SCOPING PAPER

COAL-BASED THERMAL POWER IN SOUTHEAST ASIAN COUNTRIES

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SUMMARY

- In 2017–18, the total installed power capacity of Southeast Asian countries was 280 GW. Coal represents 75 GW, i.e., 25 per cent of it.
- Overall, Indonesia (65 GW), Thailand (50 GW) and Vietnam (48.8 GW) are the top three countries with respect to total installed electricity capacity. However, with respect to installed coal-based capacity, Indonesia (28.5 GW), Vietnam (19 GW) and Malaysia (10.5 GW) are the three top countries.
- The coal capacity is largely new, nearly 43 GW of it is less than a decade old, about 16 GW is between 10–20 years old and 16 GW is more than 20 years old.
- Coal capacity contributed around 40 per cent to power generation in Southeast Asian countries in 2018. As per projections, this scenario will continue till at least 2040.
- Currently, Southeast Asian countries have active plans for 92 GW of capacity; 28 GW of capacity is under construction, and 64 GW of capacity is in the pre-construction phase. Overall Vietnam, Indonesia and Philippines will contribute 90 per cent of the future coal capacity addition in Southeast Asia.
- Technology for new capacity: 5–10 GW will be subcritical, 30–40 GW will be supercritical, and the rest will be ultra-supercritical, and a miniscule portion will be IGCC.
- Among the countries that represent almost 90 per cent of coal capacity—Indonesia, Philippines, Vietnam and Malaysia—only Malaysia and Indonesia have acceptably stringent PM emission limits of 50 mg/Nm^3 and 100 mg/Nm^3 respectively.
- For sulphur dioxide, the emission limits are generally 500 mg/Nm^3 or above.
- NO_X emission limits are surprisingly lax. Norm limits are as high as 1,000 mg/Nm^3 in Philippines, while in other countries, they are 500 mg/Nm^3 or higher.
- Opposition to and public protests against coal power have taken place in Indonesia, Philippines, Myanmar, Thailand and Vietnam.
- A balanced approach needs to taken for energy security and tackling climate change.
- Along with focus on efficient and clean coal technology, thorough environment impact assessment of new coal capacity needs to be given importance.
- Focus should also shift onto cost-effective measures to improve efficiency of the existing fleet.
- Prudent use of old power stations will be crucial in reducing capital investment in new projects.

OVERVIEW

Southeast Asian countries have organized themselves into Association of Southeast Asian Nations (ASEAN). The association has 10 member states, i.e., Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam, with a total land area of about 4,485,000 km^2. In 2018, the combined population of these countries was about 650 million, and the total GDP was US $2.93 trillion. Per capita GDP was registered at about US $4,482 dollars.

Southeast Asia has emerged as the most important region for future growth in coal-fired power generation as both China and India are investing in renewable power and moving away from coal. But the future of coal is difficult to predict as coal installations are not meeting the targets in most countries, including in Southeast Asia, and governments seem to be considering cancellation of projects with decreasing cost of renewables and pressure from the civil society.

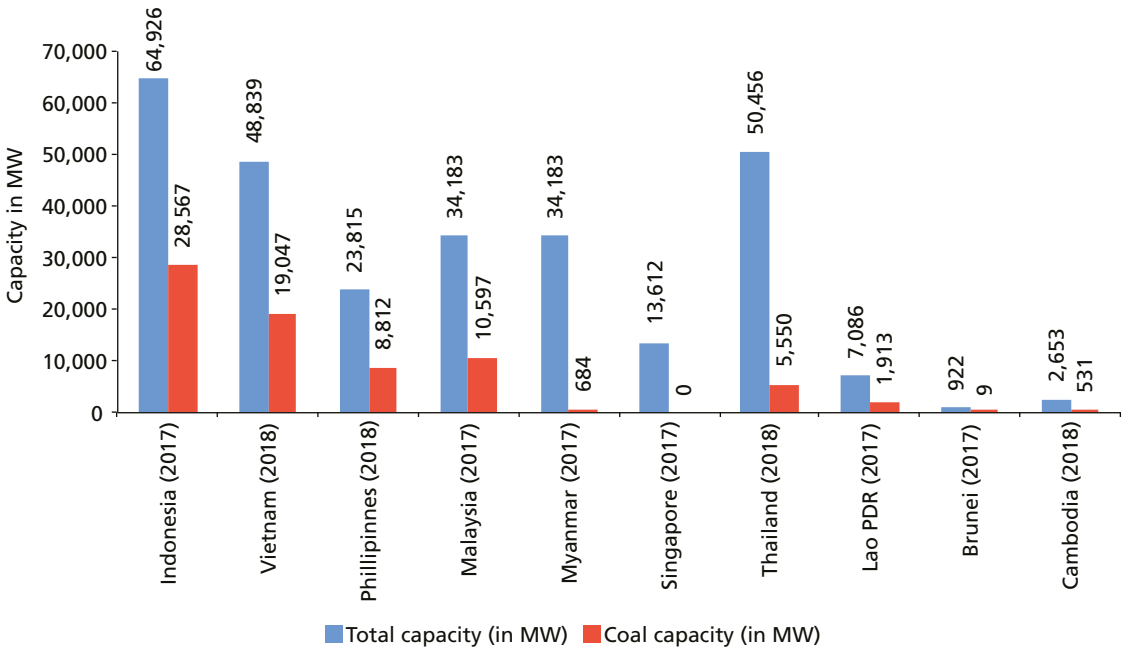
According to statistics of the International Energy Agency, 2018, the proportion of coal used in power generation in ASEAN has increased steadily; in 2016, the number in Malaysia, Vietnam and Indonesia increased by 27 percentage points, 22 percentage points and 8.2 percentage points respectively over the 2000 numbers. From 2000 to 2016, ASEAN's coal consumption increased by three times. In 2016, ASEAN's coal consumption totalled about 157.14 million tonnes of oil equivalent (Mtoe), accounting for 18 per cent of the total primary energy consumption, up by 10 percentage points from 2000. Coal-fired power generation is the main reason for the continued growth in ASEAN's coal consumption.

Overall, Indonesia (65 GW), Thailand (50 GW) and Vietnam (48.8 GW) are the top three countries with respect to total installed capacity. However, with respect to coal capacity Indonesia (28.5 GW), Vietnam (19 GW) and Malaysia (10.5 GW) are the three top countries. Indonesia, Vietnam, Malaysia and Philippines represent 90 per cent of coal capacity operating in Southeast Asia (see *Graph 2: Key coal capacity contributors in Southeast Asia*). Singapore has no coal capacity. Brunei, Cambodia and Laos have miniscule coal capacities.

According to statistics, 86 per cent of installed capacity of coal-fired power plants in ASEAN is subcritical, and 14 per cent is supercritical and above. The average thermal efficiency of power plants is about 33 per cent. Coal-fired power generation units in ASEAN countries generally have relatively small capacities, and fleet efficiency of coal-fired power plants is not very high. There is a huge potential for capacity increase and efficiency improvement.

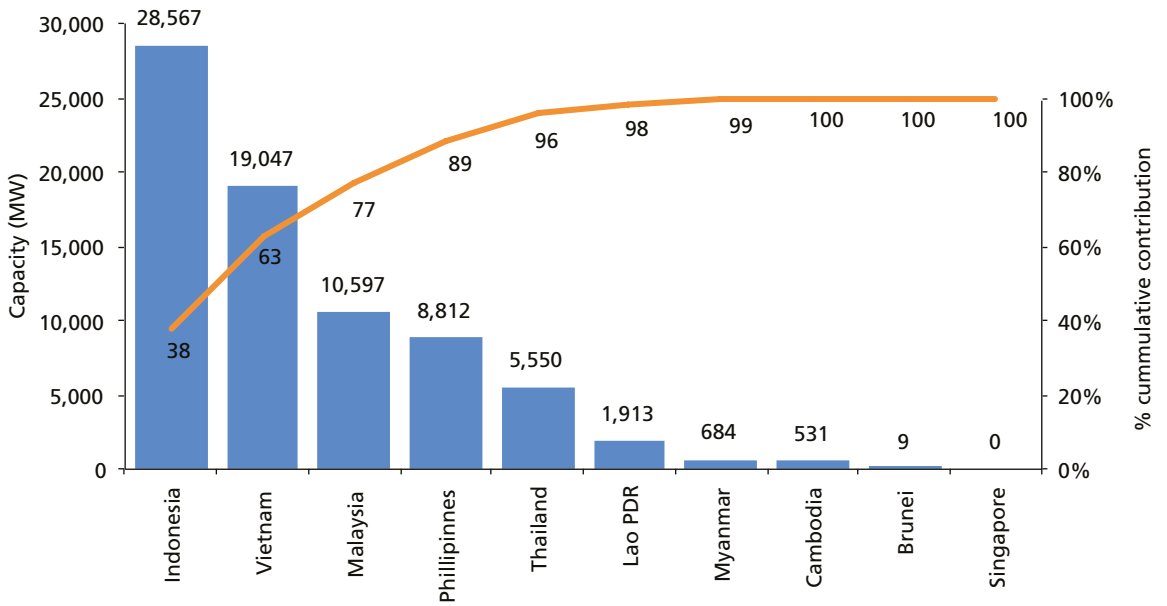
Coal electricity contributes above 50 per cent to the generation mix in Indonesia and Philippines, whereas in Cambodia, Malaysia and Vietnam it contributes over 40 per cent to the generation mix. These countries represent 90 per cent of the total installed coal capacity. Overall, coal capacity contributes over 40 per cent to the generation mix in Southeast Asia, and this scenario can be expected to last at least till 2040.

Graph 1: Total capacity and coal capacity in Southeast Asian countries*



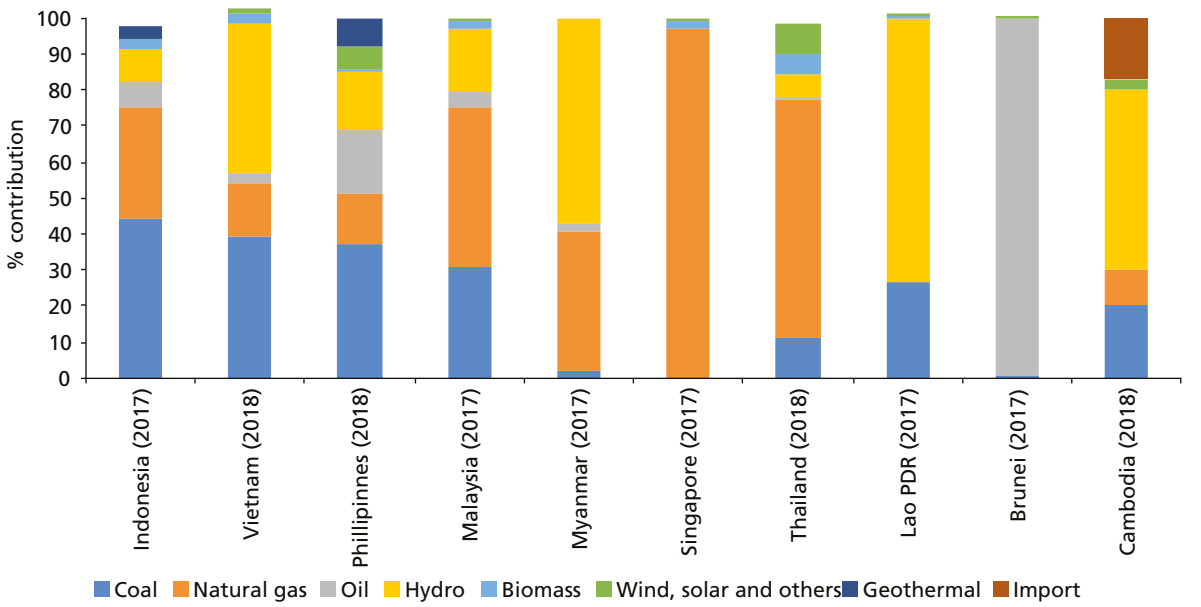
* 2017 and 2018 numbers
Source: ACE, 2018

Graph 2: Key coal capacity contributors in Southeast Asia



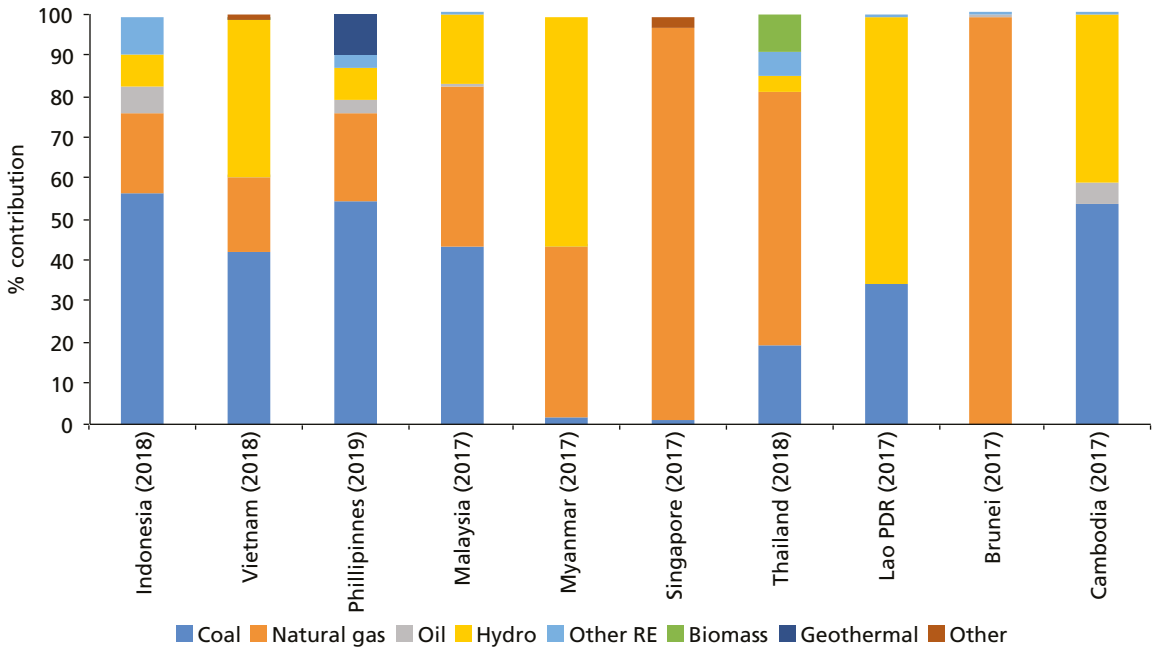
Source: CSE analysis

Graph 3: Contribution of various sources in installed power capacity



Source: CSE analysis

Graph 4: Contribution of various sources in electricity generation mix



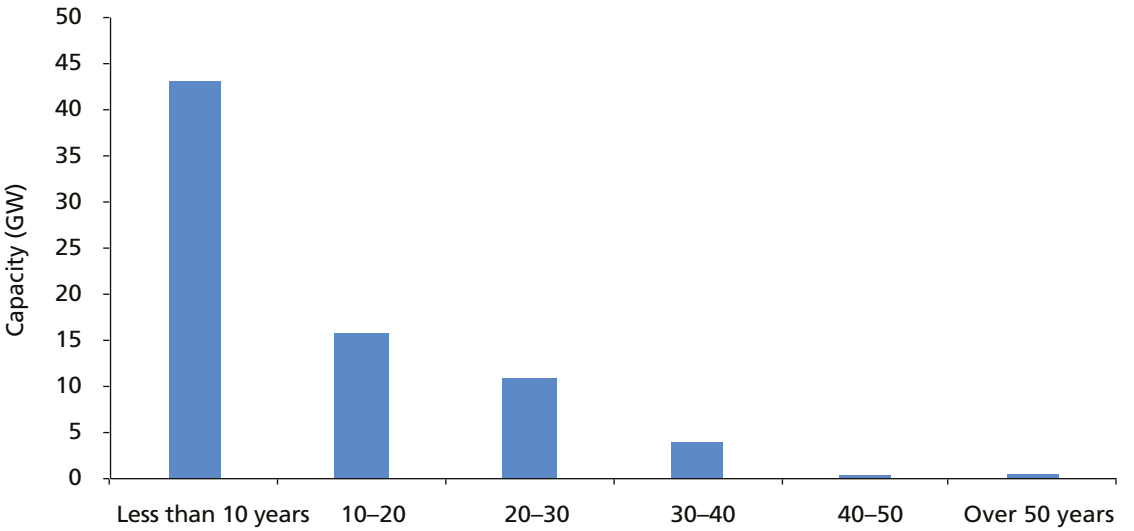
Source: CSE analysis

VINTAGE OF POWER PLANTS

The total power capacity of Southeast Asian countries is 280 GW, coal represents 75 GW (25 per cent) of it. The coal capacity is largely new, with around 43 per cent of it less than a decade old (see *Graph 5: Total capacity and coal capacity in Southeast Asian countries*).

Nearly 43 GW of the capacity is less than a decade old. About 16 GW of the capacity is between 10–20 years old, and 16 GW is more than 20 years old.

Graph 5: Total capacity and coal capacity in Southeast Asian countries

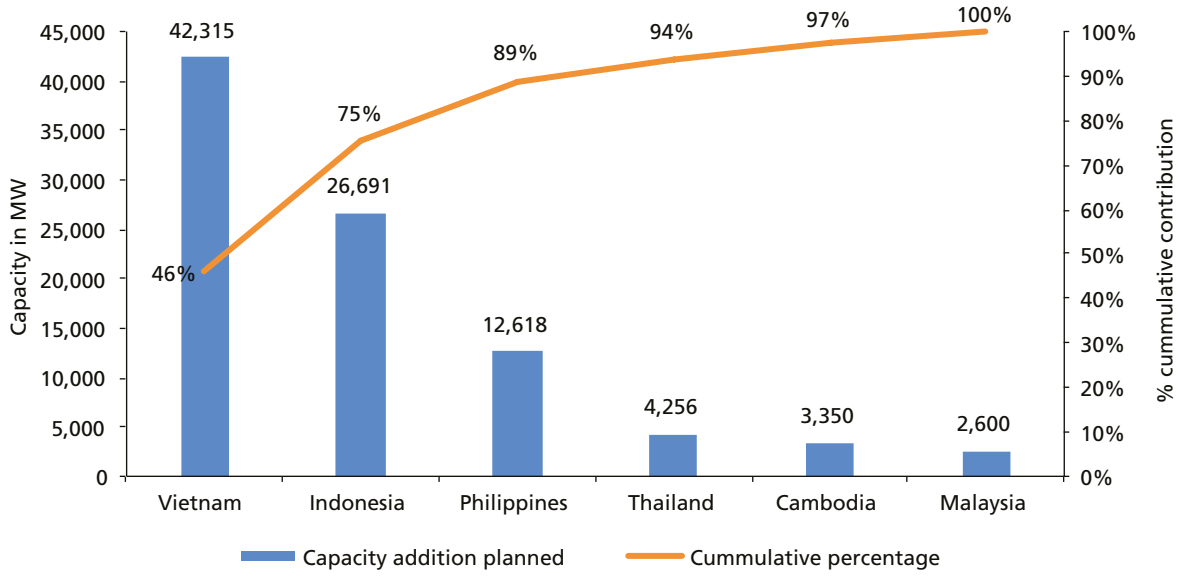


Source: IEA, 2018

PROJECTIONS REGARDING COAL-BASED CAPACITY

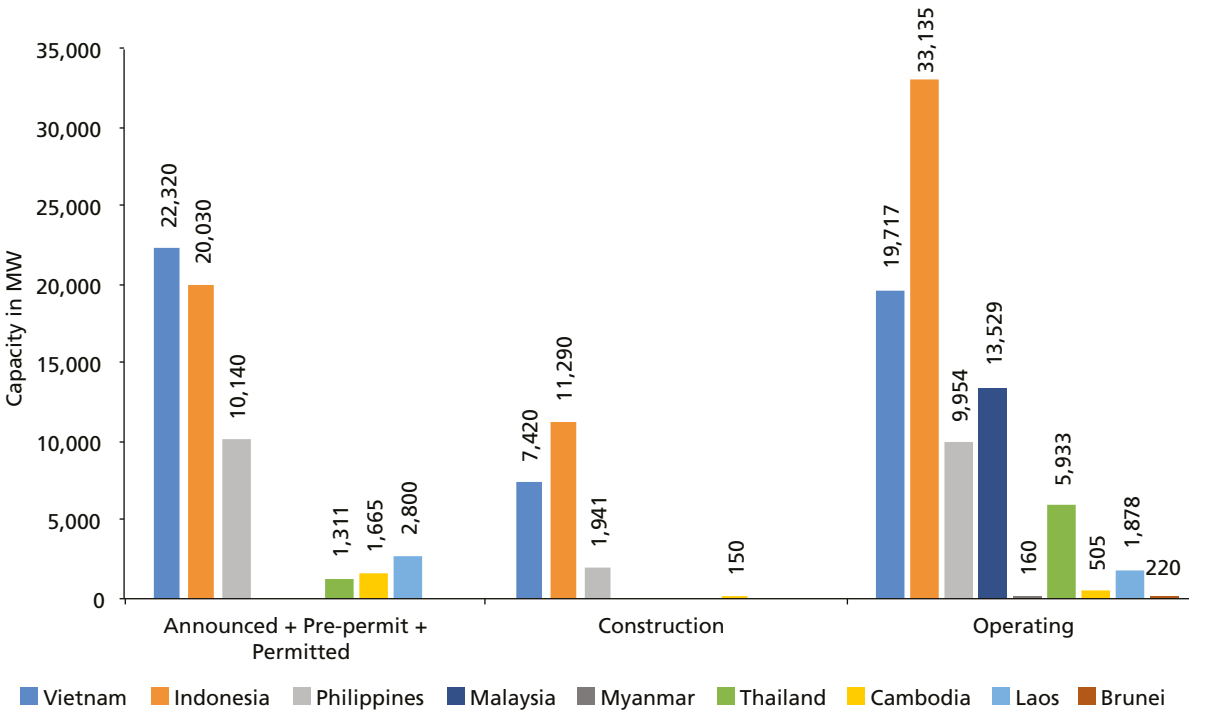
Southeast Asia had 74 GW of operating coal power capacity in 2018, and active plans for 92 GW of capacity. About 28 GW of capacity is under construction and 64 GW is in the pre-construction phase; 42 GW of capacity has been shelved (this may be resumed or abandoned). Unsurprisingly, coal power developments in Indonesia and Vietnam are substantial, which have 11 GW and 9 GW of capacity under construction respectively and about 15 GW and 32 GW respectively in the pre-construction phase. These two countries are followed by Philippines, with 2–3 GW under construction and 10 GW in the pre-construction phase. Active developments were less significant, but not negligible, in Cambodia, Malaysia and Thailand. Overall, Indonesia, Philippines and Vietnam will contribute 90 per cent of the future coal capacity additions in Southeast Asia (see *Graph: 6:Active coal capacity development in Southeast Asia*). Around 90–100 GW of coal capacity will be added during 2019–40, of which 5–10 GW will be subcritical, 30–40 GW will be supercritical, and the rest will be ultra-supercritical, with a miniscule portion coming from integrated gasification combined cycle (IGCC).

Graph 6: Active coal capacity development in Southeast Asia



Source: Boom and Bust, 2019

Graph 7: Projections of coal capacity in Southeast Asia



Source: End Coal, July 2020

However, it is difficult to predict the future of coal installations. Myanmar has significant expansions plans; coal share in electricity generation is predicted to rise from 6 per cent in 2017 to 30 per cent by 2030. Interestingly, there is no active development in Myanmar and about 12 GW of capacity was shelved because of strong civil society opposition on issues of people's health, environment and livelihoods. Opposition to coal power is not limited to Myanmar, public protest against the dirtiest electricity generating technology has also been observed in Indonesia, Philippines, Thailand and Vietnam. For examples, in Philippines, several provincial and municipal governments like San Juan and Negros Occidental recently declared that they will become coal-free and look to renewable energy as an alternative. In 2018, community protests in Thailand over the harmful effects on health and the environment of new coal power plants in Krabi and Songkhla provinces drove the government to reassess the impact of the projects.

ADOPTION OF HIGHLY EFFICIENT TECHNOLOGIES IN SOUTHEAST ASIA

Across Southeast Asia, there is an urgent need to deploy more efficient coal-fired power plant technologies. In 2014, subcritical technologies represented more than 90 per cent of installed coal-fired capacity and over 70 per cent of coal capacity added during the year. Subcritical coal-fired power plants in Southeast Asia operate at low average efficiencies (33 per cent in 2014) and have higher operating costs, since their lower efficiency levels imply larger volumes of fuel input. This compares poorly with supercritical and ultra-supercritical units that are projected to reach efficiency levels as high as 40 per cent and 45 per cent respectively.

According to Indonesia's 2015 power development policy, the use of environmentally sound technology should be prioritized, and in mature power systems (such as Java–Bali and Sumatra), clean coal technology and high efficiency low emissions (CCT/HELE) technologies should be used. In its 10-year business plan (2016–25), the state-owned utility PT Perusahaan Listrik Negara (PLN) plans to add 21.5 GW of ultra-supercritical plants in the Java–Bali and Sumatra systems over the planning period. Indonesia commissioned its first supercritical power plant in 2011–12 and intends to commission its first ultra-supercritical power plant in 2019.

In Vietnam, the coal fleet has low efficiency: about 32–35 per cent for conventional pulverized coal (PC) combustion and about 35–38 per cent for circulating fluidized bed (CFB) combustion. But new plants (13 GW of capacity is under construction) will use supercritical and ultra-supercritical technologies. To reduce the carbon footprints of the existing fleet, Vietnam intends to upgrade its performance, making use of both domestic and imported coal (which is of better quality than domestic coal), and co-fire it with biomass.

Indonesia, Philippines and Vietnam constitute the major coal usage countries in ASEAN and have the largest associated carbon footprints. In Indonesia and Vietnam, the governments have placed substantial emphasis on insulating the coal industry from competition and using power from coal to satisfy domestic energy demand.

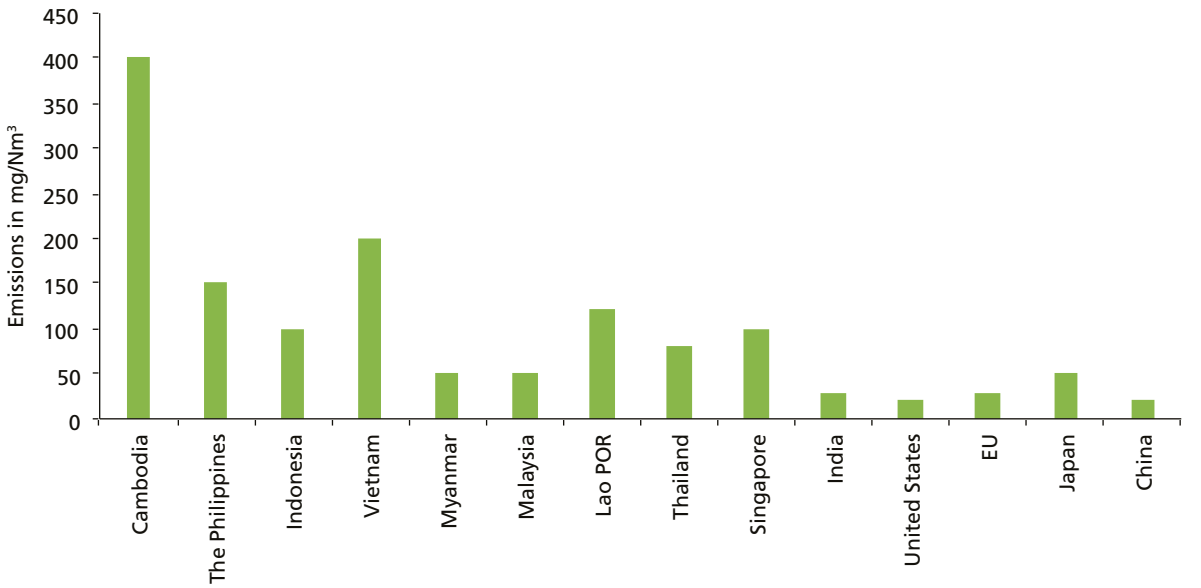
As the case of Philippines amply demonstrates, increased coal usage in these countries may be partially offset by reductions in coal use elsewhere in the region. In particular, aging infrastructure and geographic challenges may make renewables especially appealing in archipelago and island countries like Philippines. Much of the potential coal-fired power generation capacity in the region remains in the early stages of development.

COMPARISON OF EMISSION NORMS

Particulate matter (PM)

At 400 mg/Nm^3, 200 mg/Nm^3 and 150 mg/Nm^3 respectively, PM emission norm limits are relatively lax in Cambodia, Vietnam and Philippines (compared to countries like India, China, US and the EU). Among the countries that represent almost 90 per cent of the coal capacity—Indonesia, Malaysia, Philippines and Vietnam—only Malaysia and Indonesia have slightly stricter emission norm limits of 50 mg/Nm^3 and 100 mg/Nm^3; PM emission norm limits are relaxed in Philippines and Vietnam, at 150 mg/Nm^3 and 200 mg/Nm^3.

Graph 8: PM emission norms in Southeast Asian countries and select countries in other regions

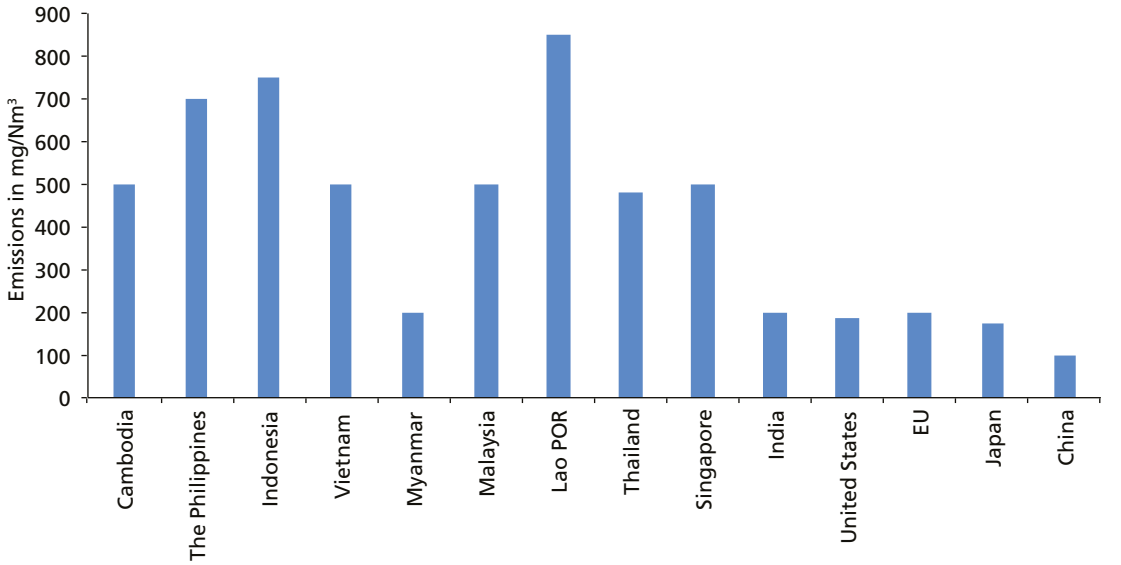


Source: IEA, 2016 & ERIA, 2017

Sulphur dioxide (SO_2)

SO_2 emission norm limits are generally 500 mg/Nm^3 or above in Southeast Asian countries. Indonesia and Lao PDR have the most relaxed norm limits of 750 mg/Nm^3 and 850 mg/Nm^3 respectively, whereas for other countries, they vary between 500–800 mg/Nm^3. These SO_2 norm limits are quite relaxed compared to those of China or India.

Graph 9: SO_2 emission norms in Southeast Asian countries and global standards

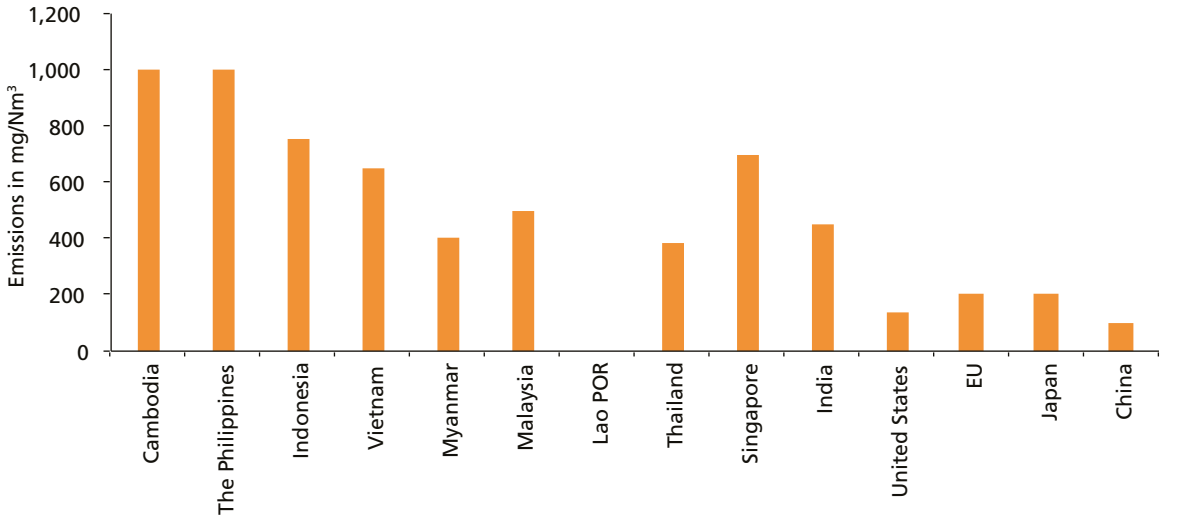


Source: IEA, 2016 & ERIA, 2017

Oxides of nitrogen (NO_x)

NO_x emission norm limits are surprisingly relaxed in Southeast Asia. Norm limits are as high as 1,000 mg/Nm³ in Philippines. Even in other countries, norm limits are 500 mg/Nm³ or higher, except in Thailand, where norm limits are 383 mg/Nm³. Overall, with respect to three-fourths of the existing coal capacity in the region, the norm limits are above 600 mg/Nm³.

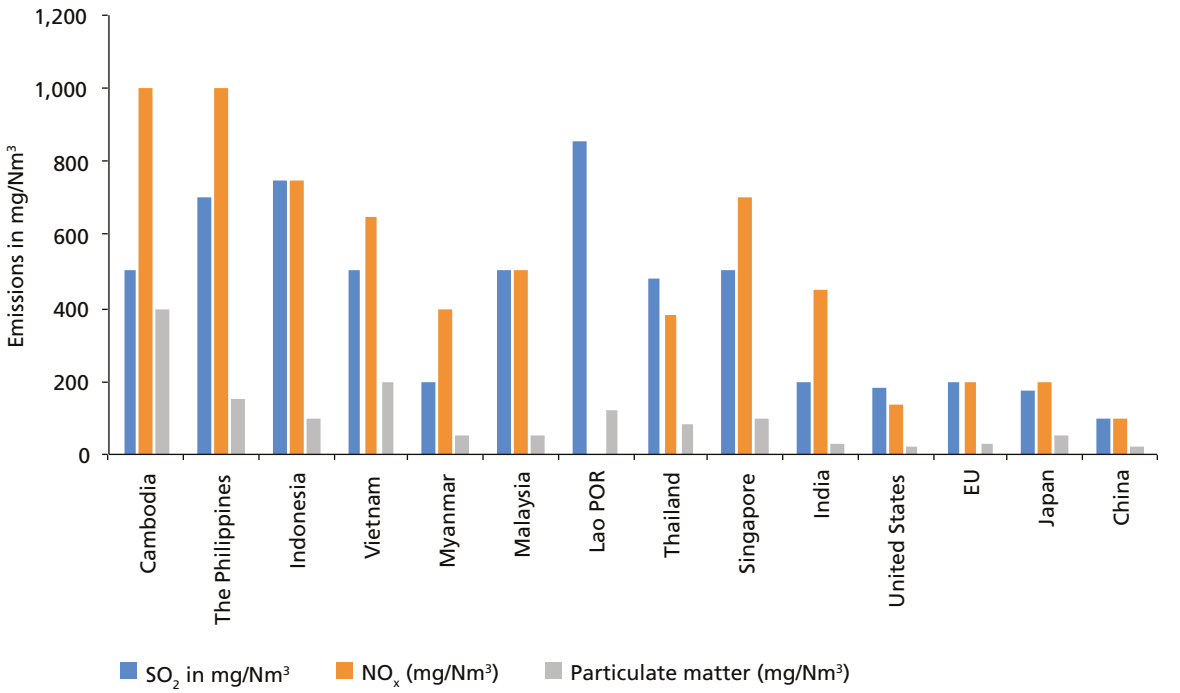
Graph 10: NO_x emission norms in Southeast Asian countries and global standards



Source: IEA, 2016 and ERIA, 2017

Indonesia, Philippines and Vietnam are planning installation of significant new coal capacity. These coal plants will continue to operate till 2050 for the energy security of these countries. Thus, it is essential that this new capacity be highly efficient as well as clean. To achieve this, along with the efficient technology selection of supercritical or ultra-supercritical plants, stringent emission norm limits should be envisaged for the new capacity, to reduce the cost in the long term and achieve environmental benefits.

Graph 11: Emission norms in Southeast Asian countries and global standards



Source: IEA, 2016 and ERIA, 2017

Continuous emission monitoring systems (CEMS)

As per available information, CEMS are in operation at coal-based power plants in Indonesia, Malaysia, Philippines and Thailand. In Thailand, the government has made stricter regulations and instituted an extensive monitoring framework for thermal power plants. In Malaysia, all coal-fired power plants are required to install CEMS, that are linked to the Department of Environment (DOE) in real time. In Indonesia, plants with capacity above 25 MW or plants with capacity below 25 MW but using coal that has a sulphur content above 2 per cent are required to install CEMS. In Philippines, though CEMS is a requirement, only major international power providers have the financial wherewithal to install CEMS. No information is available on CEMS applicability in other Southeast Asian countries.

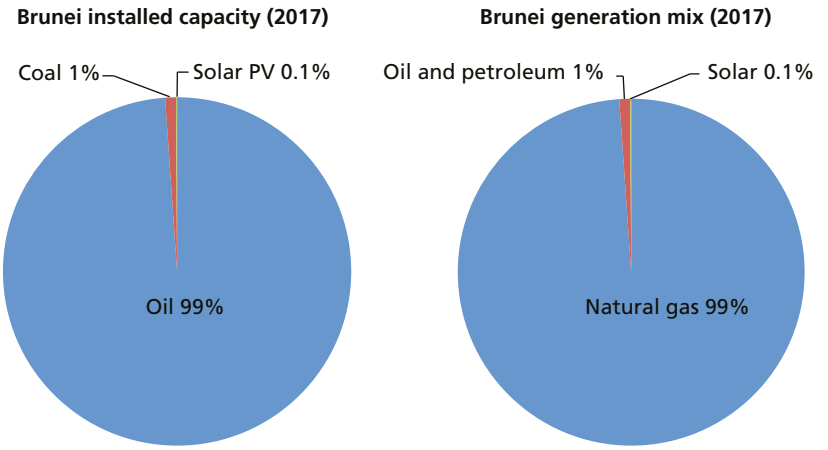
COUNTRY PROFILES

Brunei Darussalam

Brunei Darussalam is located on the northwest coast of the island of Borneo. The country has an area of 5,765 km^2 and a population of 442,400 (as of 2019). Brunei is rich in oil and gas.

In 2017, the total installed capacity of electricity in Brunei was 922 MW, comprised of oil (99 per cent), coal (1 per cent) and solar photovoltaics (PV) (0.1 per cent). In terms of generation in the same year, natural gas almost had the full pie (99 per cent), and oil and petroleum (1 per cent) and solar (0.1 per cent) contributed the rest.

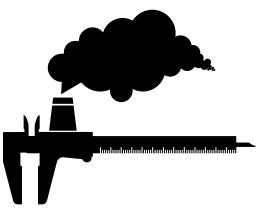
Installed capacity and generation mix in Brunei



Source: Country factsheet from Asian energy.org

PROJECTED COAL CAPACITY

In 2017, the installed coal capacity of Brunei was 9 MW. Under a business-as-usual scenario, by 2040, natural gas will continue to dominate, accounting for about 73 per cent of the country's energy supply, followed by oil at 20 per cent and coal at 7 per cent.



EMISSION STANDARDS

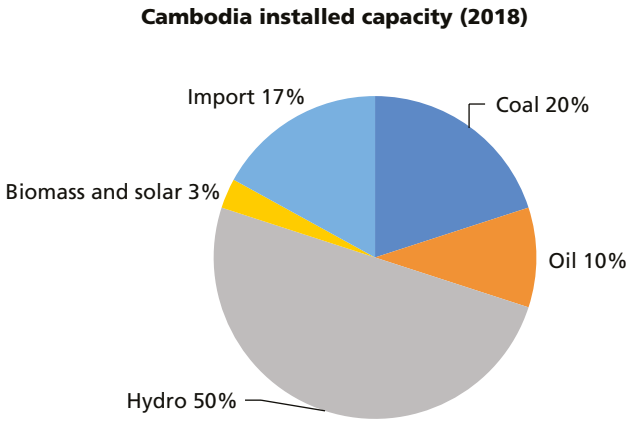
Not available.

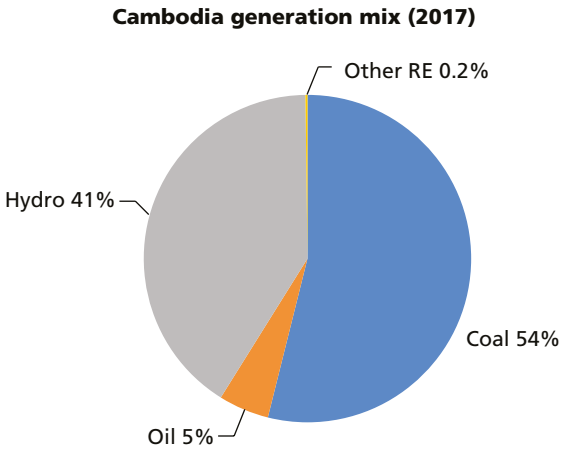
Cambodia

Cambodia is a country on the Indochinese mainland of Southeast Asia. It is largely a land of plains and great rivers, bound by Thailand, Laos, Vietnam and the Gulf of Thailand. The country has an area of 181,035 km^2 and a population of 15.98 million (as of 2019). Most of the electricity generated within Cambodia comes from hydrodams and coal-fired power stations.

In 2018, the total installed electricity capacity was 2,653 MW, comprised of hydro (50 per cent), coal (20 per cent), fuel (10 per cent), and biomass and solar (3 per cent). Together, these contribute around 83 per cent of the installed capacity. The country imports the rest of its energy needs. In terms of generation, in 2017, coal contributed 54 per cent, hydro 41 per cent, oil 5 per cent, and a miniscule amount was shared between biomass and solar PV.

Installed capacity (2018) and generation mix (2017) in Cambodia



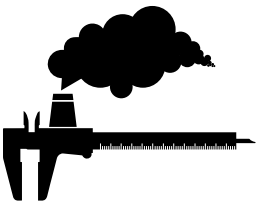


Source: Country factsheet from Asian energy.org

PROJECTED COAL CAPACITY

In 2018, the installed coal capacity of Cambodia was 531 MW. Projected additions to the coal capacity constitute around 3,350 MW. Cambodia is experiencing rapid economic growth, increased electrification rates, and a corresponding growth in energy demand. With the addition of new coal and hydropower plants, the share of thermal and hydro electricity in the energy supply increased significantly between 2010 and 2015. The basic energy plan for Cambodia (BEPC) recommends that the generation mix of 2030 will be coal (35 per cent), hydro (55 per cent) and renewable energy (10 per cent), which consists of biomass and solar PV.

EMISSION STANDARDS



In Cambodia, local governments have the authority to pass emission standards. These governments act autonomously to set emission standards voluntarily with coal power plant operators. According to the Air Pollution Control Act, operators should install public screen monitors to show emission measurements automatically (for SO_X, NO_X and PM) and must transmit it to the public through telemeters.

Emission standards of the country are very weak. PM and NO_X standards are weakest among all Southeast Asian countries. The standards should be made more stringent since the bulk of electricity in the country is generated from coal.

Emission standards for coal-fired power plants

Pollutant	Norm limit (mg/Nm³)
SO_2	500
NO_2	1,000
PM	400

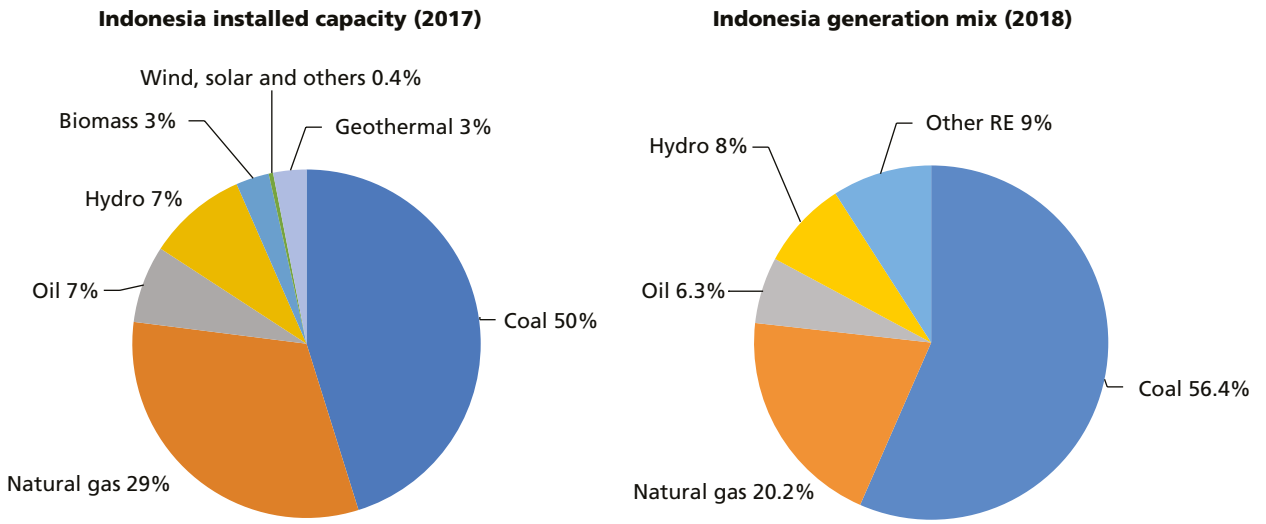
Source: Economic Research Institute for ASEAN and East Asia, 2017. Improving Emission Regulation for Coal Fired Power Plants In ASEAN. ERIA research project report 2016, No. 02

Indonesia

Indonesia is the world's largest island country and the 14th largest country by land area, at 1,904,569 km^2 (735,358 square miles). Indonesia consists of more than 17,000 islands, including Sumatra, Java, Borneo (Kalimantan), Sulawesi and New Guinea (Papua). With over 267 million people, it is the world's fourth most populous country. Indonesia is Southeast Asia's largest energy producer and consumer and is also the world's largest exporter of steam coal. Coal production increased significantly between 2009 and 2018. About 557 million tonnes were produced in 2018. Of this, 357 million tonnes (63 per cent) were exported to China and India.

In 2018, the installed capacity of electricity was 64,926 MW, comprised of coal (50 per cent), natural gas (29 per cent), oil (7 per cent), hydro (7 per cent), and biomass, solar, geothermal, wind and others (6.4 per cent). In 2018, in terms of generation, coal contributed 56.4 per cent; natural gas 20.2 per cent; oil, 6.3 per cent; hydro, 8 per cent; and RE, 9 per cent.

Installed capacity (2018) and generation mix (2018) in Indonesia

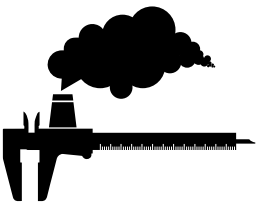


Source: Indonesia Energy Outlook (IEO) 2019

Electricity production is undertaken by Perusahaan Listrik Negara (PLN), a listed company fully owned by the national government, its subsidiaries and IPPs (independent power producers) while the transmission and distribution sector is monopolized by PLN. Currently, PLN's contribution towards electricity production is 69 per cent, IPPs contribute 23 per cent, and private power utilities (PPUs) and non-oil operation permits (NoOP) contribute 4 per cent each.

PROJECTED COAL CAPACITY

In 2017, installed coal capacity in Indonesia was 28,567 MW. About 26,691 MW of coal capacity is projected to be added in the coming years. According to the national power development plans of Indonesia, from 2018 to 2027, about 56,024 MW of capacity will be installed, of which coal capacity will be 26,808 MW (47.8 per cent). Of this, 6,045 MW is planned to be mine-mouth coal-fired capacity, and 20,763 MW will be non-mine-mouth coal capacity.



EMISSION STANDARDS

Norms regarding SO_2 and NO_X emissions are quite relaxed when compared to those in the developed world and large emerging economies like India and China. New emission standard limits for mercury of 30µg/m^3 were introduced in April 2019.

Emission standards for coal-fired power plants

Pollutant	Limit value (mg/Nm^3)	
	Old units	New units
Sulphur dioxide (SO_2)	750	750
Nitrogen oxide (NO_X) stated as NO_2	850	750
Total particulate	150	100

Source: Ministry of environment and forestry, Indonesia

CEMS IMPLEMENTATION

As per a 2008 regulation, installation of CEMS is mandated for all old and new coal-based power generation plants with an installed capacity of 25 MW and above; as well as for new generation plants with a capacity of less than 25 MW but using coal with a sulphur content of over 2 per cent. For CEMS operation, plants are required to have a quality assurance and quality control system. For power plants that do not require compulsory CEMS installation, emission levels are to be tested at least once every six months by accredited laboratories.

EXISTING AIR POLLUTION CONTROL

At present, 95 per cent of the air pollution control (APC) equipment in Indonesia is installed in coal-fired power plants. Electrostatic precipitators (ESP) are the most commonly installed APC (98 per cent). Other APC technologies utilized in Indonesia are flue gas desulfurization (FGD), low-NO_X burners, wet FGD, bag filters, and multi-cyclone and cyclone dedusters. Among the 93 power plants, 72 are using only ESP; nine are using ESP, FGD and low-NOx burners; three are using ESP, FGD, low-NO_X burners and bag filters; one is using a multi-cyclone and low-NO_X burner; and four are using ESP and cyclone dedusters. A combination of ESP and FGD is proposed for new power plants to efficiently remove mercury. Supercritical plants used by Cirebon are the most efficient, and supercritical and ultra-supercritical boilers have been proposed for new power plants.

Air pollution control equipment in coal-fired power plants

Air pollution control	Number of installations
ESP and low-NO_x burners	36
ESP, low-NO_x burners and FGD	3
ESP, low-NO_x burners, FGD and bag filters	1
ESP, low-NO_x burners and wet FGD	1
Multi-cyclone and low-NO_x burners	1
Bag filters	1
ESP, low-NO_x burners and cyclone dedusters	1
Total	44

Source: DGE, MOEMR 2017

SUMMARY

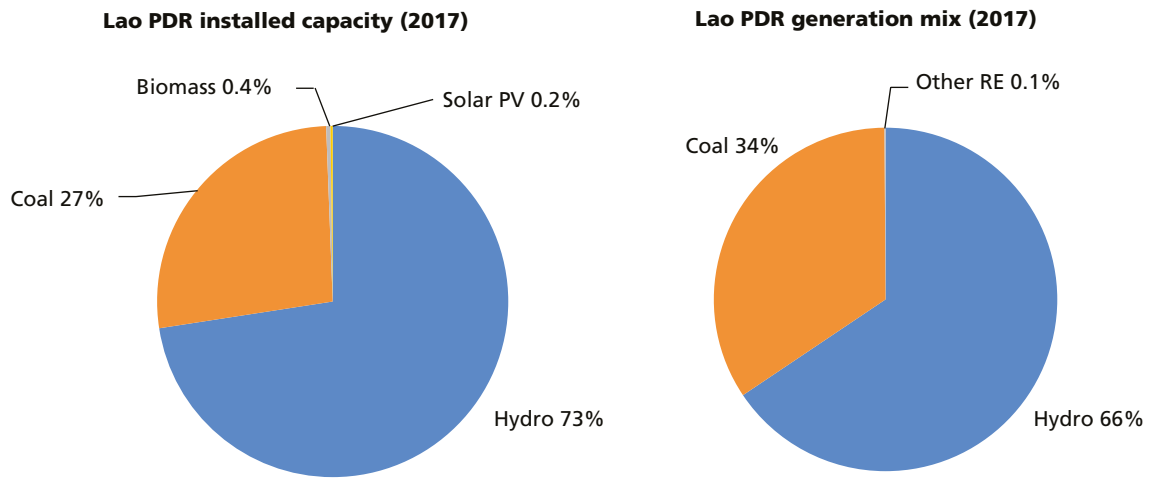
Indonesia is Southeast Asia's largest energy producer and coal contributes a significant portion to the country's generation mix. The country will continue to depend on coal for its energy security till 2050. As of now, emission standards are very weak. Thus, it is essential that new capacity be highly efficient as well as clean. To achieve this, along with efficient technology selection, stringent emission norms should be implemented for the new capacity.

LAO PDR

The Lao People's Democratic Republic (Lao PDR) is in the middle of the Southeast Asian peninsula. It is bound by five countries: China to the north, Vietnam to the east, Cambodia to the south, and Thailand and Myanmar to the west. The country has an area of 236,800 km^2 and a population of 6.88 million (as of 2019). Rising population and sustained economic growth are the main contributing factors to the increasing energy demand in Lao PDR. The country depends on renewable energy resources, especially hydropower, for most of its power generation.

In 2017, the total installed capacity in Lao was 7,086 MW. Hydropower had a share of 73 per cent, followed by coal (27 per cent), biomass (0.4 per cent) and solar PV (0.2 per cent). In terms of generation in 2017, hydro contributed around 65 per cent, followed by coal (34 per cent) and other renewable energy sources (0.1 per cent).

Installed capacity and generation mix in Lao PDR (2017)

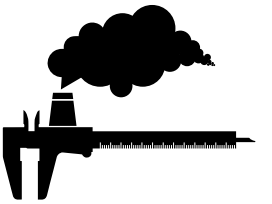


Source: Country factsheet from Asian energy.org

PROJECTED COAL CAPACITY

In 2017, the installed coal capacity of Lao was 1,913 MW. In a business-as-usual scenario, the share of coal in the primary energy supply will be 37 per cent by 2040.

EMISSION STANDARDS



Emission standards are very weak, especially regarding SO_2 emissions (weakest among all Southeast Asian countries).

Emission standards for coal-fired power plants

Pollutant	Limit value (mg/Nm³)
SO_2	853
NO_2	670
PM	120

Source: Economic Research Institute for ASEAN and East Asia, 2016

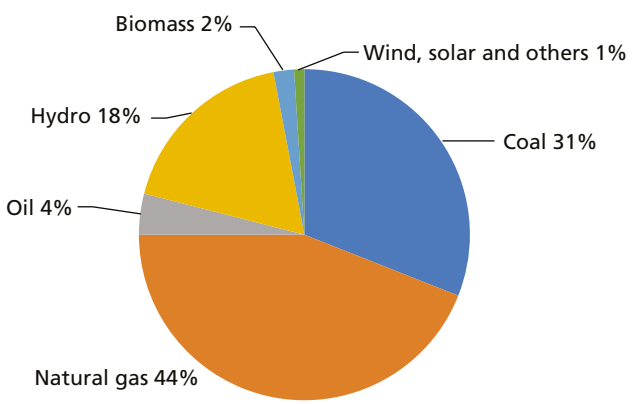
MALAYSIA

Malaysia has an area of 331,388 km^2 and population of over 32 million. The country is comprised of two distinct geographical regions divided by the South China Sea: Peninsular Malaysia and Malaysian Borneo. Coal, natural gas, and large hydro have been the main sources of power generation in Malaysia.

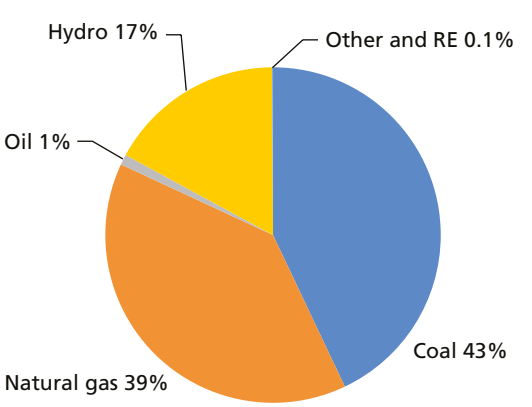
In 2017, the total installed electricity capacity was 34,183 MW, comprised of natural gas (44 per cent), coal (31 per cent), hydro (18 per cent), diesel (4 per cent), biomass (2 per cent) and solar (1 per cent). In terms of generation, in 2017, coal contributed 43 per cent, natural gas contributed 39 per cent, hydro contributed 17 per cent, and oil contributed 1 per cent.

Installed capacity and generation mix in Malaysia (2017)

Malaysia installed capacity(2017)



Malaysia generation mix(2017)



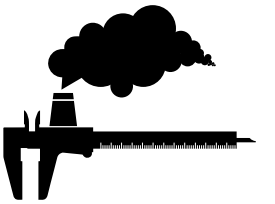
Source: Country factsheet from Asian energy.org

PROJECTED COAL CAPACITY

In 2017, the total installed coal capacity of Malaysia was 10,597 MW. Around 2,600 MW of capacity is projected to be added in the coming years. According to the eleventh Malaysia Plan (2016–20), reducing national dependency on fossil fuels while ensuring development of reliable and affordable energy resources is a focus area. In 1996, the contribution of coal in power generation was only 8.3 per cent; by 2017, it rose to about 43 per cent. The relatively low cost offered by coal is the driving force behind its growth in Malaysia. According to *Peninsular Malaysia Electricity Supply Outlook*, 2017, an additional capacity of 9,171 MW from 12 committed generation projects will be commissioned in 2017–23 against a planned retirement of

6,256 MW. The new projects consist of 5,282 MW capacity from gas, 3,000 MW from coal and 889 MW from hydro projects in Peninsular Malaysia.

EMISSION STANDARDS



According to the Environmental Quality (Clean Air) Regulations, 2014, the following (given in the table) emission standards apply to new and existing power generation boilers with a total capacity of more than 10 MW burning solid fuels, including coal and biomass.

Malaysia has comparatively stringent emission regulations than other Southeast Asian countries like Indonesia, Cambodia and Philippines.

Emission standards for coal-fired power plants

Pollutant	Limit value (mg/Nm^3)
PM	50
SO_x	500
NO_x	500
Hg	0.03

Source: Environmental Quality clean air regulations, (2014)

CEMS IMPLEMENTATION

All coal-fired power plants in Malaysia are required to install CEMS, linked to the Department of Environment (DOE) in real-time.

SUMMARY

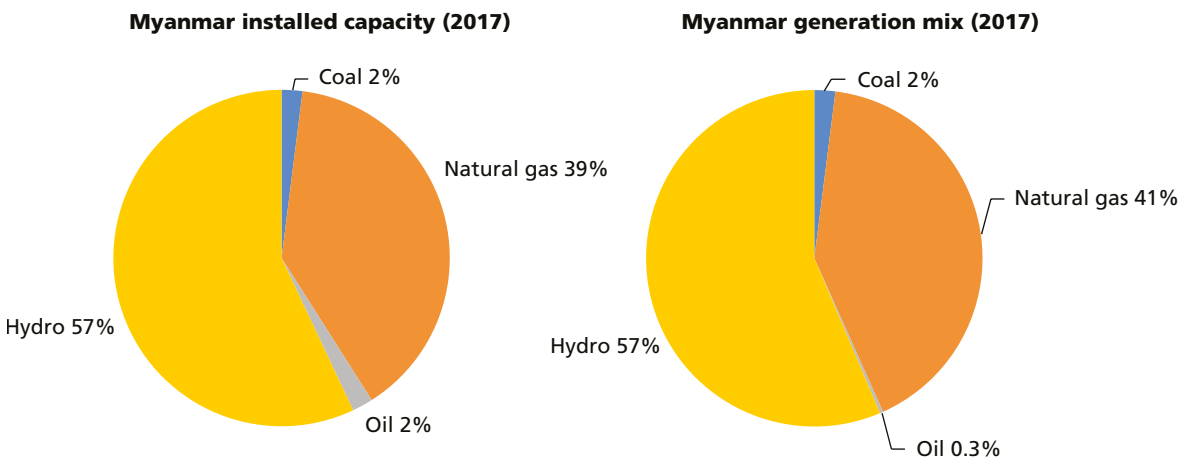
Malaysia depends on conventional sources for most of its power generation. Coal is the largest and cheapest source of fuel in the country. Hence, power generation using coal has increased over the years. The country has comparatively stricter emission regulations. Along with renewable, coal capacity is also projected to grow in the country.

MYANMAR

Myanmar is the westernmost country of Southeast Asia, bound on the west by India and with China to its north. The country has an area of 676,576 km² and a population of 53.6 million (as of 2019). It has been blessed with abundant oil and gas, hydropower, coal and renewable resources. Natural gas has served as the country's largest export commodity for years.

In 2017, the total installed capacity in Myanmar was 34,183 MW, comprised of hydro (57 per cent), natural gas (39 per cent), coal (2 per cent) and oil (2 per cent). In terms of generation, in 2017, hydro projects contributed 56 per cent, followed by natural gas with 41 per cent, coal with 2 per cent and oil with 0.3 per cent.

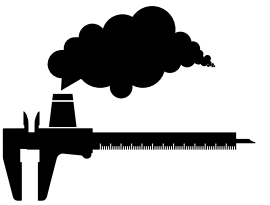
Installed capacity and generation mix in Myanmar (2017)



Source: Country factsheet from Asian energy.org

PROJECTED COAL CAPACITY

In 2017, installed coal capacity in Myanmar was only 684 MW. According to projections, coal-based electricity generation is increasing whereas hydro- and gas-based generation is decreasing. In 2014, coal-based installed capacity was only 3 per cent; by 2030, it will rise to around 34 per cent. According to the data collection survey on capacity development in the power sector, installed capacity of coal in 2030 will be 33 per cent, based on the power resource balance scenario; 18 per cent, based on the least-cost scenario; and 10 per cent, based on the domestic energy consumption scenario. Coal extraction has remained slow in the country due to low investment and remoteness of most coal sites, even though the country has estimated coal reserves of 540 million tonnes. There is widespread public opposition to new coal-based power plants in the country.



EMISSION STANDARDS

Emission standards in Myanmar are very stringent compared to other Southeast Asian countries like Cambodia and Philippines.

Emission standards for coal-fired power plants (Myanmar)

Pollutant	Limit value (mg/Nm^3)
NO_X	200–400*
PM_{10}	30–50*
SO_2	150–200*
Hg	1

* Lower value for plants of > 100 MW thermal equivalent, higher value for plants of < 100 MW thermal equivalent.
Source: Economic research institute for ASEAN and East Asia, 2017

SUMMARY

Myanmar mainly depends on hydro power and natural gas for power generation. A small (compared to other Southeast Asian countries) coal capacity is projected to be installed. Emission standards in Myanmar are strict compared to other countries. There is widespread public opposition to new coal-based power plants in the country.

SINGAPORE

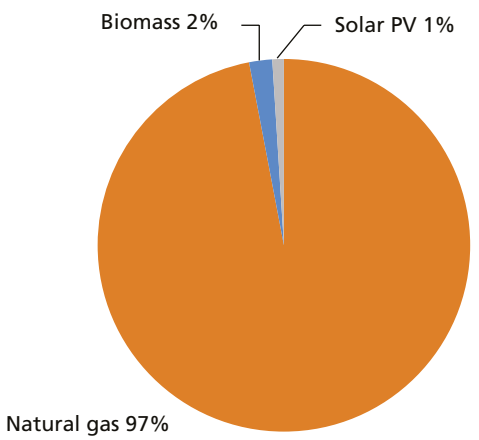
Singapore is a small city-state in Southeast Asia with a land area of 719 km^2 and a population of 3.6 million (as of 2019). Singapore's electricity production depends largely on natural gas. The country is limited in terms of cost-effective and reliable renewable energy sources.

In 2017, the total installed electricity capacity was 13,612 MW, comprised of natural gas (97 per cent), biomass (2 per cent) and solar PV (1 per cent). In terms of generation, in 2017, the contribution of natural gas was 95.2 per cent while others contributed the rest.

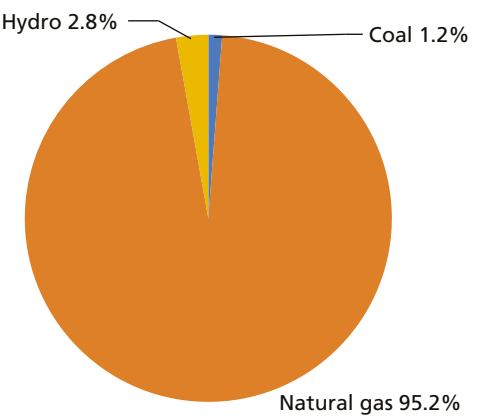
According to *APEC Energy Demand and Supply Outlook*, the power sector of Singapore will continue to be dominated by gas. Even though efforts are being made to expand renewable energy, Singapore's land and geological constraints limit the development of renewables.

Installed capacity and generation mix in Singapore (2017)

Singapore installed capacity (2017)

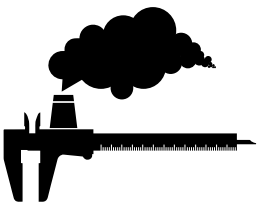


Singapore generation mix (2017)



Source: Country factsheet from Asian energy.org

EMISSION STANDARDS



Emission standards for PM and SO_2 emissions are neither very relaxed nor very stringent. Emission standards for NO_x are very much relaxed in comparison with India, China or EU.

Emission standards for coal-fired power plants

Pollutant	Limit value (mg/Nm³)
SO_2	500
NO_2	700
PM	100

Source: ASEAN Centre for Energy (ACE)

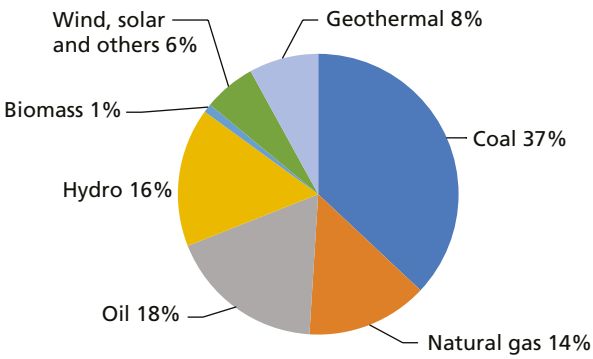
THE PHILIPPINES

Philippines, officially the Republic of the Philippines in Southeast Asia, is situated in the Western Pacific Ocean. It consists of about 7,641 islands that are broadly categorized under three main geographical divisions from north to south: Luzon, Visayas and Mindanao. The country has an area of 300,000 km^2 and a population of 106.6 million (as of 2019). In terms of energy use, conventional fossil fuels are the main source for its primary energy demands. Philippines' electricity prices are the highest in Southeast Asia due to excessive dependence on imported coal and diesel.

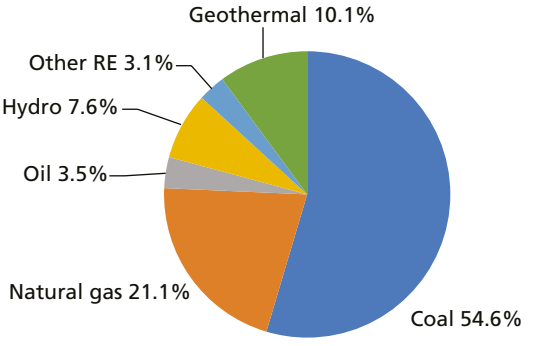
In 2018, the total installed capacity of electricity in the country was 23,815 MW, comprised of coal (37 per cent), oil (18 per cent), hydro (16 per cent), natural gas (14 per cent), geothermal (8 per cent), biomass (1 per cent) and renewable sources (6 per cent). In 2019, in terms of power generation, coal contributed around 54.6 per cent; natural gas, 21.1 per cent; geothermal, 10.1 per cent; hydro, 7.6 per cent; oil, 3.5 per cent; and other renewable energy sources, 3.1 per cent.

Installed capacity (2018) and generation mix (2019) in Philippines

Philippine installed capacity (2018)



Philippine generation mix (2019)



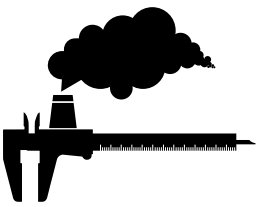
Source: Country factsheet from Asian energy.org

PROJECTED COAL CAPACITY

In 2018, the installed coal capacity of Philippines was 8,812 MW. Around 12,618 MW are projected to be added to the coal capacity in the coming years. Rising population and economic growth will result in higher energy demand. The share of coal in electricity production has also been rising over the years. In 2000, coal contributed 37 per cent to the country's power generation. This share increased to 44.5 per cent in 2015 and to 55 per cent in 2019. On the other hand, the share of renewables

has been decreasing. The expansion of coal power generation as projected will lead to a carbon-intensive path for decades.

EMISSIONS STANDARDS



Power plant operators are responsible for monitoring and self-reporting emissions. Their quarterly monitoring reports are then validated by community stakeholders in the form of a multi-partite monitoring teams (MMT) and audited by inspectors from the Department of Environment and Natural Resources (DENR). Emission standards, especially regarding NO_X and SO_2 emissions, are weak compared to all other southeast Asian countries. As the number of coal-based power plants are increasing in the country, existing emission standards will likely lead to gross increase in pollution.

Emission standards for coal-fired power plants

Pollutant	Limit value (mg/Nm³)
SO_2	700
NO_2	100
PM	150

Source: Economic Research Institute for ASEAN and East Asia, 2016

CEMS IMPLEMENTATION

For better monitoring, power plants are required to install CEMS. However, only the major international power providers have been able to install them, others can't due to lack of funds.

SUMMARY

The country depends on conventional energy sources, especially coal, for most of its power generation. Projections show that the country's dependence on coal as an energy source is set to increase. Emission standards are very relaxed, which will result in rampant emissions. New coal-fired plants must be moved in the direction of higher efficiency and cleanliness. If it is technically and economically feasible, old units can upgrade their steam turbines by changing their steam paths, operating parameters, and even by doing cross-generation technology upgrades, so as to improve efficiency and performance of existing units and reduce pollutant emissions.

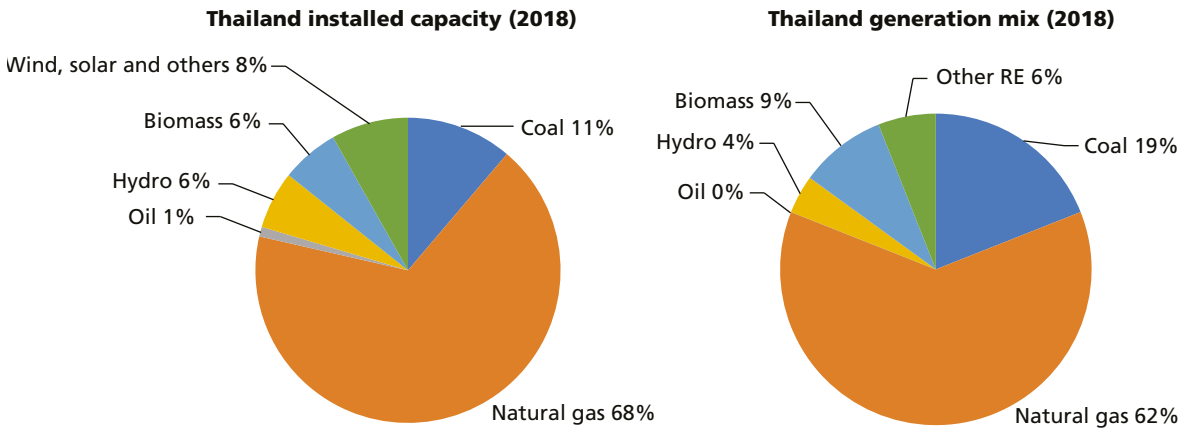
However, it should be noted that Philippines relies heavily on imported coal, and this threatens the long-term sustainability of the sector. On the other hand, the country has significant renewable energy potential. Thus, actual coal capacity additions may vary a lot from projected capacity.

THAILAND

Thailand is located at the centre of the Indochinese peninsula. It is composed of 76 provinces, and covers an area of 513,140 km^2, with a total population of over 67.8 million (as of 2019). Thailand is the world's 50th largest country by land area, and one of the most populous countries in the world. The country relies on natural gas, followed by coal and other renewable sources, for electricity generation. Natural gas began to be produced domestically in the 1980s and since then has greatly contributed to the country's staple self-sufficiency rate (of around 60 per cent). According to the BP Statistical Review of World Energy, the reserves-to-production ratio of Thailand's natural gas is only 5.5 years. On the other hand, it has significantly more coal reserves (81.8 years).

Thailand has an installed power capacity of 50,456 MW as of 2018; comprised of natural gas with 66 per cent, coal with 11 per cent, oil with 1 per cent, hydro with 6 per cent, biomass with 6 per cent, and renewables with 8 per cent. In terms of generation, natural gas tops the list with 62 per cent, followed by coal with 19 per cent, biomass with 9 per cent, and around 10 per cent of other renewables.

Installed capacity and generation mix in Thailand (2018)



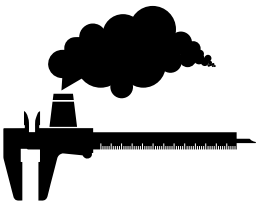
Source: Country factsheet from Asian energy.org

PROJECTED COAL CAPACITY

In 2018, the installed coal capacity of Thailand was 5,550 MW. About 4,245 MW of coal capacity is projected to be added in the coming years. The share of coal in electricity production has remained almost constant over the years, hovering around the 19 per cent mark between 2000 and 2018. The share of renewables (excluding hydro) has increased from 0.5 per cent in 2000 to 6 per cent in 2015. In 2018,

the share of renewables increased to 15 per cent. The scale of planned new installed capacity of coal-fired power is limited. Thailand is already a net fossil fuel importer. Volatile prices make it difficult to predict the financial viability of fossil fuel power plants since they face competition from renewable energy plants with predictable and decreasing prices. Under development coal plants face strong opposition from local population.

EMISSION STANDARDS



Emission standards for coal-fired units in Thailand target SO_2, NO_X and particulate matter. The limits differ, depending on whether they apply to units that acquired a permit of operation or expansion before or after 1996. They are also stricter for larger units. In June 2008, Thailand strengthened its emission standards for new power plants. Before agreeing to permissible emission levels, local authorities investigate the impact of a new coal-fired power plant on local air pollution. Thailand has stringent emission regulations compared to other Southeast Asian countries.

Emission standards for coal-fired power plants

Type and size of power plant	Emission standard		
	PM (mg/Nm³)	SO_2 (ppm)	NO_X (ppm)
New power plants (since 15 January 2010)			
1. Power plant size < 50MW	80	360	200
2. Power plant size > 50MW	80	360	200
Power plants (31 January 1996–15 January 2010)			
1. Power plant size > 500MW	120	320	350
2. Power plant size 300-500MW		450	
3. Power plant size < 300MW		640	
Existing power plant (before 31 January 1996)			
1. Mae Moh			
Unit 1–3	180	1,300	500
Unit 4–7	180	320	500
Unit 8–13			
Total SO_2 loading of Mae Moh Unit 1–13 shall not be more than 11 tonne per hour			
2. Other power plants	320	700	400

Source: Notification of the Ministry of Industry B.E.2547 (2004), issued under Factory Act B.E.2535 (1992), dated September 28, B.E.2547 (2004)

CEMS IMPLEMENTATION

The Thai government has made stricter regulations and instituted an extensive monitoring framework for thermal power plants. All power plants are required to install CEMS for the monitoring of SO_2, NO_X, carbon monoxide, excess oxygen, opacity, flue gas temperature, and flue gas flow. Ambient air quality monitoring stations must also be installed for monitoring air quality in the vicinity of plants. Newer plants use CEMS for monitoring water temperature as well. All data collected through these monitoring systems must be reported daily, weekly and monthly to local and national monitoring authorities. In the case of the Mae Moh power plant, the data is also reported daily to the local health authorities.

FLY ASH

As part of Environmental Impact Assessment (EIA), coal-fired power plants must describe how fly ash is disposed of. New plants are required to, at the very least, landfill ash to obtain an operating permit. Some power plants sell their ash to cement manufacturing companies for recycling. Fly ash is collected from six Mae Moh units and supplied to such companies. Most other coal-fired units in Thailand dump ash in various places without any prior processing.

SUMMARY

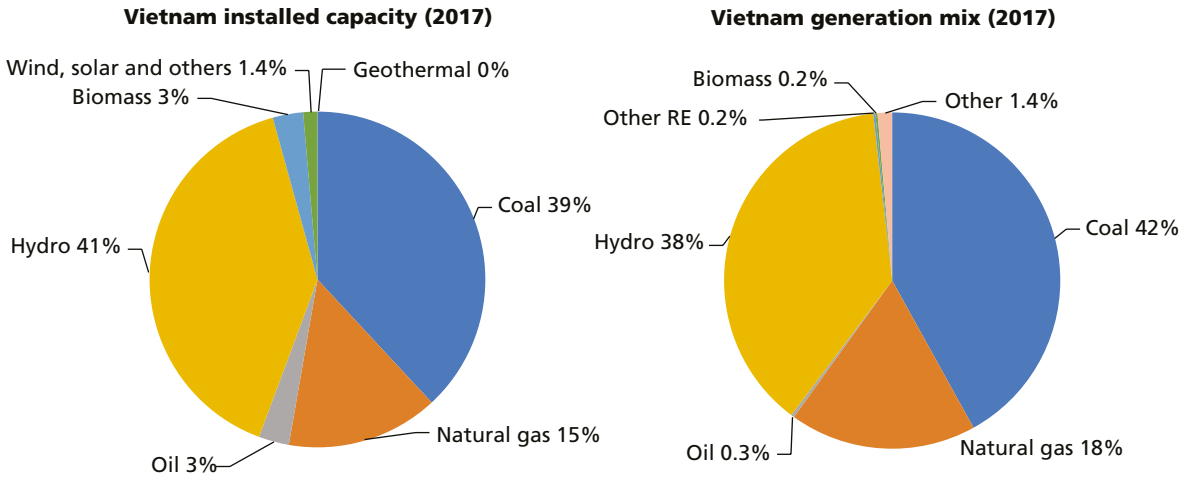
Thailand relies on natural gas, coal and other renewables for most of its power generation. Given the resistance of people against coal utilization, construction of new coal-fired power stations should be large in scale, high in efficiency and low in emissions, to convince the public about their economic benefits and cleanliness. At present, the emission standards in the country are comparatively stricter.

VIETNAM

Vietnam is the 15th most populous country in the world with an estimated population of 96.2 million (as of 2019). The country has an area of 331,230 km^2. It has been a net energy importer since 2015, though it became a net importer of coal much earlier (in 2005). Coal imports come primarily from Russia, China and Australia. Vietnam is expected to import almost 50 per cent of its total commercial primary energy demands over the next decade, with coal on track to become the primary electricity source.

In 2017–18, the total installed capacity in the country was 48,839 MW, comprised of coal (39 per cent), natural gas (15 per cent), hydro (41 per cent) and others (5 per cent). The generation mix follows the same trend as installed capacity, with contributions from coal (42 per cent), natural gas (18 per cent), hydro (38 per cent) and others (2 per cent).

Installed capacity and generation mix of Vietnam (2017)



Source: Vietnam factsheet for Aseanenergy.org

PROJECTED COAL CAPACITY

In 2017, the total installed capacity of coal was 19,047 MW. Around 42,315 MW of capacity is projected to be added in the coming years. As per projections, Vietnam will continue to rely on coal-fired power generation in the coming decades, despite the increasing share of renewables.

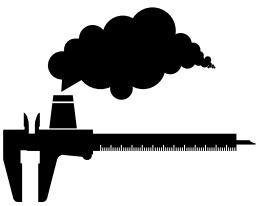
According to Vietnam's National Energy Development Plan, coal demand will grow at an average annual rate of 2.9 per cent between 2016 and 2035. In 2035, coal demand will

reach 86.94 million tonnes, of which about 72.5 per cent will be used for coal-fired power generation. It is estimated that by 2030, Vietnam's installed power capacity will reach 129.5 GW, of which coal-fired power installed capacity will be 55.5 GW, an increase of more than 40 GW over that of 2016. Minister of Industry and Trade reports that coal-fired power will account for 36–37 per cent of the country's energy supply in the new energy development plan for 2021–30. Ten coal-fired projects with 7,000 MW capacity were scheduled to be put online during the period, but all of them will not meet the deadline this year.

Vietnam is a flashpoint in the global debate about coal power. About 17 GW of coal power is already under construction, with another 29 GW in various pre-construction phases. The country has the fourth-largest number of plants in the pipeline, according to Bloomberg NEF, many of which have drawn financing in the past years from lenders in Japan and other countries.

The Vietnamese government is likely to focus on renewables in its new power development plan. Even then, threats of power shortages and the need to support economic growth means the government will probably maintain its commitment to coal.

EMISSION STANDARDS



Emission standards for thermal power plants were released on 16 November 2009. Vietnam's standards are based on the size of operation and location of the facility.

Emission standards are not stringent enough, especially PM standards. Since Vietnam will continue to rely on coal-based power generation, emission standards should be stricter. Further, there is no information available on applicability of CEMS in thermal power plants. CEMS is crucial to ensure compliance of operating units as well as future installations with emission standards.

Emission standards for coal-fired power plants in Vietnam

Pollutant	Limit value (mg/Nm³)
PM	200
NO_X	650 (coal with volatile organic compound content >10 per cent) 1,000 (coal with volatile organic compound content < 10 per cent)
SO_2	500

Source: The Decision Requiring Use of Vietnamese Standards Regarding the Environment. Decision No 22/2006/QD-BTNMT, Ha Noi, Vietnam. December 18, 2006

OPPOSITION TO COAL IN VIETNAM

Vietnam is ranked 15th in the list of 98 countries and territories with the worst air quality in the world, with an average $PM_{2.5}$ level of 34.1, second only to Indonesia in Southeast Asia.

Coal also faces local opposition, considering air quality problems throughout Asia. In early January, an alliance of social and professional organizations in Hanoi focused on

health and environmental rights, called for construction to be suspended at 14 coal-fired plant projects with a total capacity of 17.4 GW, according to the Thanh Nien newspaper.

Concerned over the environmental and health toll that coal-fired power plants exact, leaders of 12 networks and non-government organizations collectively urged Prime Minister Nguyen Xuan Phuc to stop 14 coal-fired plants in Vietnam. As per ground reports, the government could cancel at least half of its planned new coal-fired power plant generation capacity this decade. Vietnam has also begun to develop infrastructure to import as much as eight billion cubic meters of liquefied natural gas (LNG) annually by 2030, to increase gas-fired power generation.

The way forward

Southeast Asia's electricity consumption is projected to more than double by 2040 due to significant demographic and economic growth. Despite massive expansion plans, coal power in Southeast Asia is increasingly facing powerful opposition from socio-environmental, and economic and financial perspectives. This opposition has a tale to tell about the future of coal in Southeast Asia and across the world.

Growing social and environmental opposition from the public in Indonesia has delayed some coal projects. For instance, the 1,000 MW Cirebon-2 power plant has been blamed for having adverse impact on the surrounding mangrove and coastal marine ecosystems, as well as the livelihoods of the local community. When Cirebon-1 started running eight years ago, salt farmers reported significant losses in production and traditional fish farmers reported that the pollution from the plant destroyed their livelihood, as reported in *Mongabay Series* in 2020.

In Philippines, resistance against coal power is gaining traction in at least 12 provinces, with the Palawan province, where government approved a 15 MW plant, having the most discord. According to local environmental groups, power plants threaten the province's biodiversity and undermine cheaper renewable power generation options, as reported in *Mongabay Series* in 2019. Apart from this, after an intense movement initiated by youth, communities and non-governmental organizations, several provincial and municipal governments like San Juan and Negros Occidental declared that they would become coal-free and look to renewable energy as an alternative.

In November 2020, the government of Philippines declared that the country had stopped accepting new coal-based power proposals. In 2018, communities in Thailand protested over the harmful effects of new coal power plants in the Krabi area on health and environment, specifically fisheries as well as the tourism industry. Protests were held in the Songkhla province as well, and this drove the government to cease plans of coal expansion. In January 2020, it was reported that the Strategic Environmental Assessment Committee (SEA) was still assessing the need for a coal plant in Krabi.

In Vietnam, coal faces local opposition considering air-quality problems. According to Thanh Nien newspaper, in early January 2020, an alliance of social and professional organizations in Hanoi suspended 14 coal-fired plant projects with a total capacity of 17.4 GW. Concerned over the environmental and health toll that coal-fired power plants exact, leaders of 12 networks and non-government organizations collectively urged Prime Minister Nguyen Xuan Phuc to stop 14 coal-fired plants in Vietnam, as reported in VN Express.

Myanmar has significant coal power expansions plans. In 2014, coal-based installed capacity contributed only 3 per cent to the generation mix, but by 2030, its share will rise to around 34 per cent. Interestingly, there is no active coal power development in Myanmar because of strong civil society opposition fearing for people's health, environment and livelihoods. In 2010, a 4,000 MW power plant was planned which would have been the largest coal power plant in Southeast Asia if it had not been suspended because of relentless protests. In 2017, Toyo-Thai coal power plant was planned in Hpa-

an (in Kayin State). However, streets were filled with protesters, resulting in the cancellation of the plans.

Protests against coal power in Southeast Asia mirror those in India. In India, too, new coal capacity has been missing annual targets. This only goes to prove that community awareness regarding the right to clean environment and access to natural resources has spread across the globe. Moreover, the world is aiming to keep down the rise in global temperature to below 2ºC above pre-industrial level. A multi-pronged approach is needed for a sustainable future while utilizing the benefits of cheap coal power.

Adopt a balanced approach: Governments as well financial investors are quite wary of new coal power projects. A balanced approach needs to be taken on renewable energy sources and clean and efficient coal technology. Such an approach has to be country-specific and take into consideration local conditions and the pecularities of indigenous resources. Possibilities of indigenous research and innovation in the coal power sector need to be explored. Along with indigenous research, countries have to look for efficient combination of coal with renewables to optimize future coal installations.

Ensure energy security with gradual decarbonization: Energy is the engine of growth for any economy. The contribution of coal in industrialization and uplifting millions of people from poverty through energy security cannot be ignored. Thus, the decision on coal power is country-specific. Electricity access and per capital electricity consumption are crucial factors for estimating future demand. Moving towards low carbon transition pathways, the only option for ASEAN is to keep on working with coal while improving the state of its technologies.

Make right predictions on coal power, considering its environmental impacts: In India, various models have provided rough estimates regarding energy installations (coal and renewable) in the coming decades. However, experts believe that all these estimates have not given due consideration to some crucial inputs such as water stress and solid waste impact in their modelling. Thus, a country should critically consider all parameters for establishing future estimation of electricity generation. For example, along with stringent PM, SO_2 and NO_x standards, mercury (Hg) emission and control will be crucial in future installations.

Thorough Environment Impact Assessment is the key: Installing a coal power plant with heavy reliance on technologies and materials that depend on supply chains is definitely not ideal. Pandemic times (such as COVID-19) can seriously hurt the energy security of countries with such dependence. Further, coal reserves might be a boon for a country but accessibility to coal and the technologies used in mining are major factors and may lead to ecological degradation of mining areas. With growing concerns about biodiversity loss, indigenous peoples' right and the impact of deforestation, investments in coal power are continuously hampered if a thorough environment impact assessment has not been conducted at the initial stage of the project.

Account for actual cost of coal power; promote cleaner power: Abundant coal and competitive technologies have kept coal power largely cheap but that does not mitigate the serious environmental impact of coal-based power. As negative externalities of coal are being included into project planning and assessment, with stringent environmental standards (air and water pollution and solid waste management), the actual cost of coal power needs to account for proper environment pollution control technologies. In countries like India, the average cost of renewable power is coming closer to coal power, the

difference will continue to vane with the decreasing cost of renewable technology and increasing cost of operating coal power (with the installation of environmental pollution control technology).

Focus on easily achievable targets for decarbonization: Renovation and modernization and biomass cofiring are globally accepted cost-effective methods of improving the efficiency of the existing fleet. As per vintage and technology, heat rate standards can improve the operation of existing plants. Old power stations need to prudently utilize their land resources, coal linkages etc. Such measures can save capital investment in new projects.

Recognize the important role of CEMS: CEMS has a key role to play in the future of coal-based power plants. It not only assures environment authority of clean operation of a plant but also eases monitoring efforts. Moreover, it helps build community as well as investors' confidence when a plant discloses their round-the-clock emission levels transparently to all stakeholders. CEMS play a major role in maintaining operational efficiency of a plant. Since a significant capacity in Southeast Asian countries is young, maintaining the efficiency of boiler operations and emission control devices is key to reducing environmental footprints of coal-based power.

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ASEAN—Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam—has emerged as the most important region for future growth in coal-fired power generation as both China and India are investing in renewable power and moving away from coal.

This growth is a little iffy, as installation of new coal power capacity faces stiff resistance from environmentalists and the hoi polloi alike. But in a business-as-usual scenario, it will lead to a tremendous increase in pollution. Especially since the emission standards of important parameters are quite lax in most of these countries.

Can ASEAN chart a new energy future that combines cleaner coal power and better regulation and monitoring with synergetic phasing-in of renewable energy? This scoping paper mulls over these questions.

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