431 MW, while the capacity to be retired is 25,310 MW. The total installed capacity at the end of 2037 is expected to be 77,211 MW.[4] Renewable energy is projected to reach 28,004 MW in terms of installed capacity. Biomass is forecasted to account for 17% (4,690 MW) of all renewable installed capacity in 2037.

Viet Nam

Figure 2.17. Generation Mix of Viet Nam, 2017



Source: BP (2018).

The power generation plan is contained in the PDP. The power plan up to 2030 was published in the revised version of PDP 7 (2011–2020) on 18 March 2016. The revised version sets the annual economic growth rate at 7%. Power generation in 2030 is 572,000 GWh, 3.2 times that of the present. Coal accounts for 53% (Table 2.9).

Table 2.9. Future Power Generation Plan of Viet Nam

Power generation capacity (MW)

	2020	2025	2030	
Coal	25,620	47,575	55,167	43%
Hydro	18,060	20,458	21,886	17%
Gas	8,940	15,054	19,037	15%
Renewables	5,940	12,063	27,195	21%
Nuclear	0	0	4,662	4%
Import	1,440	1,351	1,554	1%
Total	**60,000**	**96,500**	**129,500**	**100%**

Power generation (GWh)

	2020	2025	2030	
Coal	130,645	2,200,000	304,304	53%
Hydro	66,780	696,000	70,928	12%
Gas	43,990	764,000	96,096	17%
Renewables	17,225	276,000	61,204	11%
Nuclear	0	0	32,604	6%
Import	6,360	64,000	6,864	1%
Total	**265,000**	**4,000,000**	**572,000**	**100%**

Source: Office of the Prime Minister, Viet Nam (2016).

[4]http://gizenergy.org.vn/media/app/media/PDF-Docs/Legal-Documents/PDP%207%20revised%20Decision%20428-QD-TTg%20dated%2018%20March%202016-ENG.pdf#search=%27Vietnam+428%2FQDTTg%27

2.2. Coal resources, production, utilisation, and plans for power plants

Cambodia

Coal resources and reserves

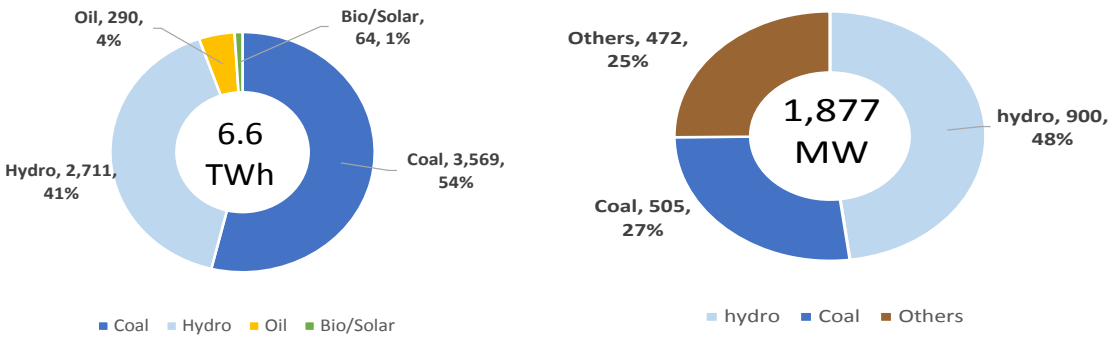
Cambodia coal was discovered in Otdar Meanchery province, Stung Treng province in the north, and in Kampong Thom province, the Kratie province in the central area, and Battambang province in the west area. In addition, although the presence of coal has been confirmed in Kompot province in the south and in Kaoh Kong province in the southeast, coal exploration in Cambodia has only begun, and data on coal resources is not enough. The coal reserves of Stung Treng province and Otdar Meanchery province total 18 million tons and 5 million tons, respectively (official figure is only 23 million tons). The underground coal mine of Yun Khean Minerals located in Anlong Veng of Otdar Meanchery province was developed with the support of China, but its operation is currently suspended.

Current situation of the power sector

- Corporate structure of the power business
  The electricity business in Cambodia is governed by the Ministry of Mines and Energy (MME). The electricity supply is implemented by the Electricité Du Cambodge (EDC), which is the state-owned Cambodia Electric Power Corporation and is the distributor and producer of electricity in Cambodia. The EDC supplies its own power and purchased power from the independent power producers (IPPs) in the metropolitan areas and major regional cities. Outside of the EDC electricity supply area, rural electricity enterprises and public electricity utilities, which are provincial electricity companies, are supplying electricity. The IPPs began to operate in 1997.

- Power generation capacity
  Power generation capacity in Cambodia in 2017 was 1,877 MW, consisting of 48% hydropower and 27% coal. The power generation in 2017 was 6,634 GWh, consisting of 54% coal, 41% hydropower, 4% oil, and 1% biomass-solar. The business model was 98% IPP, 1% EDC, and 1% others. The operating ratio of hydropower decreased during the dry season; coal had a small installed electricity capacity but the amount of power generation was large. Domestic power generation alone could not support domestic demand; therefore, 1,439 GWh of power was imported from neighbouring countries in 2017. Cambodia imported electricity mainly from Viet Nam (76%), Thailand (20%), and the Lao PDR (4%). Domestic consumption amounted to 8,073 GWh in 2017 (Figure 2.18).

Figure 2.18. Power Generation Capacity and Power Generation of Cambodia, 2017



Source：EAC (2017).

Current situation of coal-fired power plants

Two coal-fired power plants are currently operating in Cambodia. Both are located in Sihanoukville province southwest of Cambodia. Coal is imported from Indonesia. Cambodia uses coal, 2 million tons of which are imported annually with the quality of 5,800 Kcal/kg as calorific value, 5% ash content, and 20% total moisture. The details are as follows:

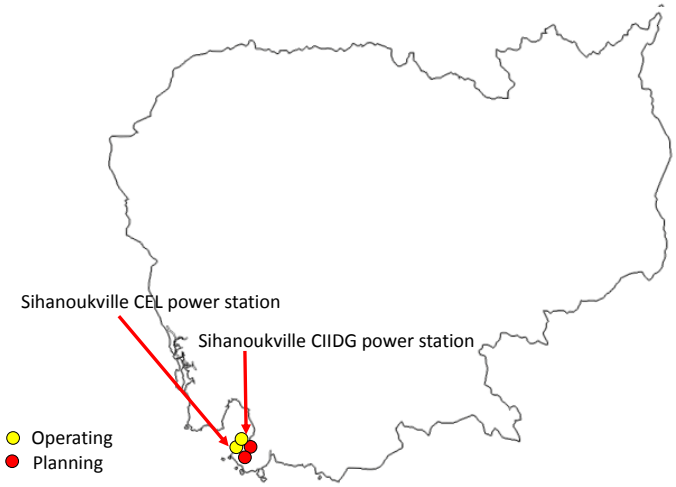
- Sihanoukville CIIDG power station

  This power plant is an IPP power plant operated by the Cambodia International Investment Development Group (CIIDG) with the support of Chinese companies. Power capacity installed was 135 MW in 2014, 135 MW in 2015, and 135 MW in 2017. Total power capacity was 405 MW.

- Sihanoukville CEL power station

  It is the first coal-fired power plant in Cambodia with 100 MW. It is an IPP power plant currently operated by the Malaysian-owned Cambodia Energy Limited (CEL). The owner is a Malaysian company Leader Universal Holdings Bhd It is called CEL.

Figure 2.19. Operating and Planning Coal-fired Power Plants in Cambodia



Source: Created by the Authors from the data of the Ministry of Mine and Energy.

Indonesia

Coal resources and reserves

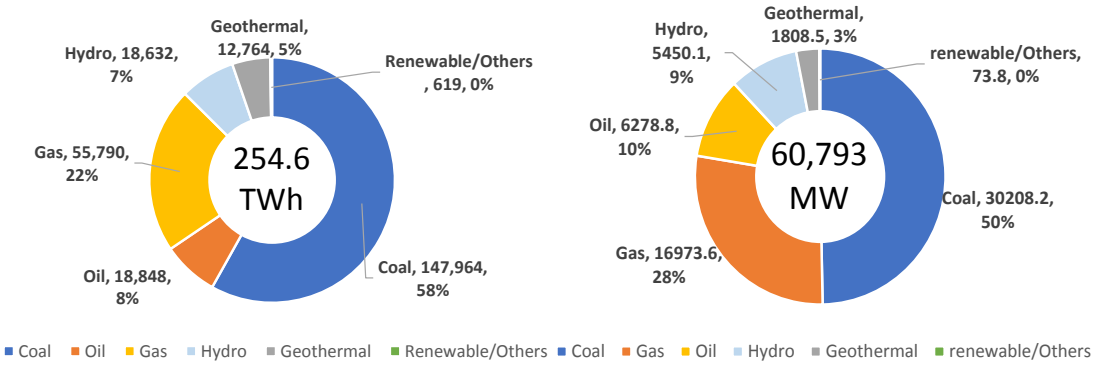
Indonesia is one of the world's leading coal-producing and coal-exporting countries. Coal is mainly distributed in Sumatra Island and Kalimantan Island. Coal resources total 125,177 million tons and reserves are 24,239 million tons. Coal production was 461 million tons, domestic consumption was 97 million tons, and 364 million tons of coal were exported in 2017.

Current situation of the power sector

- Corporate structure of the power business
  The electricity business is governed by the Directorate General of Electricity, Ministry of Energy and Mineral Resources. Electricity supply is managed and distributed by the state-owned power company PLN (Perusahaan Listrik Negara), which is also the power generator. It also manages the transmission to the gird. Among the PLN subsidiaries, PT. Indonesia Power and PT. Pembangkitan Jawa-Bali have power plants and are operating the power business under the PLN. In addition, many IPP power plants have been built, and the PLN purchases power from these power plants.

- Power generation capacity and power generation
  Power generation capacity of Indonesia in 2017 was 60,793 MW, consisting of 50% coal, 28% gas, 10% oil, 9% hydropower, 3% geothermal, and 0.1% renewables/Others. The power generated in 2017 was 254,617 GWh, consisting of 58% coal, 22% gas, 8% oil, 7% hydropower, 5% geothermal, and 0.02% renewables/Others. Coal has more than half of the total power generation facilities and power generation (Figure 2.20).

Figure 2.20. Power Generation Capacity and Power Generation of Indonesia, 2017

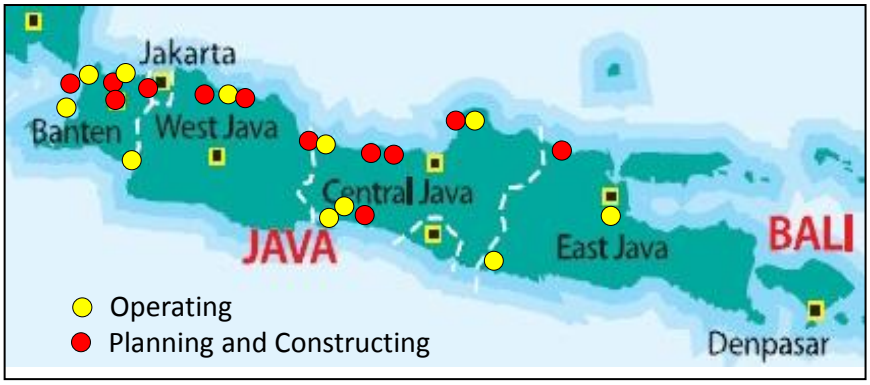


Source: MEMR (2018).

Current situation of coal-fired power plants

Many large coal-fired power plants are being built on Java Island. Coal is transported from Sumatra and Kalimantan by barges and coal vessels to power generation companies. A mine mouth coal-fired power plant is being constructed next to the coal mines in Sumatra and Kalimantan. A large-scale coal-fired power plant will be constructed in Java in the future (Figure 2.21).

Figure 2.21. Operation, Planning, and Construction of Coal-fired Power Plants in Java Island



Source: Created by the Authors from PLN (2018).

Lao PDR

Coal resources and reserves

The Lao PDR is a coal-producing country whose yearly production reaches about 800,000 tons (excluding lignite in the mine mouth power plant). The coal field is divided into the northern and southern areas. The northern area has the same layer as tertiary brown coal in Thailand. The southern area is lined with Viet Nam's anthracite coal. The coal reserve is 739 million tons, 90% of which is lignite and subbituminous coal, and anthracite is only 10%. The excavated coal is partially exported to Thailand. About 15 million tons of coal is excavated annually from the lignite coal mine located next to the Hongsa Power Plant, which was built near the Thailand border in northern Lao PDR. Thus, coal production in the country is 15.8 million tons. Coal production and consumption are almost the same.

Current situation of the power sector

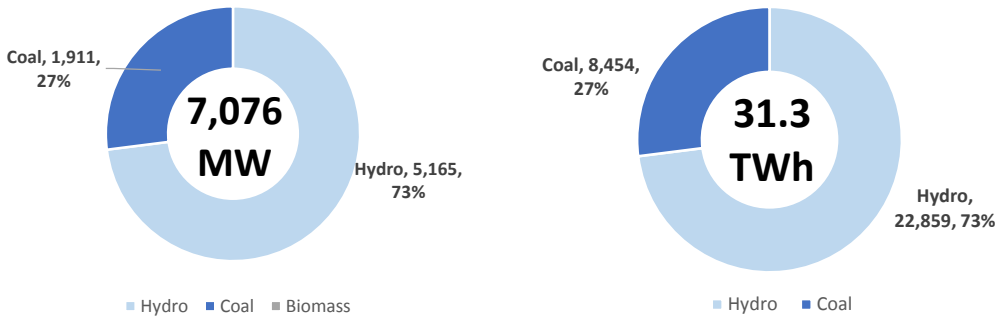
a) Corporate structure of the power business

The electricity business in the Lao PDR is governed by the Ministry of Energy and Mines. Electricity supply is managed by the state-owned company, Électricité du Laos (EDL) or the Laos Electric Power Company, which is a100% state-owned enterprise. The EDL manages the domestic supply of electricity and imports and exports work from neighbouring countries. The EDL also participates in the IPP business. In 2010, EDL separated the power generation business and established the EDL Generation Public Company (EDL-Gen), 25% of whose shares were released to the private sector (75% owned by the EDL). After that, the power generation facilities in operation were transferred from the EDL to EDL-Gen sequentially including the IPP business.

b) Power generation capacity and power generation

The power generation capacity of the Lao PDR in 2017 was 7,076 MW, consisting of 73% hydropower and 27% coal. The business form was IPP for overseas, 67%; IPP for domestic, 21%; EGL-Gen, 9%; and EDL, 3%. Power generation in 2017 was 31,315 GWh, 16% of which was used domestically, while the remaining 84% was exported to neighbouring countries.

Figure 2.22. Power Generation Capacity and Power Generation of the Lao PDR, 2017

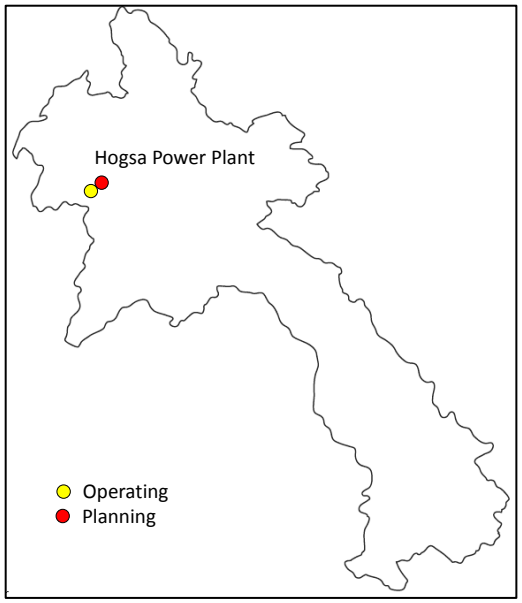


Source: EDL (2017).

Current situation of the coal-fired power plant

The Hongsa coal-fired power plant, which was built in Xaignabouri province in northern Lao PDR, is a mine mouth power plant using lignite from nearby areas. Investors are RATCH (40%), a Thai power generation company; Banpu (40%), a Thai mining company); and the Lao government (20%). The first unit (with output of 626 MW) started in June 2015, the second unit (with 626 MW output) started in November 2015, the third unit (with 626 MW output) started in March 2016, and current total capacity is 1,878 MW in operation. The amount of lignite used annually is 14.3 million tons.

Figure 2.23. Operating and Planning Coal-fired Power Plants in the Lao PDR



Source: Created by the Authors based on the data of the Ministry of Energy and Mines.

Malaysia

Coal resources and reserves

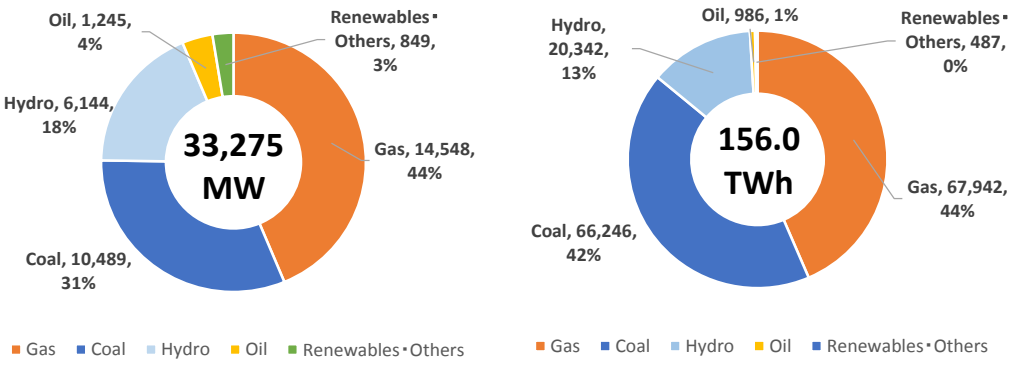
Coal resources in Malaysia total 1.8 billion tons, mainly distributed in Kalimantan Island, 1.5 billion tons in Sarawak province, and 300 million tons in Sabah province in Kalimantan Island. Yet, there is almost no coal in the Malay Peninsula. Coal is produced only in Kalimantan Island. In 2016, coal produced was 2.41 million tons.

Current situation of the power sector

- Corporate structure of the power business
  The electricity business in Malaysia is regulated by the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC). The electricity business itself has already been privatised. Power supply in the Malay Peninsula is managed by the Tenaga Nasional Berhad (TNB) or Tenaga National. The power supply in Sabah is managed by the Sabah Electricity Sdn. Bhd., and the power supply in Sarawak is controlled by the Sarawak Energy Bhd. Besides these companies, some private companies and IPPs generate power.

- Power generation capacity and power generation
  The power generation capacity of Malaysia in 2017 was 33,275 MW, consisting of 44% gas, 31% coal, 18% hydropower, 4% oil, 3% renewables/Others. The power generation in 2016 was 156,003 GWh, consisting of 44% gas, 42% coal, 13% hydropower, 1% petroleum, and 1% renewables/Others.

Figure 2.24. Power Generation Capacity and Power Generation of Malaysia, 2017

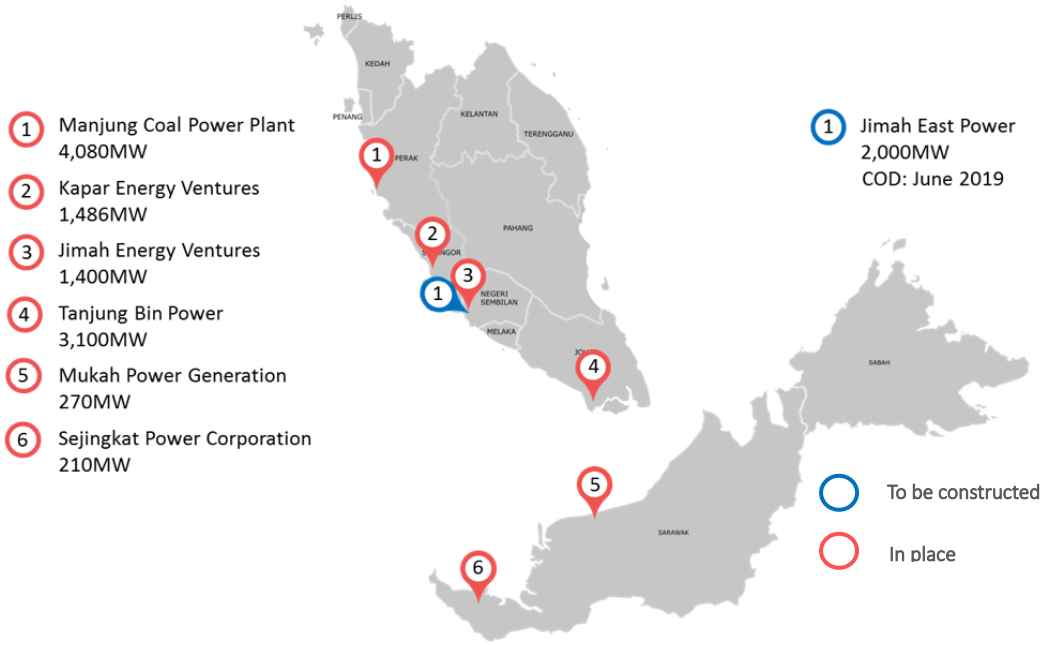


Source: MESTECC (2018).

Current situation of coal-fired power plants

Coal-fired power plants in Malaysia operate in the Malay Peninsula and Sarawak province in Kalimantan Island. One coal-fired power plant is currently under construction in the Malay Peninsula.

Figure 2.25. Coal-fired Power Plants in Operation/Under Construction/Being Planned in Malaysia



Source: Energy Commission (2019).

Myanmar

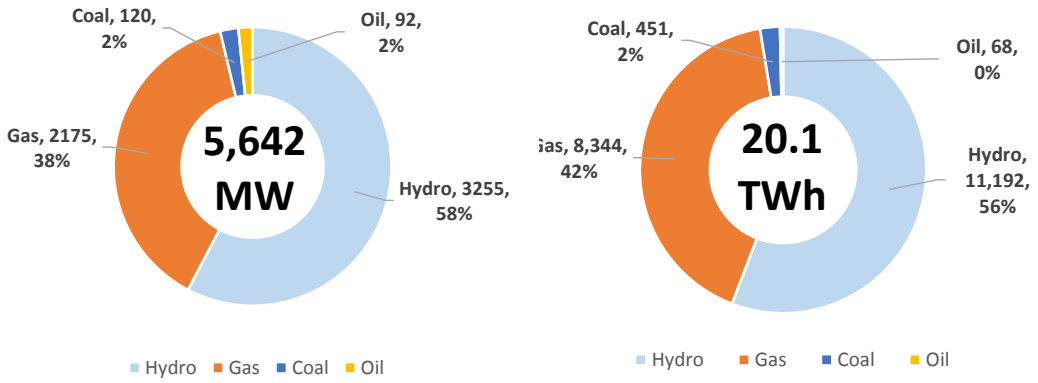
Coal resources and reserves

Coal resources in Myanmar total 711 million tons, and the indicated coal reserves of the major 34 coal deposits which are distributed throughout the country total 543 million tons. Coal production recorded over 1 million tons in fiscal year 2005–2007. However, since fiscal year 2008 onwards, production has been stagnant staying around 500,000 tons. The underground mining method is carried out in Kareva and some other areas. The production from underground mining is about 20% of the total coal output of Myanmar.

Current situation of the power sector

- Corporate structure of the power business
  The electricity business in Myanmar is governed by the Ministry of Electricity and Energy (MOEE), which was formed in April 2016 by merging the then Ministry of Electricity and the then Ministry of Energy. The electricity business itself is under the responsibility of the Electric Power Generation Enterprise. The distribution and retail business are managed by the Yangon Electric Supply Corporation, Mandalay Electric Supply Corporation, and Electric Supply Enterprise which are under the MOEE.
- Power generation capacity and power generation
  The installed capacity of Myanmar in March 2018 was 5,642 MW, consisting of 58% hydropower, 38% gas, 2% coal, and 2% oil. Power generation in the same period was 20,054 GWh, consisting of 56% hydropower, 42% gas, 2% coal, and 0% oil. At present, the main sources are hydropower and gas, and only 2% coal-fired power plants (Figure 2.26).

Figure 2.26. Power Generation Capacity and Power Generation of Myanmar, 2018

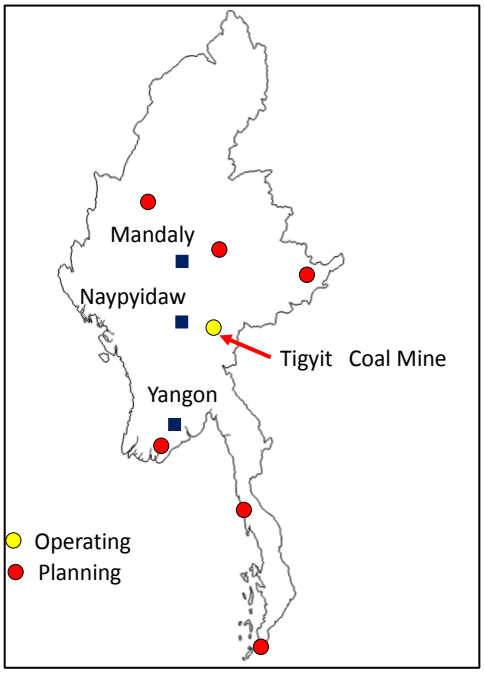


Source: MOEE, Myanmar (2018).

Current situation of the coal-fired power plant

At present, the Tigyit coal-fired power plant is the only one operating in Myanmar. The power plant was built with the support of China. The two 60 MW units installed have a total capacity of 120 MW. Coal is supplied by the coal mine located next to the power plant. Coal consumption is designed to be 320,000 tons annually, but the total coal consumption is 640,000 tons annually. Coal operation rate is low due to some malfunction in the power plant operation. Therefore, coal consumption has not reached the desired quantity. The operation of the power plant, currently under a Chinese company, is promoting the environmental equipment. Desulphurisation and denitrification equipment were installed. Figure 2.27 shows the results of environmental monitoring of the residents surrounding the power plant.

Figure 2.27. Operating and Planned Coal-fired Power Plants in Myanmar



Source: Created by the Authors based on data of MOEE Myanmar (2018).

Philippines

Coal resources and reserves

The Philippines is divided into three major areas – Luzon, Visayas, and Mindanao – and coal is distributed in these three areas. Coal resources total 2,367 million tons, and recoverable reserve is 469 million tons (Department of Energy website). Coal production in 2018 was 13.05 million tons, 99.19% of which was produced from the Semirara coal mine in the Visayas Islands. Exported are 5.05 million tons of Semirara coal, which is 38.6% of the annual production of the company. Export destinations are China (98%), India (1%), and Thailand (1%). Domestic consumption is 30.83 million tons: 25.13 million tons of which are imported, while 5.7 million tons of domestic coal are used (Department of Energy website).[5]

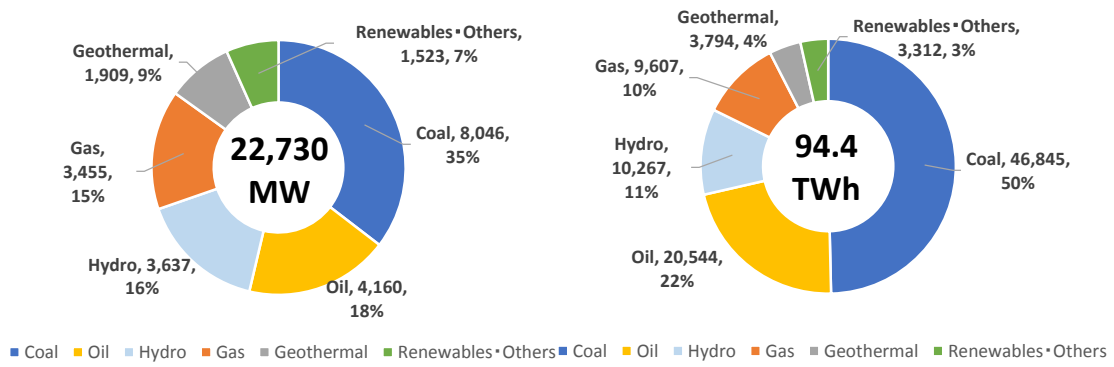
Current situation of the power sector

- Corporate structure of the power business
  The electricity business in the Philippines is regulated by the Department of Energy (DOE). Electricity in the Philippines was initially supplied by the National Power Corporation (NPC), the nationally owned power company; now power supply is mainly undertaken by the IPPs. With the enforcement of the Electric Power Industry Reform Act of 2001, the NPC has been selling power generation assets to the IPPs, and the NPC is shrinking annually. There are 20 private electric power companies such as the Manila Electric Company (MERALCO), Visayan Electric Company, Davao Light and Power Company, Inc.; 119 electric cooperatives; and 8 local government companies. MERALCO is the largest distribution company whose sales reach about 70% of the total power generation in Luzon.

- Power generation capacity and power generation
  The power generation capacity of the Philippines in 2018 was 23,815 MW, consisting of 37.1% coal, 18% oil, 15.5% hydro, 14.5% gas, 8.2% geothermal, and 6.7% renewables/Others. Power generation in 2018 was 99.765 GWh, consisting of 52.1% coal, 21.4% gas, 10.5% geothermal, 9.4% hydropower, 3.2% petroleum, and 3.6% renewables/Others. Oil and water utilisation rates are low, and coal accounts for half of all power generation (Figure 2.28).

[5] https://www.doe.gov.ph/energy-statistics?

Figure 2.28. Power Generation Capacity and Power Generation of the Philippines, 2017

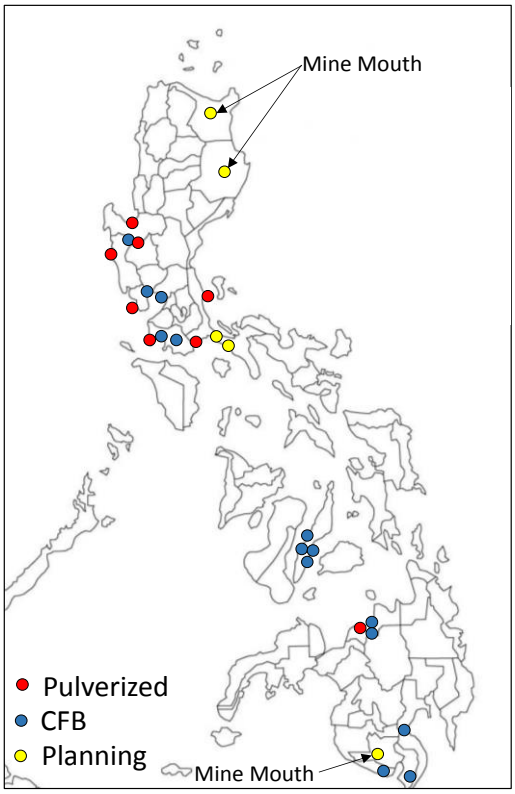


Source: Department of Energy website, https://www.doe.gov.ph/electric-power

Current situation of coal-fired power plants

The Philippines has many coal-fired power plants. The power plants are divided into pulverised coal boiler and CFB. There are many CFB boilers in Mindanao and the Visayas. Also, the coal-producing areas in Luzon and Mindanao have the potential for a mine mouth coal-fired power plant.

Figure 2.29. Operating and Planned Coal-fired Power Plants in the Philippines



CFB = circulating fluidised bed.
Source: DOE (2018).

Thailand

Coal resources and reserves

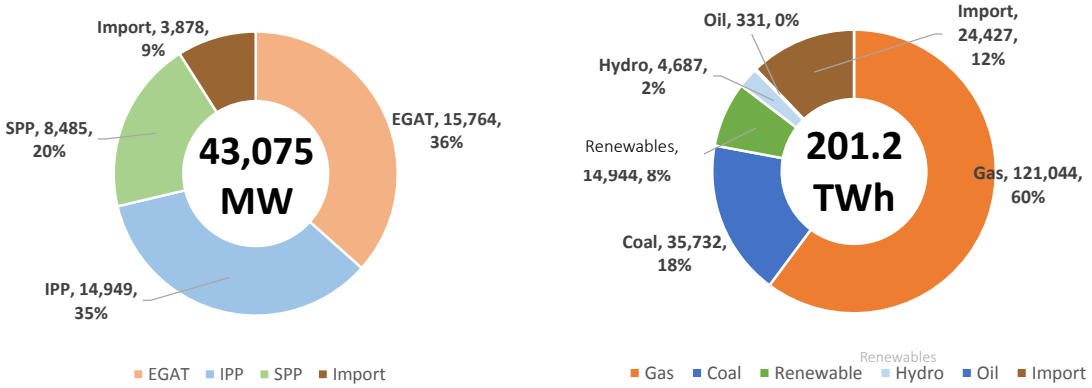
Coal resources in Thailand are distributed mainly in the northwestern area. The remaining reserves of coal in this area are estimated at 1.1 billion tons. The measured reserves and indicated reserves of coal in the undeveloped areas of the country are 785 million tons and 720 million tons, respectively, and the reserves of coal total 578 million tons. Coal produced in 2017 was 16.3 million tons, and 15.9 million tons (97%) of lignite were excavated from the Mae-Moh coal mine. Thailand imports 22.2 million tons of bituminous coal and sub-bituminous coal yearly. Coal consumption in Thailand was 38.5 million tons.

Current situation of the power sector

- Corporate structure of the power business
  The electricity business in Thailand is governed by the Ministry of Energy. The state-owned company EGAT engages in power supply from its own generation facilities and manages the entire national power supply including IPP generation and the power purchase from neighbouring countries. Power is supplied to the Metropolitan Electricity Authority and the Provincial Electricity Authority and large customers in Thailand. The IPPs started in 1992 as power producers; small power producers (SPPs) which supply less than 90 MW of electricity started in the same year.

- Power generation capacity and power generation
  The power generation capacity of Thailand in October 2018 was 43,075 MW, consisting of 36% EGAT, 35% IPP, 20% SPP, and 9% import (Figure 1.30). Power generation in 2017 was 20,165 GWh, consisting of 60% gas, 18% coal, and 2% hydropower. The 12% of the total electricity power is imported electricity.

Figure 2.30. Power Generation Capacity and Power Generation of Thailand, 2018

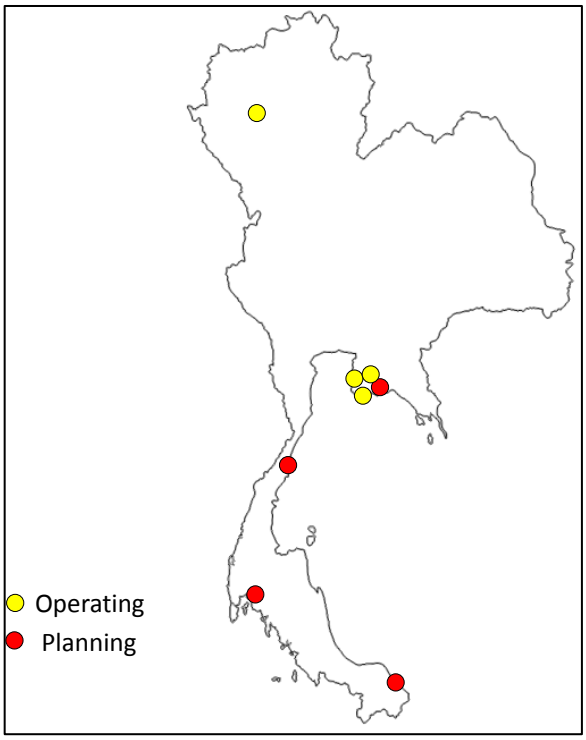


EGAT = Electricity Generation Authority of Thailand, IPP = independent power producer, SPP = small power producer.
Source: Ministry of Energy, Thailand (2015).

Current situation of the power sector

The largest coal-fired power plant in Thailand, the Mae-Moh coal-fired power plant, is located in the northern coal field of the country. The first unit was built in 1978; it has been expanded since. Currently, up to 13 units are in operation. Units 1 to 3 each have a capacity of 75 MW (total of 225 MW), Units 4 to 7 have 150 MW each (total of 600 MW), and Units 8 to 13 have 300 MW each (total of 1,800 MW). The total power generation capacity is 2,625 MW. However, since Units 1 to 3 have already been discontinued, the current installed capacity is only 2,400 MW. Coal supplied is 16 million tons yearly from the Mae-Moh coal mine next to the power plant. In addition, the IPP coal-fired power plant using imported coal operates at the coast of Thailand. Out of the 22 million tons of imported coal, 8 million tons are used for electricity.

Figure 2.31. Operating and Planned Coal-fired Power Plants in Thailand



Source: Created by the Authors from EGAT data.

Viet Nam

Coal resources and reserves

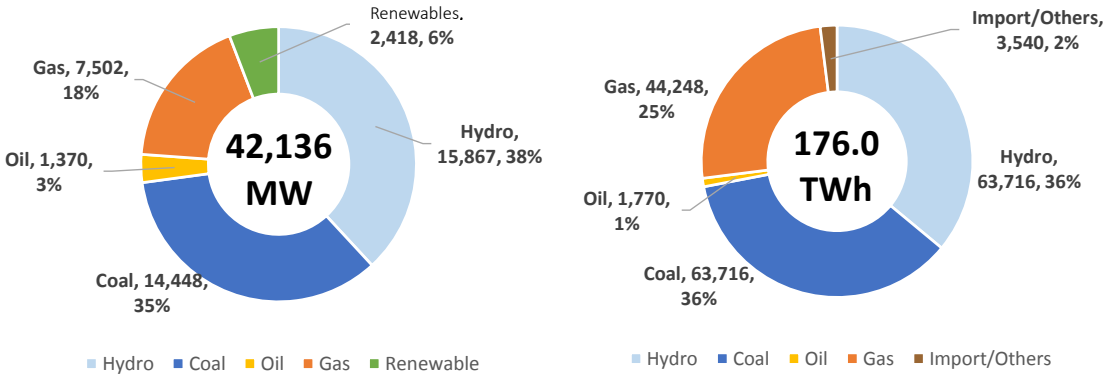
Viet Nam produces a significant amount of anthracite. The Quang Ninh area has 62.9 billion tons of coal resources and the Red River area, 42 billion tons. The coal reserve is estimated to be 3.1 billion tons. Coal produced in 2017 was 38.20 million tons (37.2 million tons of Vinacomin and 1 million tons of others) (General Statistics Office of Viet Nam, 2017). The domestic coal consumption in 2017 was over 50 million tons with 38.20 million tons of production, 2.2 million tons of export and 14.50 million tons of import.

Current situation of the power sector

- Corporate structure of the power business
  The electricity business in Viet Nam is governed by the Ministry of Industry and Trade (MOIT). The state-owned power company, Viet Nam Electricity (EVN), supplies electricity. The EVN owns and manages power generation companies, power supply control offices, power transmission companies, and power distribution companies. The power generation part of EVN was unbundled into three companies: GENCO 1, GENCO 2, and GENCO 3. The Institute of Energy under MOIT conducts energy policy and power development planning, and power investigation and research related to electricity.

- Power generation capacity
  Installed capacity of Viet Nam in 2016 was 42,136 MW, consisting of 38% hydropower, 35% coal, 18% gas, 3% oil, and 6% renewables/Others. Power generated in 2016 was 175,990 GWh, consisting of 36% hydropower, 36% coal, 25% gas, and 2% import/Others (Figure 2.32). Coal accounts over for 30% and is an important energy source.

Figure 2.32. Power Generation Capacity and Power Generation of Viet Nam, 2016

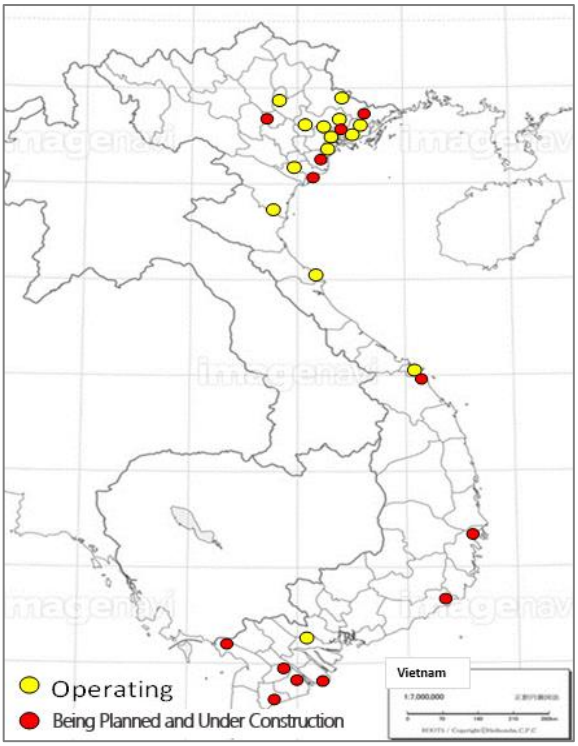


Source: Viet Nam Electricity (2017).

Current situation of the coal-fired power plant

The coal-fired power plants in Viet Nam are in the northern area where coal is produced. In the south, where the capital Ho Chi Minh City is located, coal-fired power plants are being constructed to prepare for the future increase of electricity demand and when imported coal from overseas is expected to be used (Figure 2.33).

Figure 2.33. Coal-fired Power Plants in Viet Nam: Operating, Being Planned and Under Construction



Source: Created by the Authors based on EVN (2017).

Coal demand and supply plan

The current coal consumption in Viet Nam is around 50 million tons, including domestic and imported coal. Said consumption is estimated to reach 86.1 million tons (electric power is 6,410 million tons, 74% of the total) in 2020, and 21.5 million tons (electric power is 96.5 million tons, 79% of the total) in 2025, and 158.6 million tons in 2030 (electric power 131.1 million tons, 82% of total). Domestic coal produced will be about 50 million tons, so the quantity of imported coal will increase. Imported coal is estimated at 40.3 million tons in 2020, 70.4 million tons in 2025, and 102.1 million tons in 2030. The coal ratio in the total electricity consumption will increase annually (Table 2.10).

Table 2.10. Coal Demand and Supply Plan

Coal demand (million tons)

	2020	2025	2030
Power	64.1	96.5	131.1
Fertiliser/chemical	5.0	5.0	5.0
Cement	6.2	6.7	6.9
Metallurgy	5.3	7.2	7.2
Others	5.8	6.1	6.4
Total	**86.4**	**121.5**	**156.6**

Production and import (million tons)

	2020	2025	2030
Demand	86.4	121.5	156.6
Production	46.1	51.1	54.5
Import	40.3	70.4	102.1

Source: EVN (2016).

All countries

Coal resources and reserves, production, export volume, etc.

Many countries in Southeast Asia are rich in coal resources. Indonesia, the Philippines, Malaysia, Myanmar, Thailand, Viet Nam, and the Lao PDR are using their coal to generate power. Thailand, Malaysia, the Philippines, and Viet Nam are importing coal from overseas to generate electricity in addition to their own coal. But Cambodia uses imported coal only. The total coal production in the eight countries is 547.34 Mt, consumption is 264.23 Mt, export is 372.13 Mt, and import is 90.57 Mt (Table 2.11).

Table 2.11. Coal Resources, Production and Consumption, and Export and Import (Mt)

	Coal Resources and Reserves, Mt	**Coal Production and Consumption (2017), Mt**	**Coal Export and Import (2017), Mt**
Indonesia	Coal Resources: 125,177 Coal Reserves: 24,239	Production: 461 Consumption: 97	Export: 364
Thailand	Coal Resources: 2,578	Production: 16.22 Consumption: 38.40	Import: 22.2
Viet Nam	Coal Resources: 48.800 Coal Reserves: 3.100	Production: 38.2 Consumption: 50.0	Export: 2.2 Import: 14.5
Malaysia	Coal Resources: 1.800 Coal Reserves: .500	Production: 2.41 Consumption: 31.0	Import: 28.54
Philippines	Coal Resources: 2,367 Coal Reserves: 478	Production: 13.14 Consumption: 29.32	Export: 5.93 Import: 23.33
Lao PDR	Coal Reserves: 739	Production: 15.8 Consumption: 15.8	
Myanmar	Coal Resources: 711 Coal Reserves: 543	Production: 0.57 Consumption: 0.71	
Cambodia	Coal Resources: 711 Coal Reserves: 543	Production: 0 Consumption: 2.0	Import: 2.0
Total		**Production: 547.34 Consumption: 264.23**	**Export: 372.13 Import: 90.57**

Source: Based on the respective governments' website.

2.3. Biomass resources

One major industry in ASEAN is agriculture. The agricultural products and the production volume in each country are different depending on the country's climate, etc. Table classifies these countries into two major groups according to relatively similar agricultural products. The first group comprises Indonesia, Malaysia, and Thailand, which are engaged in agricultural production with large plantations, such as palm. The second comprises the Philippines and others, which mainly produce rice.

In such situation, Indonesia and the Philippines are representative examples in the case studies of the next section.

Table 2.12. Agriculture Production in ASEAN, 2014

(million tons)

		Palm	Coconut	Cassava	Corn	Sugar Cane	Rice
Group 1	Indonesia	139.95	32.28	23.44	19.01	25.75	70.85
	Malaysia	95.38	0.60				1.83
	Thailand	12.43		30.02	4.80	103.70	32.62
Group 2	Philippines		14.70		7.77	28.00	18.97
	Cambodia			10.21	0.35	0.61	9.82
	Lao PDR			1.63	1.41	1.84	4.00
	Viet Nam			10.21	5.20	19.82	44.97
	Myanmar				1.69	11.13	26.42
	Total	258.90	47.48	72.82	41.59	192.26	216.25

Source: Food and Agriculture Organization (2016).

While Table 2.12 shows the yield of main agricultural products, Table 2.13 shows the amount of wastes generated yearly.

Table 2.13. Main Wastes of Agriculture Products

Biomass	Type of Waste	Biomass	Type of Waste
Palm (FFB)	Kernel shell (PKS) Fibre EFB (empty fruit bunch) Trunk POM effluent (liquid)	Corn	Cob
		Rice	Rice husk Rice straw
		Sugar cane	Bagasse
Coconut	Kernel shell Fibre	Rubber	Rubber wood small logs

Source: Authors.

Kernel shell (PKS) is used as a boiler fuel at palm oil mills. Because it has a low moisture content, relatively high calorific value, and low chlorine and potassium content, demand for PKS is increasing in Japan and South Korea. This biomass fuel is mixed with other types of fuel to reduce the CO_2 emissions from coal-fired power plants. Furthermore, large palm companies in Indonesia purchase PKS from other mills and use it as fuel in related facilities

other than palm oil mills. As a result, demand for PKS is increasing, thus intensifying the competition in the procurement market and making it difficult to obtain. The increased demand is also causing a rise in the price of PKS year after year. In Indonesia, PKS presently costs US$80–US$100 per ton. In such situation, PKS cannot be available for co-combustion fuel.

For rice husk, 30%–50% of the rice husk generated by milled rice is consumed for burning. A part of the remaining rice husk is used as cement raw material. In summary, 60% of the rice husk is available for co-combustion.

Other wastes are not used much. However, bagasse and cassava may be used as biofuel feedstock. In addition, fibres of coconut are used as fuel by farmers. Assuming that the availability of other wastes is about 80%, the amount available for biomass fuel will be 124 million tons (Table 2.14).

Table 2.14. Amount Available for Biomass Fuel in Waste of Agriculture Products

(million tons)

	Palm		Coconut		Cassava	Corn	Sugar Cane	Rice	
Main waste	PKS	EFB	KS	Fiber	Peel, Chop	Cob	Bagasse	Rice Husk	Total
Yield (%)	5	23	20	30	24	23	15	20	
Amount	12.95	59.55	9.50	14.24	17.48	9.57	28.84	43.25	195.36
Availability (%)	0	80	80	50	80	80	50	60	
Available for fuel	0.00	47.64	7.60	7.12	13.98	7.65	14.42	25.95	124.36

Source: Authors.

2. The Importance and Possibilities of Biomass and Coal Co-combustion

The advantages of biomass and coal co-combustion are summarised as follows:

(1) It helps mitigate CO_2 emissions.
(2) It reduces underutilised agricultural waste.
(3) It saves the amount of coal fuel so that it saves on generation cost.
(4) Intermittency of biomass supply is substituted by co-utilisation of coal.
(5) It creates more job opportunities since biomass use is labour intensive.

(1) Biomass use in the coal-fired power plant is to be applied as direct and effective mitigation measures of CO_2 in the power sector of the countries that use coal as the main energy source, such as the ASEAN region. CO_2 emission is reduced proportionally with an increased blend ratio of biomass with coal since biomass is recognised as a carbon-neutral substance.

(2) Although the imported woodchip is mainly used in the European Union and Japan as a biomass source, agricultural wastes – such as PKS, empty fruit bunch (EFB), sugar cane, rice hulk, and food waste – in the ASEAN region are thought to be potential sources of domestic energy. This also has the advantage of reducing underutilised waste. Biomass can be used in wider types of boilers such as CFB, small size pulverised boiler, and USC of larger capacity.

(3) The effectiveness of biomass as an alternative fuel in a coal-fired power plant does not only mitigate CO_2 emissions but also improve the plant operation cost if biomass is efficiently collected from the surrounding areas. One issue in utilising agricultural waste as biomass fuel is the seasonal volume which implies unstable supply.

(4) In this regard, co-firing with coal can compensate the total energy input to the plant by optimising the coal/biomass ratio.

(5) Biomass utilisation in coal-fired power plants might bring merit to regional employment by supplying biomass through the collection and selection process in the surrounding area.

In sum, expediting the co-firing of biomass and coal in a coal-fired power plant in the ASEAN region is deemed to be crucial in addressing both CO_2 mitigation and surging energy demand.