Chapter 2

Power Infrastructure Developing Plan in Each Country

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CHAPTER 2

Power Infrastructure Development Plan in Each Country

This chapter presents an overview of power infrastructure development plans in 13 countries in East Asia (Bangladesh, Brunei Darussalam, Cambodia, China [Yunnan & Guangxi], India [North-East], Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam) and projections for their installed generation capacities and power source mixes in 2020 and 2030.

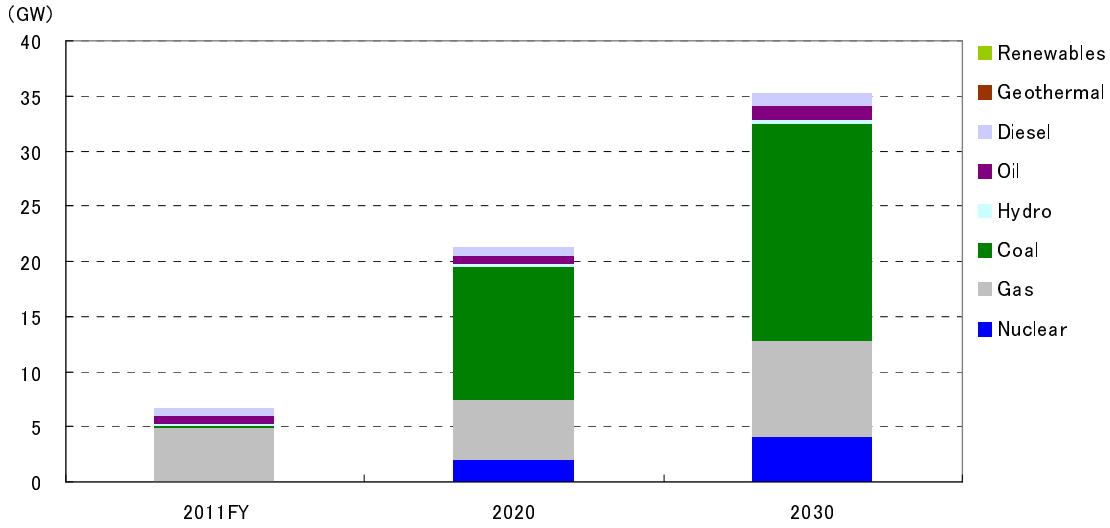
1. Bangladesh's Power Development Plan

In Bangladesh, the Bangladesh Power Development Board (BPDB) and IPPs generate electricity. The BPDB has been in unified charge of planning, construction, and operation of national power generation, transmission, and distribution since the nation gained independence in 1972. Electricity sector reform began in the 1990s with the aim of introducing private capital into the sector. Conversion of existing BPDB power plants into internal divisions and separate companies and the participation of IPPs have progressed.

Even today, however, improvement of power plants and other power transmission and distribution facilities in Bangladesh is notably lagging. Although potential power demand is extremely high, the nation has been forced into chronic power supply shortages and constant restrictions on demand. As of June 2010, the rate of access to electricity remained at a low level, 47 percent.[4] This forms an impediment to economic growth and direct investment of foreign capital. With the objective of raising national living standards, the Bangladeshi government aims to increase the amount of power supplied.

[4] Board of Investment, http://boi.gov.bd/key-sectors/power-industry

Figure 2-1: Power Development Plan toward 2020 and 2030 (Bangladesh)



Bangladesh (GW)

	2011FY	2020	2030
Nuclear	0.000	2.000	4.000
Gas	4.863	5.427	8.850
Coal	0.220	12.050	19.650
Hydro	0.230	0.330	0.330
Oil	0.671	0.735	1.199
Diesel	0.655	0.718	1.171
Geothermal	0.000	0.000	0.000
Renewables	0.000	0.000	0.000
Total Supply Capacity	6.639	21.260	35.200

Source: Power System Master Plan 2010.

In FY 2011, Bangladesh's generation capacity was 6,639 MW. The power source mix was hydropower 230 MW (3.46 percent), coal-fired power 220 MW (3.31 percent), oil-fired power 671 MW (10.11 percent), diesel power 655 MW (9.87 percent), and gas-fired power 4,863 MW (73.25 percent). The power source mix leans heavily on domestic natural gas resources.

On the other hand, development of new gas fields is lagging in Bangladesh, and the transmission network is inadequate. Due to soaring demand accompanying economic development, the supply and demand gap for domestic natural gas is expanding, and already gas supply impediments are causing restrictions on power plant operation. Diversification of the power mix is an urgent issue.

In response to this situation, the Bangladeshi government is considering development of coal-fired power plants that use domestic and imported coal,

electricity imports from neighboring countries (India, Nepal, Bhutan, and Myanmar), expanded use of renewable energy, and research on and adoption of nuclear power.

Coal, which is expected to be used as an alternative to gas, is present in the country's northwest. There are estimated deposits of about 1.5 billion tons.[5] Bangladeshi coal is generally bituminous coal, low in sulfur and ash, and well-suited for power generation. Coal production began in Barapukuria in the north in 1994. In 2005, the Barapukuria Power Plant, Bangladesh's first coal-fired power plant, began operation.

However, there are many issues associated with coal mining. Because most of Bangladesh's land is a delta area on the Indian subcontinent along the Bay of Bengal, in many places there are aquifers on top of the coal beds. When the coal is mined, therefore, advanced technologies regarding ground subsidence and water removal are necessary. Moreover, Bangladesh has a very high population density, and most of the land is level, so most potential coalfields have already been developed as agricultural or residential land. Thus, demonstrations against the displacement of residents and the environmental impact of mining have broken out. Consensus forming in local communities is thus a major issue.

As for the adoption of nuclear power, study and research on it has progressed on it in terms of a power source as part of the electricity supply and in terms of diversification of energy resources. In November 2011, Bangladesh signed an agreement with the Russian Nuclear Energy State Corporation, ROSATOM, on construction of a nuclear power plant with two 1,000 MW reactors. Construction is to begin in 2013, with completion in 2018. The planned construction site is in Rooppur, northwest of Dhaka. In addition, in September 2012, Prime Minister Sheikh Hasina announced that in addition to the Rooppur Nuclear Power Plant on which construction planning was advancing, another new nuclear power plant would be built in the nation's south.[6]

Bangladesh's potential for hydropower generation is low. Although the nation is crisscrossed by the Ganges, Brahmaputra River, and Meghna Rivers and their

[5] Japan Electric Power Information Center, "Electric utilities in other countries, vol. 2, 2010"

[6] Prime Minister's Office, press releases, 2012.9.6

tributaries and branches, most of its land, except for the hilly country in the east, is flat. There are extremely few places with the sharp changes in elevation needed for hydropower generation. Only one hydropower plant, the Karnafuli Power Plant (five units, total output 230 MW) in the Chittagong Hill Tracts, has been developed to date. According to the United States Agency for International Development (USAID), Bangladesh's hydropower generation potential is 1,897 MW. The Matamuhari and Sangu hydropower projects are under study in the Chittagong Hill Tracts, but it is unclear how realistic they are.

Finally, an overview of the transmission grid in Bangladesh will be presented. The Bangladeshi power grid is divided into east and west regions along the Brahmaputra River, which bisects the center of the country. The eastern region is blessed with natural gas resources and hydropower that utilizes the Chittagong Hill Tracts. Large gas-fired, combined cycle, and hydropower generation are the backbones of the power supply. The western region, however, is poor in resources. Oil- and diesel-fired power generation using imported fuel carries most of the supply load. In order to correct such regional disparities, starting with fuel costs, major substations around urban areas and two 230 kV transmission lines interconnecting the eastern and western region are being constructed.

The country's most advanced international interconnection line is a grid interconnection project with India's West Bengal State. A 400 kV, 125 km long transmission line between Bheramara, Bangladesh and Baharampur, India, is under construction. The Bangladeshi government has signed a contract to import 500 MW of power from India via the line. In the future, it will also be possible for Bangladesh to export power to India. Additionally, large gas fields have been discovered in Tripura State in India's northeast. Construction of an interconnection line to import power from gas-fired power plants in Tripura is now at the planning stage. Furthermore, in Bangladesh's neighbors, hydropower potential is projected at 148,701 MW in India, 42,130 MW in Nepal, and 30,000 MW in Bhutan. Study of international interconnection plans with those nations is also expected.[7]

[7] South Asia Regional Initiative for Energy, USAID

2. Brunei Darussalam's Power Development Plan

Brunei Darussalam ("Brunei") achieved its independence from the UK in 1984. It is a wealthy country, extremely stable politically and economically, with no personal income tax, and well-developed social welfare programs including free medical care. Supporting this stability and wealth are petroleum and natural gas. In the past, those industries accounted for 70 percent of GDP, and today they still account for about 50 percent. Development of petroleum and natural gas began long ago, with production starting in 1929. Ever since, they have driven the economy. Brunei's reserves as of the end of 2011 were estimated at 1.1 billion bbl for oil, with an R/P of 18.2, and 300 billion m^3 for natural gas, with an R/P of 22.5.[8]

In order to maintain stable oil and gas production and exports over the long term, energy policy centers on a "preservation plan." Barring special circumstances, rapid increases in oil and gas production will be avoided, reserves will be added through the discovery of new resources, and proven reserves will not be reduced. In recent years, therefore, Brunei has emphasized development of its deep sea area, which will contribute to stable long-term production. In March 2009, a six-year dispute with Malaysia over territorial waters was resolved. The two countries' maritime borders were finally set. A commercial agreement zone for oil and gas was arranged. Mutually beneficial exploration and development of oil and gas resources is expected. Exploration of mining areas in very deep waters is projected.[9]

Additionally, the government will proceed with joint development of new oil and gas fields together with foreign oil companies. As for domestic energy use, the government promotes energy conservation and diversification of energy sources. It is developing renewable energy, installing combined cycle gas turbine (CCGT) power plants, and campaigning for energy conservation.

Next, an overview of power supply and demand in Brunei will be presented. Electricity supply in Brunei began with the installation in various areas of small-scale diesel generators for home and agricultural use. After the completion of gas supply facilities in the Seria region in 1955, in 1967 the Seria GT Power Plant,

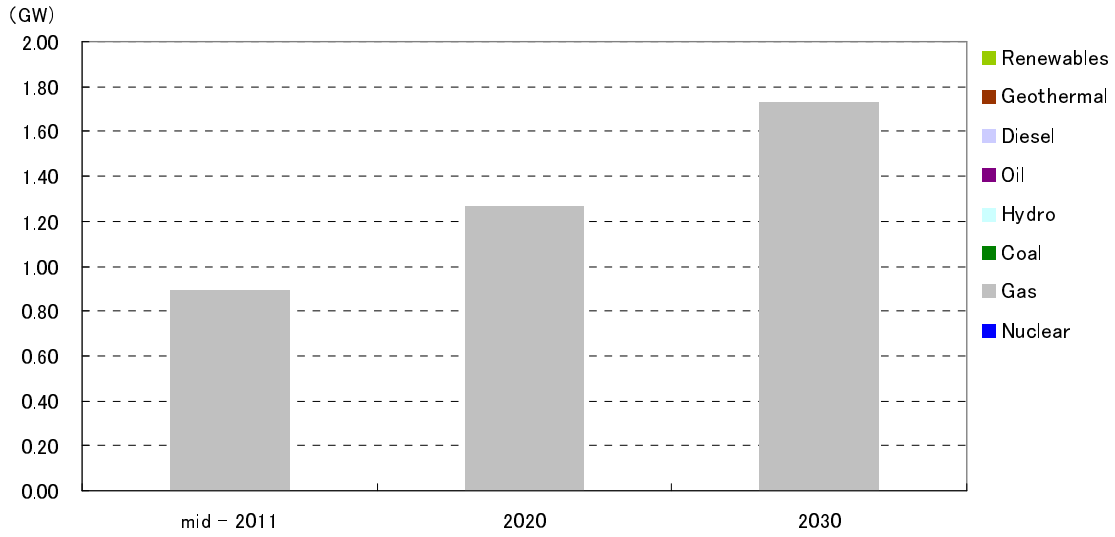
[8] BP Statistical Review of World Energy, June 2012

[9] Japan-Brunei Friendship Association, Brunei News, March 18, 2009

Brunei's first gas turbine power plant, was installed. In conjunction with that, a 66 kV transmission line between Seria and the capital area was completed. Subsequently, as natural gas production increased, it was decided to convert all power plants to gas turbines. With the exception of the Temburong region[10] in the southeast, all power plants were indeed upgraded to gas turbines. All new power plants also had gas turbines installed.

There are two electric utilities in Brunei, the Department of Electrical Services (DES), which is an internal organization of the Ministry of Energy (MOE), and Berakas Power Company (BPC),[11] which mainly provides the power supply to royal palaces, the royal family, and the military. In addition, the oil and natural gas companies Brunei Shell Petroleum (BSP), Brunei Liquefied Natural Gas (BLNG), and Brunei Methanol Co. (BMC) also generate private power and sell their surpluses to the DES.

Figure 2-2: Power Development Plan toward 2020 and 2030 (Brunei)



[10] Temburong power plants are diesel power stations owned by the DES (facility capacity 6.0 MW). They are installed outside the power grid.

[11] The BPC's primary purpose is to supply power to royal facilities, but it also sells excess power to the DES.

Brunei (GW)

	mid – 2011	2020	2030
Nuclear	0.000	0.000	0.000
Gas	0.895	1.266	1.732
Coal	0.000	0.000	0.000
Hydro	0.000	0.000	0.000
Oil	0.000	0.000	0.000
Diesel	0.000	0.000	0.000
Geothermal	0.000	0.000	0.000
Renewables	0.000	0.000	0.000
Total Supply Capacity	0.895	1.266	1.732

Source: IEEJ estimates from ERIA, "ANALYSIS OF ENERGY SAVING POTENTIAL IN EAST ASIA REGION" (2011)

In 2004, the Government of Brunei set a 30-year long-term development plan and established a task force on national vision. Beginning in January 2008, the government launched its long-term plan, which comprises three parts, the 30-year long-term vision "Wawasan Brunei 2035," the 10-year "Outline of Strategies and Policies for Development 2007-2017," and the 5-year "National Development Plan 2007-2012."[12]

However, because there is not enough data to calculate power plant capacity as of 2020 and 2030, estimated electricity outputs from ERIA Research Project Report 2011 "ANALYSIS OF ENERGY SAVING POTENTIAL IN EAST ASIA REGION" were used. According to the report's projections, Brunei's electricity output will increase from its 2009 figure of 3.6 TWh at an annual rate of 1.04 percent to reach 5.5 TWh in 2020, and then increase by 1.03 percent annually from 2020 to 2035 to reach 8.8 TWh.

Based on those figures, power plant capacity as of 2020 and 2030 is estimated to rise from 895 MW in 2011 to 1,266 MW in 2020 and 1,732 MW in 2030. Today, almost all electricity connected to the grid comes from domestically produced natural gas. That is unlikely to change in the future.

Finally, an overview of Brunei's power grid will be presented. With the buildup of power plants in Brunei, transmission line projects are also projected. In concrete terms, extension of a 275 kV transmission line to Kuala Belait in far western Brunei

[12] JPEC Report, August 5, 2011

and interconnection with Sarawak Electricity Supply Corporation (SESCO) in Malaysia is progressing.[13] SESCO's 275 kV transmission line reaches the Tudan substation just outside Brunei. Kuala Belait, Brunei, and Tudan are to be interconnected. This interconnection project has been presented to a HAPUA subcommittee. Future interconnection to Sabah, Malaysia, Kalimantan, Indonesia, and the Philippines is being studied.

3. Cambodia's Power Development Plan

In Cambodia, in the national "Rectangular Strategy" for economic development, development of power infrastructure is a high-priority strategy. Sustainable and steady electricity sector development at accessible prices and economical and environmentally-friendly power facility development are to be carried out.

Today, however, regions with an electricity supply are limited to the capital and major cities. Electrification has yet to reach many areas. Nationally, about 20 percent of households have electricity. In cities, about 80 percent have it, but in rural areas, only about 10 percent do. Even in areas with a nominal electricity supply, many factories, hotels, and so on get their power from their own generators. Thus, potential power demand is likely to be quite large. It is therefore necessary to improve the development situation for generation and distribution facilities to supply inexpensive, stable power.[14]

Cambodia has hydropower, oil, natural gas, lignite, etc., but none of them have been adequately developed. Over 90 percent of the country's electricity output is generated using diesel, which has kept electricity charges high.

The impact of the civil war that started in 1970 and lasted about 20 years kept both technical prowess and financial power low. The hydropower plants now operating are O Chum 2 (1 MW) and Kirirom 1 (12 MW), and Kamchay Power Station (195 MW), which went into operation on December 7, 2011. The Kamchay Power Station, constructed on the Kamchay River in southern Cambodia, was

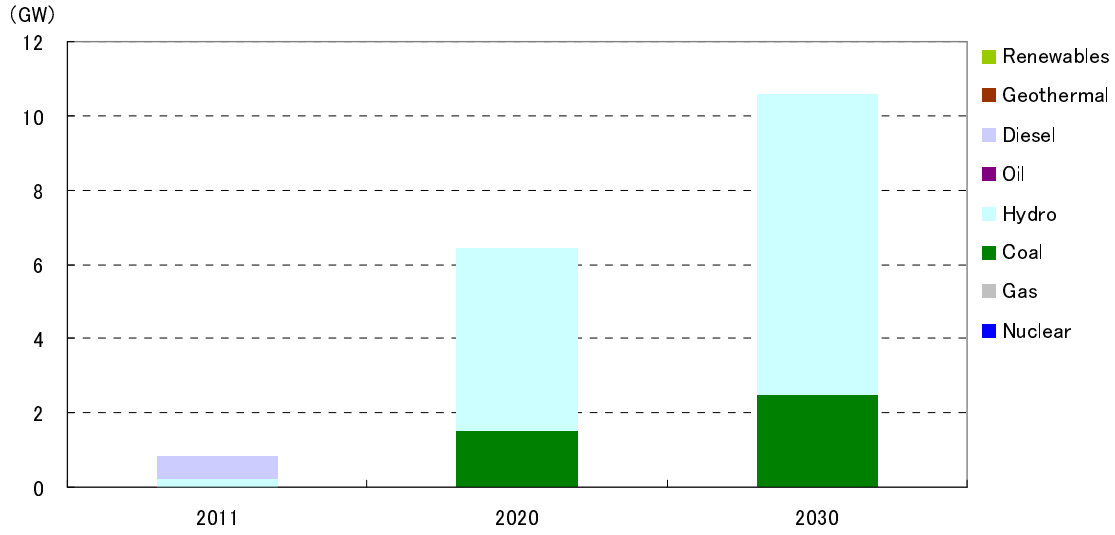
[13] Japan Electric Power Information Center, "Electric utilities in other countries, vol. 2, 2010"

[14] Japan Electric Power Information Center, January 2009

constructed at a total cost of 280 million US$. The Sinohydro Group, which also built the Three Gorges Dam, the world's largest, carried out the construction.[15]

Cambodia is surrounded by highlands and has many rivers, including the Mekong River. It therefore has high expectations for domestic hydropower development, for which the potential is considered high. According to the Asian Development Bank, Cambodian hydropower resources that can be economically developed are approximately 8,600 MW. That includes 6,500 MW on the main Mekong River, 1,100 MW on tributaries, and 1,000 MW not on the Mekong River. The Ministry of Industry, Mines, Energy (MIME), on the other hand, estimates the potential at 10,000 MW (5,000 MW on the main Mekong River, 4,000 MW on tributaries, and 1,000 MW not on the Mekong River). The Electricity Authority of Cambodia estimates the hydropower potential that it is technically possible to develop at 6,700 MW (broken down the same as above at 3,580 MW, 1,770 MW, and 1,340 MW).

Figure 2-3: Power Development Plan toward 2020 and 2030 (Cambodia)



[15] Morningstar, December 8, 2011

Cambodia (GW)

	2011	2020	2030
Nuclear	–	–	–
Gas	–	–	–
Coal	0.010	1.518	2.497
Hydro	0.207	4.924	8.101
Oil	–	–	–
Diesel	0.600	–	–
Geothermal	–	–	–
Renewables	0.002	0.002	0.002
Total Supply Capacity	0.819	6.444	10.600

Source: Power Development Plan

Cambodia's power source development plan was set by Electricity Du Cambodia (EDC) in 2008. It is progressing based on the country's long-term power supply strategy through 2022, the "Master Plan on Power Sector Development of Kingdom of Cambodia." The master plan sets forth the following goals.

1. Increase hydropower and coal-fired generation in addition to diesel
2. Develop a power grid interconnecting the nation
3. Electrification of outlying areas
4. Study frameworks for electricity trading with Vietnam, Thailand, Laos, and other ASEAN nations
5. Promote commercialization and participation by private capital, and set up electricity market competition and regulatory policy

The Ministry of Industry, Mines, Energy's (MIME) most recent "Power Development Plan" calls for construction of 4,717 MW of hydropower and 1,508 MW of coal-fired power by 2020. If development proceeds according to plan, as of 2020 power plant capacity will be 4,924 MW hydropower and 1,518 MW coal-fired power. Hydropower is thus projected to account for more than 75 percent of Cambodia's total capacity. With that great improvement from the current power source mix that heavily depends on diesel, the high electricity charges that are now an issue are expected to fall.

On the other hand, because plans beyond 2020 are not clear, the power source mix as of 2030 was estimated using estimated electricity output from the ERIA Research

Project Report 2011 "ANALYSIS OF ENERGY SAVING POTENTIAL IN EAST ASIA REGION." According to the report, Cambodia's electricity output of 1.2 TWh in 2009 is projected to increase to 8.2 TWh in 2020, and then increase at an annual rate of 1.05 percent to reach 17.3 TWh in 2035. Estimation of Cambodia's power plant capacity in 2030 based on this found an increase to 10,600 MW (with hydropower major the main power source at 8,101 MW, and coal at 2,497 MW). Today, Cambodia imports electricity from Thailand and Vietnam, but with the increase in hydropower, it is projected to become an electricity exporting nation.

Finally, an overview of Cambodia's transmission grid will be touched on. Its transmission lines are mainly in two grids only, around Phnom Penh and around Siem Reap. Those grids are independent, unconnected to each other. The grid around Phnom Penh is formed by a 230 kV transmission line from Vietnam via the Takeo Substation and a 115 kV transmission line that brings power to the capital from the Kirirom 1 hydropower plant. In 2007, a 115 kV transmission line from Thailand was connected to the Siem Reap area, which has the nation's second highest power demand. Other cities only have their own independent distribution grids. That is one reason for the low rate of electrification in Cambodia.

As for international interconnection plans, the Ministry of Industry, Mines, Energy (MIME) has set the following goals for electricity trading with neighboring countries.

- Cooperate on Cambodia's domestic generation and transmission plans in order to trade electricity with neighboring countries
- Coordinate electricity trading with neighboring countries in order to improve supply reliability and ensure energy security
- Facilitate power procurement in order to reduce poverty in mountainous and border areas and to improve lives materially and psychologically

Thus, in light of estimated increases in power demand in Cambodia, it is necessary to advance power source development plans for hydropower with its high potential in particular, and at the same time advance plans for transmission line expansion in terms of both domestic and international interconnection.

4. China's Power Development Plan

In Chinese energy policy, the National Energy Commission, which was established in the first session of the 11th National People's Congress in March 2008, is the decision-making body for national energy strategy. The National Energy Administration absorbed the functions of the China Atomic Energy Authority, which had been in charge of nuclear energy policy, and was upgraded to quasi-ministerial status. Under the umbrella of the National Development and Reform Commission, the National Energy Administration is in overall charge of energy administration as the executive office of the National Energy Commission.

China's latest basic policy on energy is laid out in the "Medium- and long-term plan for energy development (2005–2020)" (published June 2004). It is based on the following eight policies.

1. Make energy conservation a highest priority measure and raise energy efficiency.
2. Optimize the energy mix and adhere to an all-out development strategy for coal, electricity, oil, natural gas, and new energy.
3. Rationally allocate energy resources development. Comprehensively consider the rational allocation of energy production, transport, and consumption in accordance with demand in the eastern, central, and western parts of the country and in urban and rural areas.
4. Utilize both domestic and foreign resources.
5. Promote the progress and updating of science and technology and strengthen scientific management.
6. Strengthen environmental protection and bear resource constraints and environmental tolerance in mind.
7. Pay a high degree of attention to energy safety and proceed with the diversification of the energy supply.
8. Set a security policy for energy development.

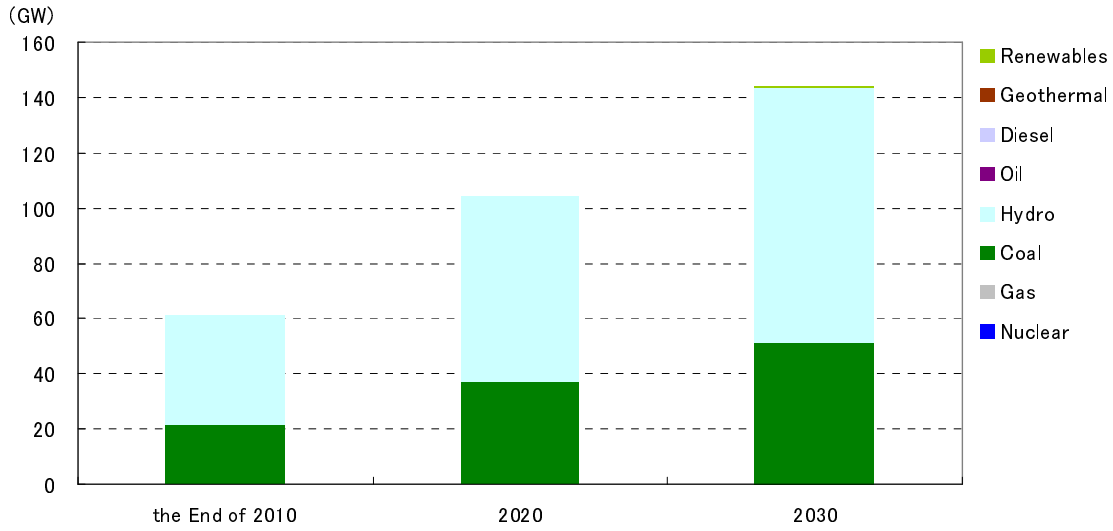
China's short- and medium-term policies are based on five-year plans that are reset every five years. The latest (12th) plan period is 2011–2015.

In the "12th Five-Year Guideline on National Economic and Social Development," announced in March 2011, the economic growth rate for the following five years is set at 7.0 percent. By 2015, non-fossil energy is to account for 11.4 percent of primary consumption, energy consumption per GDP unit is to decrease by 16 percent from the 2010 level, and CO_2 emissions are to decrease by 17 percent from the 2010 level. The "12th Five-Year Plan for Energy Development," set by the Managing Director Board of the State Council in October 2012, lists the following seven items as priority areas.

① Enhancement of the exploration and development of domestic resources
② Promotion of a shift to highly efficient and clean energy
③ Promotion of reform of the means of supplying energy
④ Acceleration of the construction of facilities for energy storage and transport and enhancement of reserves and ability to respond to emergencies
⑤ Implantation of civilian energy projects and promotion of the equalization of urban and rural public energy services
⑥ Rational regulation of total energy consumption
⑦ Rationalization of frameworks for energy price formation in important sectors such as electricity, coal, oil, and natural gas, and adherence to energy security through the encouragement of private sector capital participation in the energy sector and the deepening of international cooperation

As for projected power demand, the "12th Five-Year Plan for Energy Development" projects that electricity consumption will rise at an average annual growth rate of 8 percent from 4,200 TWh in 2010 to 6,150 TWh in 2015.

Figure 2-4: Power Development Plan toward 2020 and 2030
(China [Yunnan & Guangxi])



China (Yunnan & Guangxi) (GW)

	the End of 2010	2020	2030
Nuclear	–	–	–
Gas	–	–	–
Coal	21.720	37.073	51.083
Hydro	39.290	67.063	92.405
Oil	–	–	–
Diesel	–	–	–
Geothermal	–	–	–
Renewables	0.370	0.370	0.370
Total Supply Capacity	61.380	104.506	143.858

Source: IEEJ estimates from China Electricity Almanac

The "12th Five-Year Plan for Energy Development" discusses projections for power source development. It estimates that the 970 GW of installed capacity as of 2010 will increase to 1,490 GW as of 2015. The plan also includes the following projections for installed capacity for each power source.

Table 2-1: Outlook of Power Generation Capacity

	Unit	2010	2015	AAGR
Coal	GW	660	960	7.8%
Hydro	GW	220	290	5.7%
Nuclear	GW	10.82	40	29.9%
Gas	GW	26.42	56	16.2%

Wind	GW	31.00	100	26.4%
Solar	GW	0.86	21	89.5%
Total	GW	970	1,490	9.0%

Source: 12th Five-Year Plan for Energy Development.

China has abundant domestic coal reserves, and generation cost is low, so coal-fired power plants account for most power plant capacity (about 80 percent). Small electric utilities hold about 40 percent of China's power plant capacity. Their thermal power plants are aging and low in energy efficiency. In 2007, the National Development and Reform Commission therefore pursued the closing of small units and issued a "Notice of the promotion of the shutdown of small thermal power generation" and a "Notice of the lowering of wholesale electricity rates for small thermal power generation and the promotion of its shutdown." Additionally, 194 supercritical pressure units (as of the end of 2010) and 39 1-GW ultra-supercritical pressure units (as of the end of 2011), which have greater generating efficiency, have been installed. As a result of those measures, average thermal efficiency improved from 33.3 percent in 2005 to 36.9 percent in 2010.

China has the most domestic hydropower resources of any country in the world, with 541.64 GW technically capable of being developed. China has worked to build small-scale hydropower plants since its founding. Today, it is proceeding with medium- and large-scale plants, such as the Three Gorges Dam, which began operating at its planned installed capacity (22.5 GW, the world's largest generating capacity) in 2012. In addition, there are signs that full-fledged development may begin on the Yarlung Tsangpo River in Tibet Autonomous Region, which has a technically developable capacity of 67.85 GW, but where little work has been done.

China's hydropower resources are skewed towards the southwestern side of the country. In order to transport electricity to the eastern coastal area where demand is high, long-distance transmission lines of 1,000–2,700 km will be needed. Extra-high-tension (800 kV) direct current transmission is therefore planned.

China is also working on the development of nuclear power. As of January 2013, it had 16 reactors in operation and 29 under construction. Using technology from other countries, i.e., Russia (Rosatom VVER light water reactor), the USA, (Westinghouse

AP1000 light water reactor), and France (AREVA EPR light water reactor), China is rapidly proceeding with construction of nuclear facilities.

Following the Fukushima Daiichi nuclear accident in March 2011, new construction permits for nuclear plants were frozen, but as of the end of 2012, permit procedures had returned to normal. The "12th Five-Year Plan for Energy Development" estimates 4,000 MW of installed capacity for nuclear power in 2015. According to the "nuclear power medium- and long-term development plan" announced in November 2007, installed capacity for nuclear power was to be increased to 4,000 MW by 2020. The 12th Five-Year Plan does not address installed capacity in 2020. Reuters and others have reported that there are plans for 58,000 MW of installed capacity as of 2020.

As for renewable energy, China has promoted the adoption of individual types, as with the "Catch the Wind Plan" to nationalize wind power generation and the "Lighting Process" that plans to bring electrification through wind and solar power to non-electrified areas. The Renewable Energy Law passed in 2006 prepared basic frameworks for development, installation, and dissemination. Under the law, 1) all renewable energy power must be purchased, 2) wholesale electricity charges must be approved by the government, and 3) costs are to be shifted to retail electricity charges.

Additionally, China has adopted a renewables portfolio system (RPS) for power producers. For producers with at least 5 GW eligible capacity (installed capacity at wholly-owned power plants + invested power plants × investment ratio), installed capacity of renewable energy (other than hydropower) must account for at least 3 percent of total capacity in 2010 and at least 8 percent in 2020.

The 12th five-year plan concerning the development of renewable energy, published in August 2012, includes the following goals for renewables to be achieved by 2015. 1) They are to account for at least 9.5 percent of primary energy demand, and 2) 160 GW (hydropower 60 GW, wind power 70 GW, solar 20 GW, biomass 7.5 GW, etc.) of new power plant capacity is to be installed. According to the China Wind Energy Association (CWEA), whose record on installing wind power is remarkable, at least 10 GW of wind power generation facilities have been added every year since 2008. At the end of 2012, there had been an increase of 14.049 GW,

to reach 76.413 GW. As of the end of 2012, solar power installed capacity was 7,000 MW, an increase of almost 5,000 MW since the end of 2011.

An overview of international collaboration follows below.

In addition to the Chinese territories of Hong Kong and Macao, China carries on electricity trading with neighboring countries such as Russia, North Korea, Mongolia, and Vietnam. However, because the scale was small, the central government was not involved. Instead, each province's power companies carried it out on its own, and often the objective was simply peak exchanges.

China annually imports about 300 GWh of electricity from Russia, but when the planned direct current transmission line between the Amur River and Tianjin is competed, power will be transmittable with small loss from Siberia's rich hydropower resources to Beijing. In 2008, the government therefore approved a construction project that will connect with Russia over a 500 kV transmission line.

Yunnan Province and other areas are connected with Vietnam via 220 kV and 110 kV transmission lines for electricity export. Since power demand in Yunnan is not that high, the amount of electricity exported to Vietnam had been increasing. However, along with the necessity of increasing transmission capacity to Guangdong Province, balance within Yunnan has become an issue. Additionally, as will be discussed in the Vietnam section, the Vietnamese side has been thinking that it would like to curb electricity imports. For those reasons, it is unclear how long stable transmission will continue.

On the other hand, China imports electricity from Myanmar over an international collaboration line constructed between Myanmar's Shweli Hydropower Plant and China's Dehong Substation. Under a September 2009 agreement, the purchase price for electricity from the Shweli power plant is 0.184 yuan/kWh (about 2.9 yen/kWh).

5. India's Power Development Plan

Energy policy in India is set by the Ministry of Power based on energy five-year plans. The Central Electricity Authority (CEA) sets detailed power source

development plans during each five-year period. The latest plans, published in January 2012, are the "12th Five-Year Plan (2012-2017)"[16] and the "National Energy Plan."[17]

In the 12th Five Year Plan, during the 12th Period (2012-2017) and the 13th Planning Period (2017-2022), in the base case scenario annual GDP growth is assumed to be 9 percent, with 0.9 and 0.8 values of elasticity. In the final year of the 12th Planning Period, FY 2016 (April 2016 through March 2017, other fiscal years below are the same), estimated total demand is 1,403 TWh. In the final year of the 13th Planning Period, FY 2021, estimated total demand is 1,993 TWh. In the base case scenario, with load factors of 78 percent and 76 percent, peak demand values are estimated at 197,686 MW in 2017 and 289,667 MW in 2022. For sensitivity analysis, with the elasticity value set at 1, total demand in 2017 is estimated at 1,489 TWh, and peak demand value at 209,339 MW. These estimates are based on the 17th Electric Power Survey (EPS), released in March 2007. According to a draft version of the 18th EPS, total demand is 1,354 TWh, and peak demand is 199,540 MW, so the demand estimate is about the same.

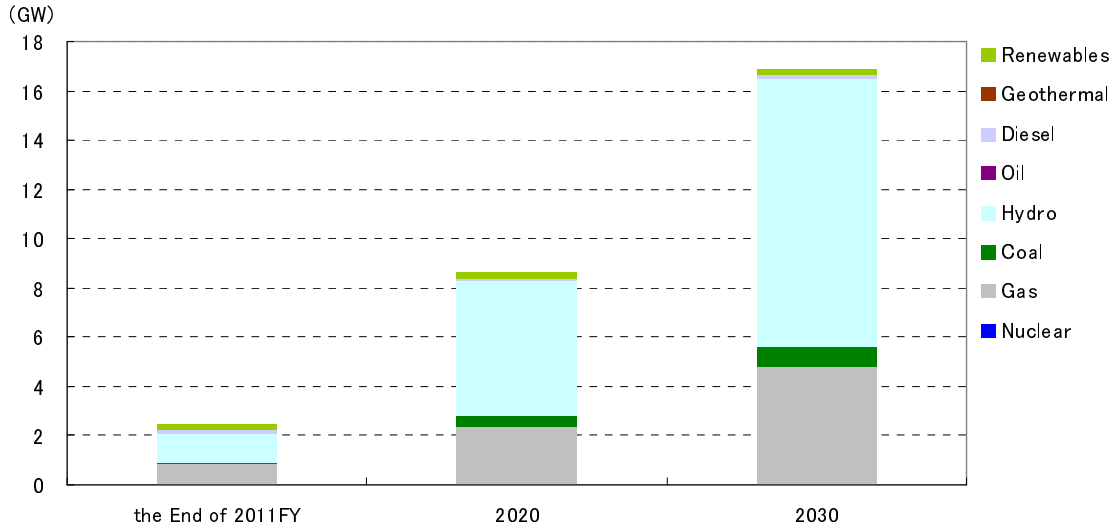
Additionally, according to the 12th Five Year Plan, for more than six years, power demand will exceed generation capacity. In FY 2010, power fell short of total demand by 73.236 TWh (8.5 percent) and of peak power by 12,031 MW (9.8 percent). Along with promotion of power source development, improvement of energy efficiency and enhanced demand side management are noted as major issues.

The changes in power source development shown below are for Northeast India (Assam, Nagaland, Meghalaya, Manipur, Tripura, Mizoram, and Arunachal Pradesh), so the figures differ from those in the CEA plan discussed below.

[16] Report of The Working Group on Power for Twelfth Plan(2012-2017), January 2012, Government of India Ministry of Power

[17] National Energy Plan, January 2012, CEA

Figure 2-5: Power Development Plan toward 2020 and 2030 (N-E India)



India (North East) (GW)

	the End of	2020	2030
Nuclear	–	–	–
Gas	0.824	2.383	4.756
Coal	0.060	0.422	0.842
Hydro	1.200	5.460	10.898
Oil	–	–	–
Diesel	0.143	0.143	0.143
Geothermal	–	–	–
Renewables	0.228	0.228	0.228
Total Supply Capacity	2.455	8.636	16.867

According to the National Energy Plan set by the CEA in January 2012, in order to respond to chronic power shortages during the 11th Planning Period (2007-2012), a large volume of base load power sources was added. However, because demand disparities between day and night and between workdays and holidays are expanding, simply adding base load power sources is considered inadequate. Additionally, based on a low-carbon growth strategy, minimization of carbon dioxide emissions volume is also necessary.

Therefore, in the National Energy Plan, installation of hydropower, nuclear power, and renewable energy is to be promoted. During the 12th Planning Period, in the base case scenario, installation of 79,690 MW of new power sources is planned. Breaking down the base case, that will be hydropower 9,204 MW, nuclear power 2,800 MW, coal-fired 66,600 MW, and gas-fired 1,086 MW. The generation capacity

for renewable energy is estimated separately from conventional power sources. In the low installation case, it is 18,000 MW, and in the high installation case, it is 18,500 MW. Separately from that, 1,200 MW of electricity imports is also under consideration, and 4,000 MW of power plant capacity will be shut down during the period.

During the 13th Planning Period, in the base case scenario, 79,200 MW of power sources will be installed. Broken down, that is hydropower 12,000 MW (not including 8,040 MW imported from other countries), nuclear power 18,000 MW, and coal-fired 49,200 MW. At least during the next 10 years, coal-fired power will be the mainstay. Renewable energy in the low installation case will be 30,500 MW, and in the high installation case, it will be 45,000 MW.

India is rich in domestic hydropower resources and is actively developing hydropower plants. According to the CEA, there are 83 candidate sites that could possibly begin operation during the 12th and 13th Planning Periods. Their total development potential as hydropower plants is 22,011 MW. They include some on which construction has already begun, and others where there are geographical or environmental uncertainties. During the 12th Planning Period, 31 sites are projected to begin operating, with an estimated 9,204 MW developed.

With no help from the international community since it carried out nuclear testing, India has developed and installed its own heavy water reactors. Their output, however, remains lower than that of the light water reactors in other countries. In recent years, therefore, India has been proceeding with the construction of nuclear power plants that adopt foreign technology. The CEA projects that four nuclear power reactors, each a heavy water reactor with 700 MW of output and thus totaling 2,800 MW, will go into operation during the 12th Planning Period. They are Rajasthan No. 7 and 8 and Kakrapar No. 3 and 4. No light water reactors are projected to begin operating during the period.

In order to reduce CO_2 emissions volume, the CEA intends to promote the installation of combined cycle gas turbine (CCGT) coal-fired plants, which have a high efficiency of about 55 percent versus the 38–40 percent efficiency of existing coal-fired plants. In light of factors such as transmission efficiency, gas-fired power plants should be built near demand areas.

During the 12th Planning Period, because of concerns over a tight coal supply and in order to cut CO_2 emissions volume, the CEA intends to install 12,000–15,000 MW of gas-fired power plants. However, of gas-fired power plants now under construction, only 1,086 MW of them have a sure gas supply planned. That is the estimate for the base case scenario. Of gas-fired power plants that are under construction or completed, 13,184.5 MW of them do not have a gas supply specified yet.

Regarding India's adoption of renewable energy, the Ministry of New and Renewable Energy (MNRE) puts India's domestic wind power development potential at 45,000 MW. Expectations are high. There are also other unconventional power sources (biomass, small and micro hydropower, wave power, and solar). The MNRE projects renewable energy to expand to a total of 183,000 MW in about 2032. However, the CEA notes that renewable power sources cannot change output in accordance with demand, so it is not responsive to peak power demand. In addition to that problem, costs are higher than with conventional power sources, so (in order to make them economically viable) their use for now should be limited to power transmission to distant areas that would be very expensive to connect to the grid and to the elimination of supply and demand gaps in isolated areas, etc. In order to promote the dissemination of relatively expensive renewable energy, there are an FIT system and subsidies for all renewable energy (wind power, small hydropower of 25 MW or less, solar, biomass, biogas, etc.).

Regarding the installation of renewable energy, the CEA estimates that in the low installation case, during the 12th Planning Period, wind power 11,000 MW, solar 4,000 MW, and other 3,500 MW will be installed for a total of 18,500 MW, while during the 13th Planning Period, wind power 11,000 MW, solar 16,000 MW, and other 3,500 MW will be installed for a total of 30,500 MW. In the high installation case, the estimate for the 12th Planning Period is wind power 15,000 MW, solar 10,000 MW, other 5,000 MW, total 30,000 MW, while for the 13th Planning Period, it is wind power 20,000 MW, solar 20,000 MW, other 5,000 MW, total 45,000 MW.

An overview of international collaboration follows.

India has built good bilateral relations with Bhutan. India has constructed large hydropower plants in Bhutan, which has abundant hydropower resources, and imports electricity from that country. Today, Bhutan has hydropower plants in three places (Chukha, Kurichu, and Tala), with a total output of 1,416 MW. India imports electricity from them via international interconnection lines. Hydropower plants with a total output of 2,940 MW are now under construction in three places (Punatsangchhu Phases 1 and 2 and Mangdechu). The electricity generated by those plants will also be imported by India over newly established international interconnection lines. In addition, detailed project reports (DPRs) for six sites have been approved or submitted, and another is being prepared. For the three competed sites, 60 percent of the construction funds were provided by India, and the remaining 40 percent consisted of loans from India. For the projects now under construction, 60–70 percent of the funding is loans from India, and the remainder is to be provided by India.[18]

Neighboring country Nepal is also projected to have abundant hydropower, and there are plans for India to import electricity over interconnection lines. Construction of a tie line between Dhalkebar, Nepal, and Muzaffarpur, India, is planned. The project will cost 182.3 million dollars, with 99 million dollars to be borrowed from international banks. According to a report from an international bank dated March 2013, a construction contract was to be signed in June 2012, but it still had not been signed, and construction had not begun. With a transmission capacity of 1,000 MW, operation is scheduled to begin in 2016.[19] According to the CEA, in addition to the four sites in Nepal where India is cooperating on hydropower plant construction (Pokhra, Trisuli, Western Gandak, and Devighat), hydropower plant construction through joint funding at four other sites is being considered.[20]

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[18] COOPERATION WITH BHUTAN, 2013/2/28, CEA

[19] Nepal-India Electricity Transmission and Trade Project and South Asia - Nepal-India Electricity Transmission and Trade Project : P115767 - Implementation Status Results Report : Sequence 04 (2013/3/26), The World Bank

[20] Indo- Nepal Cooperation in Hydro Power Sector, CEA, 2013/2/28

6. Indonesia's Power Development Plan

Indonesia's power development plan is the National Power General Plan (RUKN) set by the Ministry of Energy and Mineral Resources (MEMR) for the coming 20 years based on energy policy and environmental policy. Additionally, the Indonesia State Electricity Company (PLN) sets the Electricity Power Supply Business Plan (RUPTL), a detailed 10-year plan for the power supply based on the RUKN.[21]

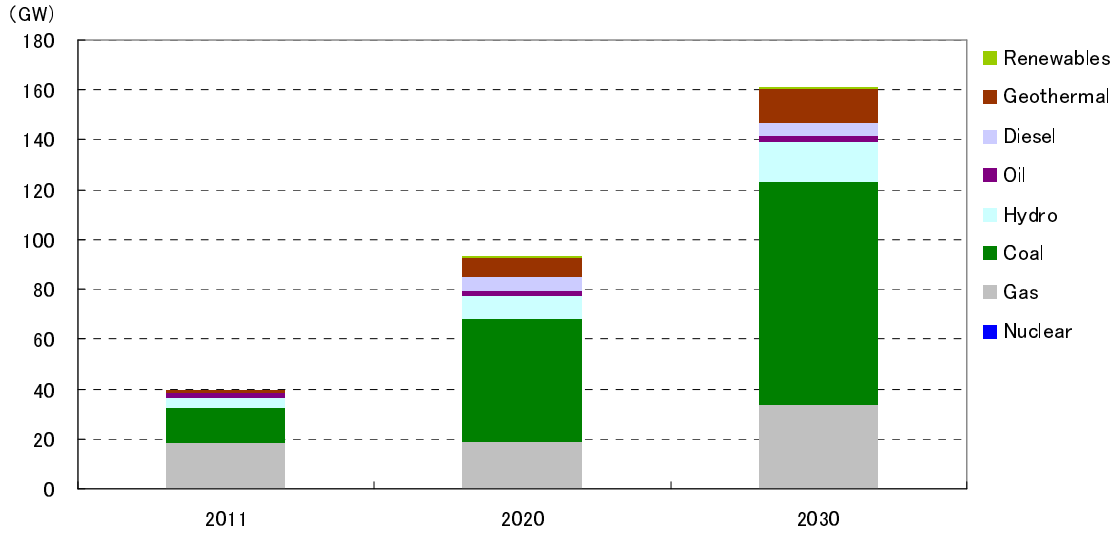
According to the "RUPTL 2011-2020," which is the power development plan for 2011 through 2020, power demand during the period is projected to grow at an average annual rate of 8.5 percent, reaching 328.3 TWh in 2020. Maximum demand as of 2020 is projected to be 55,053 MW, an average annual growth rate of 8.14 percent.

By region, projected demand for Java and Bali is 241.2 TWh in 2020, with an average annual growth rate of 7.8 percent. Eastern and western Indonesia, where the electrification rate has been low, are projected to grow at a faster rate than Java and Bali are. Eastern Indonesia is predicted to grow at an average annual rate of 10.8 percent to 31.7 TWh in 2020. Western Indonesia is predicted to grow at an average annual rate of 10.2 percent to 55.3 TWh in 2020.

In order to meet that demand, expansion and improvement of all facilities for production, transmission, and distribution is essential.

[21] Japan Electric Power Information Center, "FY 2010 Report on survey of electric power in Indonesia"

Figure 2-6: Power development plan toward 2020 and 2030 (Indonesia)



Indonesia (GW)

	2011	2020	2030
Nuclear	–	–	–
Gas	18.399	18.668	33.632
Coal	14.018	49.689	89.521
Hydro	3.881	8.983	16.183
Oil	2.250	2.250	2.250
Diesel	–	5.472	5.472
Geothermal	1.209	7.502	13.516
Renewables	0.129	0.758	0.758
Total Supply Capacity	39.885	93.322	161.332

Source: Power Development Plan (MEMR)

In "RUPTL 2011-2020," a power development plan for 2011 through 2020 is laid out in order to meet the above-mentioned power demand. Development of 53,700 MW of generating facilities by 2020 is projected. By producer, PLN accounts for 31,376 MW (58.4 percent) and IPPs for 22,324 MW (41.6 percent).

Breaking down the power development plan through 2020 by type, coal-fired power plants account for the majority of power plants to be built, with a total capacity of 34,300 MW (not counting coal gasification) accounting for 63.8 percent of the whole. Meanwhile, gas-fired power plants and combined cycle power plants together are 7,400 MW (13.7 percent). As for renewable energy, geothermal has the largest planned share at about 6,100 MW (11.3 percent), followed by hydropower at around 5,700 MW (10.6 percent).

By producer, both PLN and IPPs will carry out development centered on coal-fired power plants. National policy of moving away from oil and effectively utilizing domestically produced coal is obviously reflected.

For changes in power plant capacity towards 2020 and 2030 in this study, estimates were made based on information from the Ministry of Energy and Mineral Resources (MEMR). According to this information, total power plant capacity as of 2020 will be 93,322 MW. Of this, the major power source of coal-fired thermal will account for 49,689 MW. Total power plant capacity as of 2030 is projected at 161,332 MW, with coal-fired thermal increasing to 89,521 MW.

According to a 2010 report by the Ministry of Energy and Mineral Resources (MEMR), Indonesia's coal reserves total 21.1 billion tons (9.9 billion tons in Kalimantan and 11.2 billion in Sumatra). In light of increasing domestic demand and the strength of inquiries from the international market, production capacity is expected to rise. Because high-quality coal is being aggressively exported as a means to acquire foreign currency, low-quality coal such as lignite and subbituminous coal is the heart of the domestic supply. Therefore, if power source development is to proceed according to plan with the focus on coal, ensuring supply and quality are issues that must be addressed.

In terms of ensuring supply, the Indonesian government has developed a domestic market obligation (DMO) policy. Coal producers are required to set aside a portion of production for domestic use. Additionally, the need to improve supply infrastructure so that the coal produced at mines can be transported to power plants nationwide is recognized. In terms of quality, there are many issues. Low-quality coal such as lignite and subbituminous coal has high moisture content and low heat output, so generating efficiency is low, and CO_2 emissions volume is high for the amount of electricity generated. Expectations are therefore high for the establishment and commercialization of clean coal technology for more efficient coal-fired power plants.

Indonesia has abundant natural gas resources, with 164.99 Tscf. Large amounts have been confirmed in the Natuna Islands, South Sumatra, and East Kalimantan. However, most of those large gas fields have been tied up in export-oriented long-term contracts. Moreover, because of booming domestic demand, an adequate supply

of natural gas for power plants is not projected. Expectations are therefore high for ensuring supply capacity through steady progress on currently planned gas field development projects and further development of gas pipelines.

The "Master plan survey on Indonesia's geothermal development" carried out by West JEC in 2007 is a survey report on Indonesia's geothermal resources and stockpile. According to the report, 50 sites with 9,000 MW can be developed in Indonesia. The potential is at least 12,000 MW. In "RUPTL 2011-2020," many geothermal power projects are included in Sumatra, Java, North Sulawesi, Nusa Tenggara, and Maluku in particular. In Indonesia's remote areas, especially its outlying islands, diesel generation is the most common power source. Because of fuels costs and CO_2 emissions as well, it is therefore planned to effectively utilize what is said to be the world's greatest geothermal potential and develop geothermal power plants as an alternative power source. For the power source plan to progress steadily, it is expected that the government will contribute funds for development and that CDM will be commercialized.

Indonesia also has high hydropower development potential. Nippon Koei's 2011 "Master plan survey for the development of hydropower in Indonesia" reported finding a potential of 26,321 MW. On the so-called outer islands other than Java, although development of large hydropower plants is possible, power demand is low because of the population density distribution, and the cost of transmission to demand areas is very high. Site selection for development is therefore very important.

Nuclear power is not included in the "RUPTL 2011-2020." Although nuclear power plants are under consideration as a very promising power source to meet Indonesia's power demand, lack of clarity on capital costs, spent fuel disposal and storage costs, and reactor decommissioning costs is an issue. Detailed construction plans that address multiple factors such as political issues, safety, and community acceptance in addition to economic and energy issues have not been made clear.

Finally, an overview of international interconnection will be presented. At this time, Indonesia has no record of electricity import/export with any neighboring country. However, international interconnection plans with Malaysia and Singapore are under study. As discussed above, Indonesia has a shortage of gas for domestic consumption because of the need to maintain its gas exports to other countries.

Effective utilization of coal, for which abundant reserves have been confirmed, is planned. On the other hand, most thermal power plants in Singapore burn gas supplied by pipeline from Malaysia and Indonesia. Improvement of that skewing towards gas firing has been raised as an issue in terms of energy security and fuel costs. Indonesia exporting coal-fired power to Singapore is expected to optimize power in the region. It would help Indonesia solve its domestic gas shortage because of the export gas supply, and allow Singapore to diversify its energy sources and lower electricity rates.

7. Laos's Power Development Plan

Laos's power development plan focuses on hydropower, except for small-scale things not connected to the grid. Flowing out of China's Yunnan Province, the Mekong River flows from north to south through Laos for 1,500 km. a number of rivers flow into the Mekong from highlands such as the Annamite Range. Its development potential is very high. It has been theoretically put at 26,000 MW or 30,000 MW, so there is enormous room left for development. As of the end of 2011, installed capacity was 2,570 MW.

The Laotian government therefore considers hydropower projects to be an important sector that contributes to economic growth and fighting poverty. It names the objectives of such power source development as "ensuring a stable and adequate power supply in the nation" and "acquisition of foreign currency through promotion of the export of electricity from hydropower."

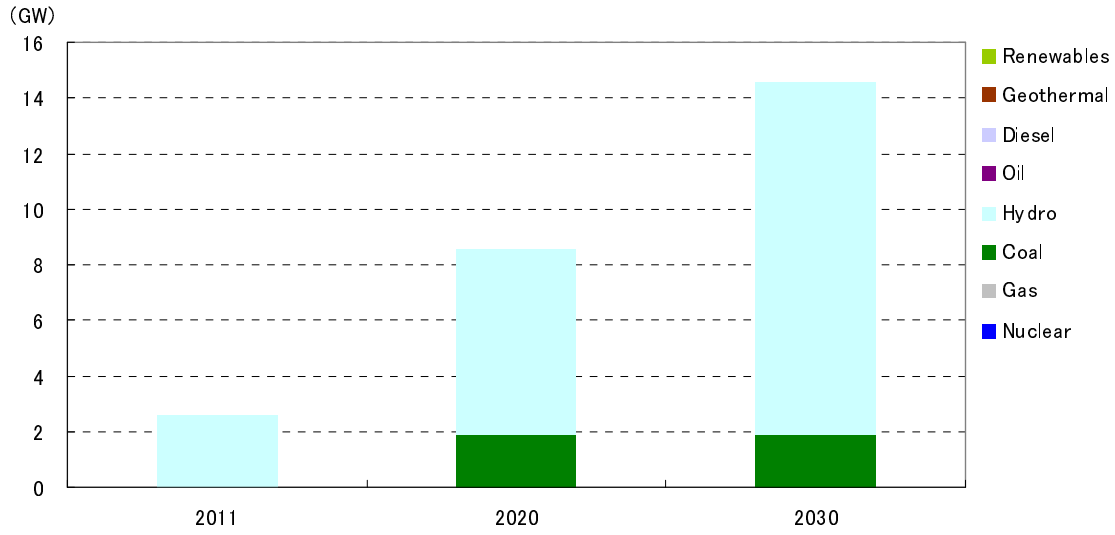
It is planning and attempting a basic policy of promoting IPP power source development through the BOOT (Build, Own, Operate and Transfer) method[22] is an example of that.

As for the domestic electricity supply, in contrast, power demand areas are scattered through mountainous land, and despite being surrounded by those abundant water resources, many areas are geographically difficult to connect to the grid for

[22] The method in which private-sector corporations undertake construction, including procurement of funds, and, after completion, own the project for a fixed period of time, receiving the profit from operation, and then transfer ownership.

electrification. Therefore, renewable energy such as solar, biomass, and small-scale hydropower has an important role to play. Currently operating power sources are small-scale hydropower at 6.2 MW, solar at 2.2 MW, and the only thermal power, diesel at 1.7 MW.

Figure 2-7: Power Development Plan toward 2020 and 2030 (Laos)



Lao (GW)

	2011	2020	2030
Nuclear	–	–	–
Gas	–	–	–
Coal	–	1.878	1.878
Hydro	2.570	6.646	12.689
Oil	–	–	–
Diesel	0.002	0.002	0.002
Geothermal	–	–	–
Renewables	0.008	0.008	0.008
Total Supply Capacity	2.580	8.534	14.577

Source: Powering Progress.

Regarding Laos's power development plan, the Department of Energy Promotion and Development (DEPD) publishes on its website "Powering Progress" (http://www.poweringprogress.com) detailed data on projects in the construction, planning, and feasibility study phases.

First, projects under construction will be discussed. Laos is currently constructing power plants at 12 sites. The relatively small projects are planned for

domestic use, while the large ones are planned for electricity export. Hydropower projects account for the majority, but the only project scheduled to be in operation in 2015 is the Hongsa Lignite power plant (1,878 MW), which will use lignite as its energy source and become the nation's first large coal-fired power plant.

Against the background of the abundant water resources of the Mekong River system, Laos has built hydropower generation. However, hydropower is characterized by sharp fluctuations in output between rainy and dry seasons, so the annual average operating rate is only 40–60 percent. If there is a dry season supply and demand gap, Laos will have to import electricity from Thailand. Expectations are therefore rising for the adoption of thermal-fired power as a stable base power source. However, the Electricity Generating Authority of Thailand (EGAT) has a contract to purchase up to 95 percent of the power plant's electricity output, so it will not be a dramatic solution. The number one candidate for a base power source is coal-fired thermal power using domestically produced lignite.

Regarding the Xayabouri hydropower plant (1,285 MW) under construction in northern Laos, a ministerial-level meeting of the Mekong River Commission (comprising Thailand, Vietnam, Cambodia, and Laos) held on December 8, 2011, decided to postpone the construction plan and carry out environmental impact assessment. It is now uncertain when the plant will go into operation.[23]

Power plant projects in the planning phase in Laos are all hydropower plants. Twenty-five of them are listed. Construction of power plants at five sites (combined output of 970–1,270 MW) as power sources for export to Vietnam and Thailand is in the planning phase.

All the power plants currently in the feasibility study phase are also hydropower plants. Including large power sources, over the medium- and long-term (from 2020 on), they will meet increases in domestic demand. At the same time, they are expected to become an important means of foreign currency acquisition for Laos. There are currently 35 power plant sites totaling about 7,750 MW undergoing feasibility studies.

[23] Asahi Shimbun, December 9, 2011

Finally, an overview of the transmission grid in Laos will be presented. Laos's transmission lines to Thailand for electricity export include 500 kV transmission lines from the Nam Ngum 3 and Nam Theun 2 hydropower plants, and 230 kV transmission lines from the Thenm Hinboun and Houay Ho hydropower plants. There are also transmission lines under 115 kV with Cambodia, China, Vietnam, and Thailand, but none of these are interconnected to the domestic grid.

The domestic grid currently comprises only 115 kV transmission lines in the vicinities of the capital, Vientiane, and cities in the south. According to the Ministry of Energy and Mineral Resources (MEM), only 30–40 percent is interconnected, so some areas have surplus electricity, while others rely on imports to supply their power. A mix that can effectively utilize existing facilities has not been achieved.[24]

Laos has signed memoranda (MOUs) to sell electricity to Thailand (7,000 MW), Cambodia (300–500 MW), and Vietnam (5,000 MW). In the future as well, against the background of abundant water resources, electricity exports will be a pillar of industrial policy. Export-oriented resources development through IPPs will be promoted to acquire foreign currency. From the perspective of energy security, on the other hand, facilitation of transmission line construction projects that can quickly enable economical and efficient interconnection is necessary.

8. Malaysia's Power Development Plan

The energy division of the Economic Planning Unit (EPU), an organization under the Prime Minister's Department, the highest decision-making body, is in charge of Malaysian energy policy. The latest energy policy is the 10th Malaysia Plan 2011-2015, announced in June 2010.[25]

The 10th Malaysia Plan emphasizes energy security and economic efficiency along with environmental and social considerations. It has five strategic priorities on energy: "Initiatives to Secure and Manage Reliable Energy Supply," "Measures to

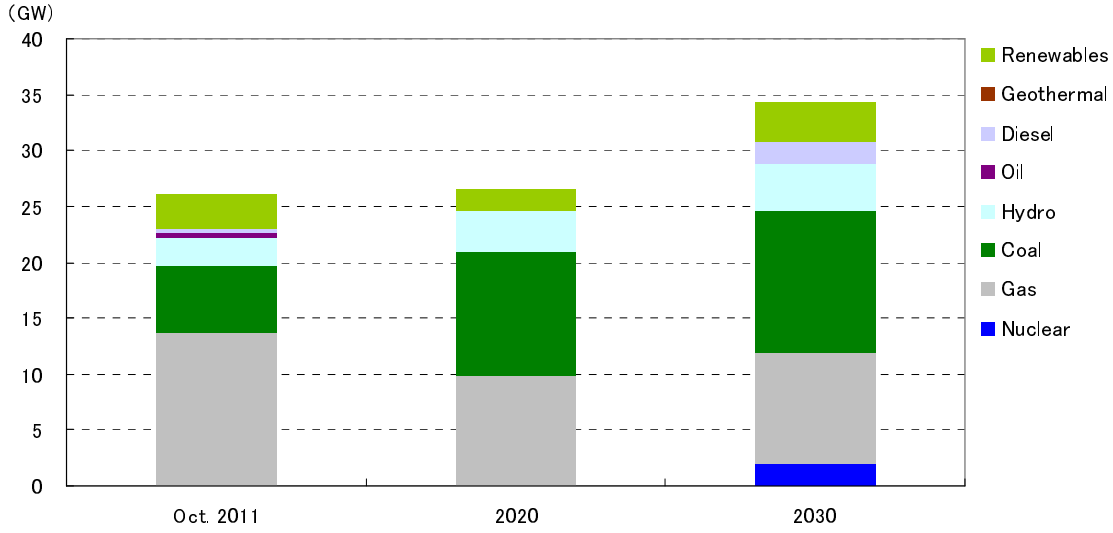
[24] Japan Electric Power Information Center, February 2009

[25] The Tenth Malaysia Plan 2011-2015, Economic Planning Unit Prime Minister's Department, June 2011

Encourage Efficient Use of Energy," "Adoption of Market-based Energy Pricing," "Stronger Governance," and "Managing Change."

In the 9th Plan period (2006-2010), economic growth was sluggish, but that was because of the global slump. Without economic reforms that can meet changes in the outside environment, long-term growth cannot be expected. Improving domestic competitiveness and raising productivity during the 10th Plan period are considered necessary for economic growth. If that is achieved, an average annual GDP growth rate of 6 percent during the 10th Plan period is estimated. However, the plan does not include any estimates for power demand.

Figure 2-8: Power Development Plan toward 2020 and 2030 (Malaysia)



Malaysia (GW)

	Oct. 2011	2020	2030
Nuclear	–	–	2.000
Gas	13.627	9.900	10.000
Coal	6.070	11.000	12.600
Hydro	2.406	3.700	4.224
Oil	0.516	–	–
Diesel	0.352	–	2.000
Geothermal	–	–	–
Renewables	3.060	2.000	3.500
Total Supply Capacity	26.031	26.600	34.324

Source: IEEJ estimates from IHS Global Insight.

Regarding the development of generating facilities, the 10th Plan discusses facilitating expanded use of existing coal and LNG-fired power plants as well as hydropower. It also discusses construction of supercritical pressure coal-fired power plants and beginning consideration of nuclear power. The detailed power source development plan during the 10th Plan period is as follows.

As for hydropower, construction is progressing at Ulu Jelai and Hulu Terengganu. Their combined output will be 662 MW. Tenaga Nasional Berhad (TNB), the electric utility in charge of Peninsular Malaysia is carrying out the construction. Construction of a 2,400 total MW hydropower plant at Bakun is also progressing. Although the project was originally approved for construction in 1986, it was temporarily halted in 1990, restarted in 1993, and then suspended again in 1997 during the Asian currency crisis. In 2002, construction restarted with Malaysia-China Hydro (MCH) as the main construction contractor. In 2011, the generators first began producing electricity. There has been much criticism of the project because many residents were displaced and because of the claim that capacity is excessive in comparison to power demand. (Power demand in Sarawak is currently about 1,000 MW.) It is reportedly planned to expand the generators to 2,400 MW in 2014.[26]

As for coal-fired power, TNB subsidiary TNB Janamanjung is constructing a supercritical pressure coal-fired power plant in Janamanjung. With an electricity output of 1,000 MW, it is scheduled to begin operating in 2015. Once it goes into operation, it will become Southeast Asia's first 1 GW class supercritical pressure coal-fired power plant. The main contractor is France's Alstom. According to that company. Total project costs will be about 1 billion euros.[27]

As for gas-fired power, a subsidiary of the national oil company, Petronas, is constructing the Kimanis power plant (300 MW, scheduled to begin operating in 2013), Malaysia SPR Energy is constructing the SPR power plant (100 MW, scheduled to begin operating in 2013), and TNB is constructing the Lahad Datu power plant (300 MW, scheduled to begin operating in 2016). All of those gas-fired power plants are located in Sabah State.

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[26] Malaysia's Bakun dam online but criticisms persist, AFP, 2011/10/27

[27] South East Asia’s first 1000 MW supercritical coal-fired power plant at Malaysia’s Manjung for €1 billion, Alstom, 2011/4/4/

As for nuclear power, the 10th Plan clearly states it is to be considered a long-term option. Development of nuclear power is assigned an important place in energy security. The Malaysian government has announced that nuclear plants of 1,000 MW each are scheduled to go online in December 2010, 2021, and 2022. In January 2013, after the Fukushima Daiichi nuclear accident, Malaysia Nuclear Power Corporation CEO Mohd Zamzam Jaafar stated that feasibility studies for power plant construction would be six months late, and that construction of the first nuclear power plant in Malaysia is expected to begin in 2021. It is unclear what effect the accident has had on the plans.

Renewable energy is positioned as a "fifth fuel" to supplement conventional energy resources (oil, natural gas, hydropower, and coal) and its use is promoted. During the 9th Plan period, however, installation of renewable energy power plant capacity fell well below targets. As of 2009, installed capacity was only 41.5 MW (<1%). The 10th Plan therefore sets out a plan to bring renewable energy power plant capacity up to 985 MW (5.5 percent). An FIT system has been operating since December 2011. The government agency in charge of the FIT system, the Sustainable Energy Development Authority (SEDA), has established a "renewable energy fund" for the operation of the system and the collection of surcharges. The fund is used to pay power companies the difference from their average generating costs. The source of the fund is a 1 percent surcharge on the electric bills of consumers who use more than 300 kWh in a month. The goals for renewable energy adoption are 985 MW/5.4 GWh in 2015, 2,080 MW/11.3 GWh in 2020, 4,000 MW/17.2 GWh in 2030, and 21.4 GW/44.2 GWh in 2050.

An overview of international collaboration is as follows.

Malaysia has power tie lines with Thailand and Singapore. According to Suruhanjaya Tenaga (Malaysian Energy Commission), the amount of power exported in 2010 was 88 GWh, and the amount imported was 0.03 GWh. Compared with exports in 2007 (2,477 GWh), the amount has been trending down year by year.[28] This is probably because, with the opening of gas pipelines from Malaysia and

[28] Industri Pembekalan Elektrik di Malaysia 2010, Suruhanjaya Tenaga

Indonesia to Singapore, that country has shifted to gas-fired power plants utilizing that gas.

As discussed in the Indonesia section, there are plans to construct an international tie line between Malaysia and Indonesia. Singapore relies on gas imported through pipelines. The need to improve that skewing towards gas-fired power has been indicated from the perspectives of security and fuel costs. Diversification of power sources and lowering of electric charges through imported electricity is projected. However, in Indonesia, control of gas for export has led to domestic shortage, which could also be improved.

Additionally, the concept of constructing a 275 kV transmission line with a transmission capacity of 50–100 MW between Sarawak and Indonesia's West Kalimantan and beginning electricity trading in 2014 has been announced.[29]

9. Myanmar's Power Development Plan

Myanmar's energy policy is set by the Energy Planning Department (EPD) under the Ministry of Energy (MOE). The EPD set an energy plan during the 1990s, but it still has not been updated. The following five areas have been taken up as issues in power policy.

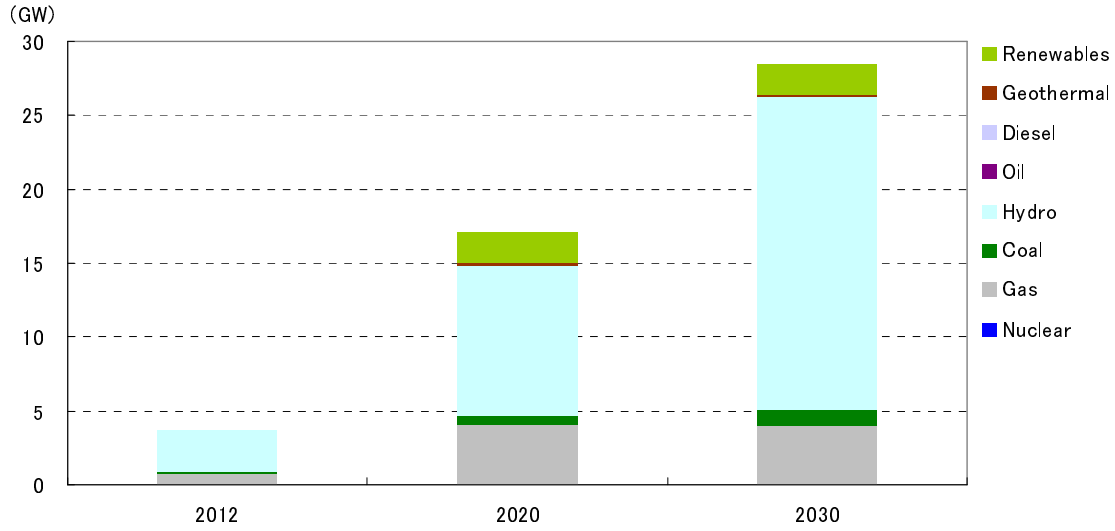
1. As a short-term plan, expansion of gas turbines in order to alleviate planned power outages
2. As a medium- and long-term plan, promotion of hydropower development and electricity exports
3. Upgrading of power transmission and distribution equipment
4. Reduction of transmission and distribution loss and promotion of energy conservation
5. Promotion of renewable energy development

Myanmar's power demand grew by an annual average of 3.8 percent from 1987 through 2008. Electricity output has been increasing rapidly since 2008. FY 2008

[29] Malaysia, Indonesia to begin power trade in 2014, New Straits Times, 2012/2/28

electricity output was 6,622 kWh. In FY 2011, it was 10,000 kWh, for a high average annual growth rate of 14.7 percent. As for projected future power demand, materials[30] published by the (Ministry of Electric Power 2 (MOEP2) in 2008 estimate high peak demand, with the annual rate through 2021 expected to be 9–10 percent, and the annual rate after that expected to be 7–7.5%. Projections are 3,575.9 MW as of the end of 2020, and 7,334.82 MW as of the end of 2030.

Figure 2-9: Power Development Plan toward 2020 and 2030 (Myanmar)



Myanmar (GW)

	2012	2020	2030
Nuclear	–	–	–
Gas	0.715	4.042	4.042
Coal	0.120	0.690	0.990
Hydro	2.780	10.088	21.247
Oil	–	–	–
Diesel	–	–	–
Geothermal	–	0.200	0.200
Renewables	–	2.066	2.066
Total Supply Capacity	3.615	17.086	28.544

Source: IEEJ estimates from 1st WG, Nov. 2012 Presentation

After a military government took over Myanmar in 1988, economic assistance (ODA, etc.) from other countries was cut off. That led to electricity shortages and

[30] Country Report on Progress of Power Development Plans and Transmission Interconnection Projects, 25th–27th November 2008

ongoing supply restrictions. Efficient power source development is therefore important. Since large gas fields were discovered in 1992, gas turbine power plants, which require only short construction periods, have been built and subsequently converted to combined cycle in an effort to shorten power outages. During that time, development of hydropower plants was promoted with the aim of ending electricity shortages. Today, natural gas exports are seen as an important means of foreign currency acquisition, and effort is being put into hydropower development.

Myanmar's domestic hydropower resources are vast. Theoretical hydropower plant development potential is estimated at 10.8 GW. Of that, economically developable capacity is estimated to be about 43.45 GW., Development is promising for the Thanlwin River, the Ayeyarwady River, the Chindwin River basin, the Shan Highlands, the Arakan Mountains, and thee southern peninsula area.

With ODA cut off, development of hydropower resources stagnated. In recent years, however, development has shifted into high gear through economic cooperation and direct investment from China and Thailand. Including those based on bilateral cooperation, development of hydropower plants is planned for 18 sites (total output 31,059 MW). The largest plan, a joint venture with China Power Investment Corp, is a project to put seven generators with a total output of 16,500 MW on the upper Ayeyarwady River. The first generator is expected to go into operation around 2015. Additionally, joint development with China of hydropower plants in Shweli and Dapein is planned. With a Thailand’s corporation and the Ministry of Electric Power 1 (MOEP1) have formed a joint venture company that is developing hydropower plants in Ta Sang and Taninthayi. In Hutgyi, a joint feasibility study with Thailand was completed in 2007. With India, a memorandum of understanding (MOU) on development of a hydropower plant in Tamanthi was signed with the National Hydroelectric Power Corporation (NHPC) in 2008. The plan calls for development of six 200 MW hydropower plants for a total of 1,200 MW. The objectives of constructing the Tamanthi power plants include flood prevention and control. In addition, domestic IPPs have signed MOUs for development of hydropower plants in Thaukyegat, Baluchaung, Saidin, and Upper Baluchaung.

Inside Myanmar, exploration for oil fields on land began during the 1960s. No major fields were discovered, however, and production volume from land-based oil and gas fields is trending downwards. Exploration of offshore oil fields beginning in the 1970s, however, led to the 1992 discovery of vast gas fields. Full-fledged gas production began at the Yadana gas field in 1998 and at the Yetagun gas field in 2000. The gas produced at those gas fields, in addition to being piped into the domestic supply (Yadana gas field), is also exported to Thailand (Yadana/Yetagun gas fields). It has become a means for Myanmar to acquire foreign currency. As discussed above, in order to meet power demand, construction of gas-fired power plants has been underway since 1992, but because gas exports are given priority, operation must be coordinated depending on availability of fuel. No more power plants using natural gas can be constructed.

The state of international collaboration on power lines is as follows.

There is a 188 km international tie line between Myanmar's Shweli power plant and China's Dehong substation. Under a September 2009 agreement, the purchase price for electricity from the Shweli power plant is 0.184 yuan/kWh (about 2.9 yen/kWh). In addition, there are small-scale electricity import lines from China and Thailand. Electricity imported from China costs about 1.2–1.5 yuan/kWh (19–24 yen/kWh), and that from Thailand costs about 4.5–6.25 baht/kWh (15–21 yen/kWh).

Electricity exports to India re also planned. Electricity produced at the Tamanthi power plant that is a joint venture with the NHPC, is to be exported to India via international tie line. Construction of new transmission lines is therefore planned.

10. Philippines' Power Development Plan

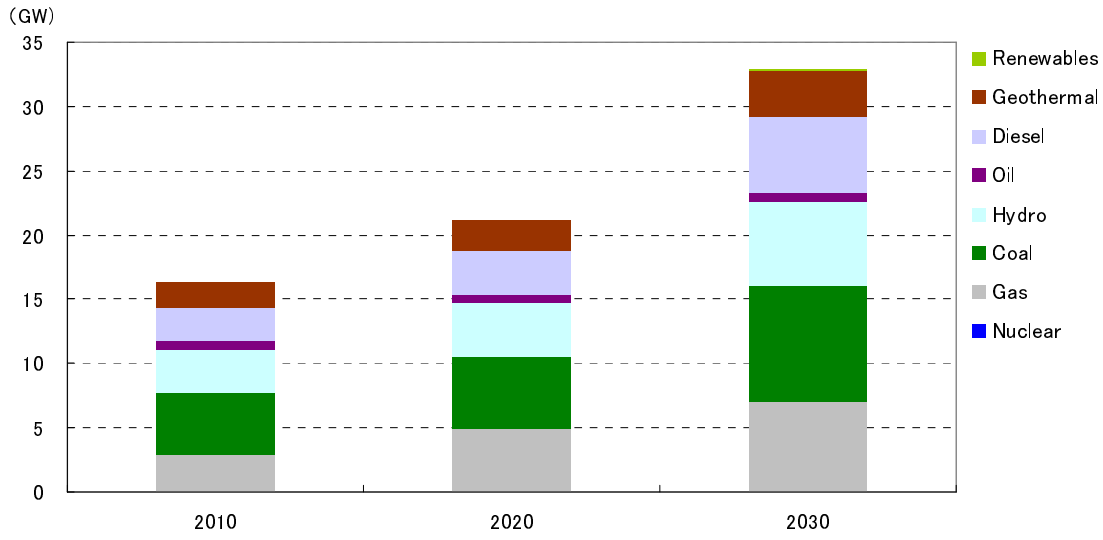
In the Philippines, the Department of Energy (DOE) has overall jurisdiction over energy policy. It is responsible for setting, implementing, and managing all plans in the energy sector. It promotes exploration, development, and use of energy resources and encourages energy conservation. The latest energy plan is the (2012-2030 Philippine Energy Plan (PEP 2012-2030). The latest power development plan is Power Development Plan 2009-2030[31] (PDP 2009-2030).

[31] Although it has not been published on the DOE website, a draft version of PDP 2010-2030 (Power Development Plan 2010-2030) was referred to as appropriate.

Major measures in the PEP 2012-2030 include "securing energy security" through expanded use of renewable energy and development of oil and coal resources, "expansion of energy supply access" through technology, and "promotion of a low-carbon society" through efficient energy utilization and clean fuel technology.

As for projected power demand, according to the PDP 2009-2030, the DOE estimates electricity output at 55,417 GWh as of 2008, 86,809 GWh as of 2018, and 149,067 GWh as of 2030. By region, the DOE predicts power demand in the Luzon islands (region) will grow at 4.53% annually to reach 109,477 GWh in 2030, demand in the Visayas islands will have a slightly faster average annual growth rate of 5% to reach 19,121 GWh in 2030, and demand in the Mindanao islands will grow at an average of 4.62% annually to reach 20,470 GWh in 2030.

Figure 2-10: Power development plan toward 2020 and 2030 (Philippines)



Philippines (GW)

	2010	2020	2030
Nuclear	–	–	–
Gas	2.861	4.961	7.061
Coal	4.867	5.627	8.972
Hydro	3.400	4.112	6.605
Oil	0.650	0.650	0.650
Diesel	2.543	3.443	5.943
Geothermal	1.966	2.295	3.559
Renewables	0.073	0.072	0.072
Total Supply Capacity	16.360	21.160	32.862

Source: IEEJ estimates from Draft PDP 2010-2030.

According to the PDP 2009-2030, by running simulations based on the above demand forecasts, the DOE calculates that 17 GW of power source development will be necessary by 2030. However, the only power plants development plans to which commitments have been made are two in the Luzon islands (600 MW), one in the Visayas islands (100 MW), and three in the Mindanao islands (258 MW), for a total of 958 MW. New plans are needed to make up the difference. The DOE calculates that the capacity that must be installed is 11,900 MW in the Luzon islands, 2,150 MW in the Visayas islands, and 2,500 MW in the Mindanao islands.

In the past, the National Power Corporation (NPC) carried out power plant development in the Philippines on an exclusive basis. Participation by independent power producers (IPPs) has been permitted since 1993, and the NPC has been selling off assets, so the NPC's share of electricity output has fallen sharply from 68.1% in 2001 to 14.5 percent in 2010. IPPs now handle most power source development as well.

The DOE estimates hydropower potential in the Philippines at 13,100 MW. However, a total of only 3,400 MW has been developed so far, so there is still much development left. The government's policy is to develop hydropower as part of its renewable energy development. It plans to increase hydropower to 7,530 MW by 2030. There are many issues in hydropower development. In the Luzon islands, the division between the summer season and the rainy season makes it easy for droughts to occur. In the Mindanao islands, which depend on hydropower for over 50 percent of their power, abnormal weather in early 2010 forced daily power outages of 5–8 hours.

As of 2000, there were about 5,000 MW of oil-fired power plants (including diesel). Through the closing of aging facilities and so on, that fell to about 2,000 MW as of 2010.

For the sake of energy self-sufficiency, the government promotes the opening of gas fields. Production volume as of 2009 was 35 billion cf; the plan is to increase that to 2.694 trillion cf by 2030. Natural gas from the Malampaya gas fields has since 2001 been supplied via pipeline to gas-fired power plants in the Luzon islands and Batangas State. Currently, 2,861 MW of gas-fired power plants are in operation. First Gen Corp. plans to build a 500 MW (ultimately, 1,300 MW) gas-fired power plant in

San Gabriel.[32] Additionally, Energy World Corp. plans to build an LNG terminal in Pagbliao, along with a 300 MW gas-fired power plant.[33]

The Philippine government is pushing the development of coal resources as an alternative to oil. It intends to increase annual production volume to 2.5 times as much (about 1.2 million tons) by 2030. The installed capacity of coal-fired power plants as of the end of 2000 was 3,963 MW. As of 2010, it had gradually increased to 4,867 MW. Development of coal-fired power plants continues. In 2012, GN Power Ltd. began operating a 600 MW coal-fired plant in Bataan on Luzon.

The Philippines has an estimated 4,790 MW of geothermal resources. Generating cost is the least expensive after hydropower, and utilization ratio is high, so it is utilized an important base power source. As of 2010, there were geothermal power plants at 10 locations in the Philippines, with total installed capacity of 1,996 MW, the second most in the world. The Philippine government plans to continue developing geothermal power, to raise installed capacity to 3,450 MW by 2030.

The Philippines decided to build a nuclear plant in Bataan. Construction began in 1976 and was completed in 1984. However, numerous defects were found, and in light of the Chernobyl disaster, it was mothballed rather than going into operation. In 2010, however, although nuclear power itself was not abandoned, a final decision was made to never use the Bataan nuclear power plant. How to use it, including possible sale, is under consideration.

As for renewable energy, in 2008, the government set out the National Renewable Energy Program (NREP) and passed the Renewable Energy Law. According to NREP, installed capacity of renewable energy is to be doubled from its 5,300 MW in 2008 by 2030. Therefore, a corporate income tax exemption (7 years), an exemption on duties on imported equipment (10 years), and a reduction of property taxes have been adopted along with a feed-in tariff (FIT) system beginning in 2010.

As for international collaboration, the Philippines is an island nation far from its neighbors, so at this time it has no electric tie lines with any of them.

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[32] First Gen unveils $2.3-b expansion, Manila Standard Today, 2013/3/4

[33] Under Development – Philippines, Energy World HP, http://www.energyworldcorp.com/ud-phil.html

11. Singapore's Power Development Plan

Singapore separated from Malaysia and gained its independence in August 1965. It is an urban nation with a land area of about 700 km^2 and a population of more than 5 million. Singapore has no hydropower resources. Constrained by a small land area and high population density, it is unclear if nuclear power can be a realistic option for Singapore. All the nation's power plants are thermal generation. Capacity as of October 2010 was 12,330 MW. The power source mix by fuel type was natural gas about 70 percent and oil about 30 percent, and some refuse incineration power generation also in operation. As for coal-fired power, its installation is also considered problematic because of land constraints.

There is zero domestic production of the two main power sources, gas and oil, so all of it must be imported. This makes energy security an extremely important issue for Singapore.

As for oil, Singapore holds to a policy of fostering industry in free markets and free trade with minimal government interference. It has built itself into a global oil hub with oil companies from around the world, including the majors.

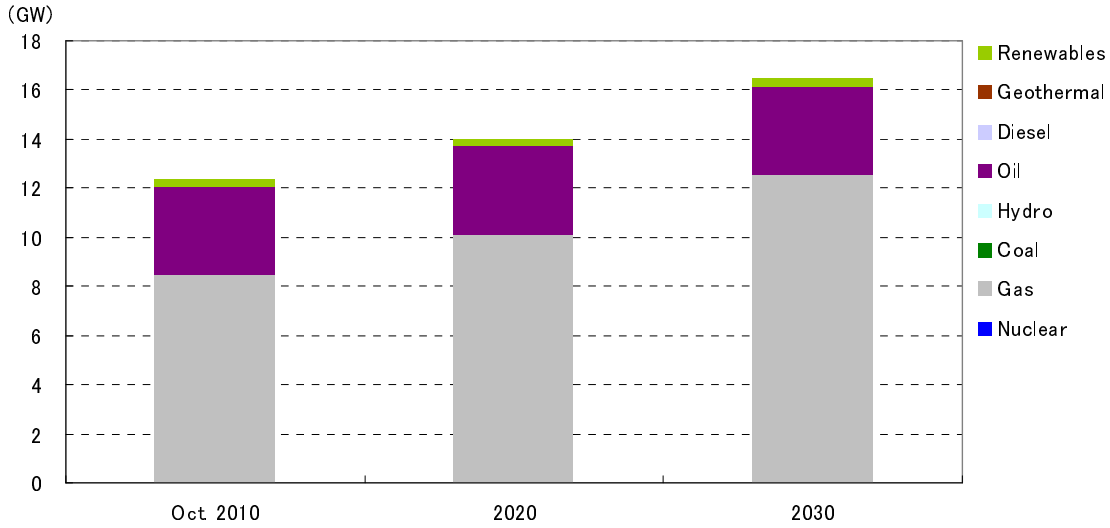
As for natural gas, Singapore began importing it from Malaysia via pipeline in 1992. It also began importing gas via undersea pipeline from West Natuna and southern Sumatra in Indonesia in 2001 and 2003, respectively. Today, therefore, it is supplied from three locations. In addition, Singapore is moving forward with plans to import LNG in order to secure stable supply through source diversification and to prepare to meet soaring gas demand. It will also build its first LNG receiving terminal on Jurong Island, the import site for pipeline gas from Indonesia. Initial site capacity is projected at 3.5 million tons per year in two LNG tanks. Preparation is underway to begin operations during the second quarter of 2013. A third tank is to begin operating during the fourth quarter. A plan has been conceived to eventually add a fourth tank, expanding capacity to 9 million tons per year.[34]

Electricity in Singapore has been liberalized, and the competitive sectors of generation and retail sale and the non-competitive sectors of transmission and distribution are separated at the ownership level. Since January 2003, Singapore's

[34] Singapore Government, SG Press Centre 2012/10/24

electricity wholesale market has been operated through the National Electricity Market of Singapore (NEMS) by Energy Market Company (EMC), an affiliate of the Energy Market Authority (EMA), which is the regulatory agency for the electricity and gas industries. Power producers sell electricity to the wholesale market in units of 30 minutes. All electricity buying and selling in the wholesale market takes place via EMC. As of October 2010, the power producers participating in NEMS were Senoko Energy (production capacity: 3,300 MW), Power Seraya (3,100 MW), Tuas Power Generation (2,670 MW), SembCorp Cogen (785 MW), Island Power Company (800 MW), Keppel Merlimau Cogen (1,400 MW), ExxonMobil Asia Pacific (220 MW), National Environment Agency (179.8 MW), Shell Eastern Petroleum (60 MW), Senoko Waste-to-Energy (55.4 MW), and Keppel Seghers Tuas Waste-to-Energy plant (24 MW).

Figure 2-11: Power Development Plan toward 2020 and 2030 (Singapore)



Singapore (GW)

	Oct. 2010	2020	2030
Nuclear	0.000	0.000	0.000
Gas	8.457	10.079	12.499
Coal	0.000	0.000	0.000
Hydro	0.000	0.000	0.000
Oil	3.625	3.625	3.625
Diesel	0.000	0.000	0.000
Geothermal	0.000	0.000	0.000
Renewables	0.248	0.296	0.367
Total Supply Capacity	12.330	14.000	16.491

Source: Statement of Opportunities.

According to "Statement of Opportunities for the Singapore Energy Industry 2011," published by the Energy Market Authority (EMA), Singapore's total power plant capacity as of 2020 is planned to be about 14,000 MW. Although installed capacity by fuel type is not clear, judging from the shift in generating fuel from diesel oil to natural gas in recent years, development is likely to continue to focus on combined cycle generation using pipeline gas and LNG, which will start being received in 2013.

Because plans beyond 2020 are unclear, the power source mix as of 2030 was extrapolated using the estimated electricity output in ERIA Study Project Report 2011 "ANALYSIS OF ENERGY SAVING POTENTIAL IN EAST ASIA REGION." According to the report, electricity output in Singapore will increase from 41.8 TWh in 2009 to 60.7 TWh in 2020. From 2020 to 2035, it is projected to increase at an average annual rate of 1.02 percent to 77.6 TWh. Based on that, estimation of Singapore's power plant capacity in 2030 indicates an increase to 16,491 MW (with gas-fired power the major source at 12,499 MW).

Since February 2011, EMA has been working on the creation of the "Regulatory Framework for Electricity Imports." Promotion of electricity imports in Singapore is of course expected to diversify the nation's energy and fuel mix in terms of expanding both the mix by type of fuel and the sources of the supply. It is also expected to enhance power interconnection, trade, cooperation, etc., with neighboring countries in mutually beneficial ways. An overview of electricity imports presented in a consultation paper in December 2011 is as follows.[35]

- The estimated electricity import framework for power supplies from overseas is a maximum of 600 MW per country.
- Bidding and selection of winning businesses for electricity import will proceed with the aim of completion in 2013.
- Electricity importers will begin selling electricity in Singapore around 2017–2018.

[35] Ministry of Economy, Trade and Industry, "Survey of ASEAN power optimization business through Indonesian electricity exports," February 2012

- EMA will ask each bidder to bid on a contract-for-differences (CfD) price. Imported electricity will be paid at the lower of the CfD Strike Price and the general Pool Price.
- The winning electricity importers will receive an electricity import license permitting 600 MW of electricity import for 20 years.

The consultation paper expired March 30, 2012, and was made public in order to gather comments and feedback. Preparation for bidding on electricity imports is likely underway at this time.

12. Thailand's Power Development Plan

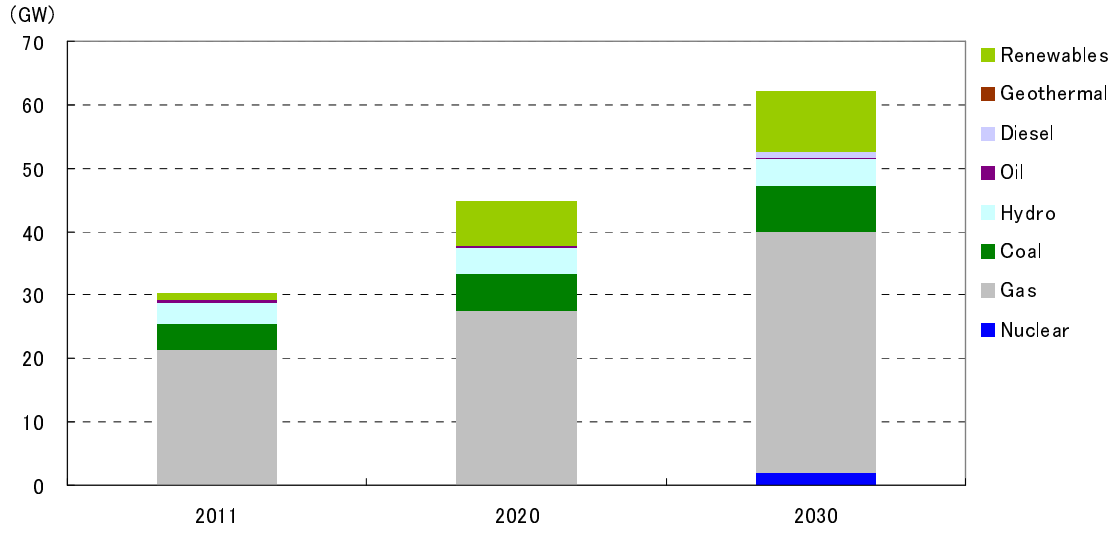
Against a background of steady economic growth, power demand in Thailand has been growing at an annual average of around 5 percent. Peak demand in 2012 was about 26,000 MW, almost 10,000 MW higher than 10 years earlier. With this growth expected to continue, ensuring supply capacity for the future is an urgent issue. Furthermore, because of past air pollution problems, Thailand has a strong aversion to coal-fired power. A power supply mix that is over-reliant on natural gas is another concern. As of 2011, of Thailand's domestic power plant capacity of 30,246 MW, natural gas-fired power accounted for 21,474 MW, about 70 percent.

The Electricity Generating Authority of Thailand (EGAT) is in charge of creating the nation's power source development plan. In April 2010, a new power source development plan, the "SUMMARY OF THAILAND POWER DEVELOPMENT PLAN 2010-2030 (PDP2010)," was released. Subsequently, in light of an opposition movement by local residents, plans for development of coal-fired power were scaled back. After the accident at Fukushima Daiichi nuclear power plant, the timing and scale of the adoption of nuclear power were trimmed as well. Those changes were reflected in the "SUMMARY OF THAILAND POWER DEVELOPMENT PLAN 2012-2030 (PDP2010: REVISION 3)" released in June 2012, which is now Thailand's latest official power source development plan.

In power source development, in consideration of ensuring energy security and clean power supply as well as addressing high fuel prices, adoption of nuclear power

as a new power source, fuel diversification, and increasing the volume of electricity imports from neighboring countries are planned.

Figure 2-12: Power Development Plan toward 2020 and 2030 (Thailand)



Thailand (GW)

	2011	2020	2030
Nuclear	–	–	2.000
Gas	21.474	27.442	37.912
Coal	3.955	5.886	7.387
Hydro	3.436	4.086	4.130
Oil	0.319	0.315	0.315
Diesel	0.004	0.004	0.754
Geothermal	–	–	–
Renewables	1.058	6.898	9.558
Total Supply Capacity	30.246	44.631	62.056

Source: PDP2010 Revision 3

According to "PDP2010: REVISION 3," Thailand's domestic power plant capacity exclusive of electricity imports, was 30,246 MW as of 2011. By 2020, it will expand to 44,631 MW. The major power source mix will be natural gas 61.5 percent (vs. 71.0 percent in 2011), coal 13.2 percent (vs. 13.1 percent), hydropower 9.2 percent (vs. 11.4 percent), and renewable energy 15.5 percent (vs. 3.5 percent). The plan is to attempt to use increased generation by renewable energy to reduce dependence on natural gas. In 2030, total output exclusive of electricity imports will be an estimated 62,056 MW. The major power source mix will be natural gas 61.1 percent, coal 11.9 percent, hydropower 6.7 percent, renewable energy 15.4 percent,

and nuclear power 3.2 percent. Plans for the construction of nuclear power plants are incorporated.

By power source, a vision is sketched of natural gas power plant capacity rising from 21,474 MW in 2011 to 27,442 MW in 2020 and 37,912 MW in 2030. In order to avoid overdependence on natural gas, gas-fired facilities will not increase, but expansion of combined cycle plants with high thermal efficiency is planned. EGAT and IPPs expect to add new combined cycle plants. Installed capacity is projected to expand to 18,495 MW (41.4 percent of the capacity mix) as of 2020 and to 31,119 MW (50.1 percent of the capacity mix) as of 2030. For the natural gas supply, in order to diversify sources, in addition to domestically produced gas, and pipeline gas from the neighboring country of Myanmar, the Map Ta Phut LNG Receiving Terminal was operational in September 2011 and began receiving LNG.

As for coal-fired power plant, installed capacity of 3,955 MW as of 2011 is projected to reach 5,886 MW in 2020 and 7,387 in MW 2030. In "PDP2010: REVISION 3", domestically-produced lignite-fired 600 MW is planned to construct in 2018. On the other hand, EGAT intends to construct new thermal power plants that use imported coal as fuel. After bringing 800 MW coal-fired power plant online in 2019, it is projected to gradually build up to 3,200 MW in 2030.

As for hydropower, there is a plan to build a 500 MW pumped-storage power plant in 2017, but there are no other large-scale hydropower development plans. As noted above, therefore, hydropower's share of total power plant capacity is projected to fall from 11.4 percent in 2011 to 6.7 percent in 2030.

As for nuclear power, in the first version of PDP2010, the plan was to begin operating the first plant (1,000 MW) in 2020, and then install more reactors for a total of five reactors (5,000 MW in total) by 2028. However, after the accident at Fukushima Daiichi nuclear power plant caused by the Great East Japan Earthquake, the installation date was extended and the scale was reduced. According to "PDP2010: REVISION 3," installation of one 1,000 MW reactor in 2026 and another 1,000 MW reactor in 2027 is planned.

Lacking abundant fossil fuels such as oil and natural gas or hydropower resources, and highly dependent on energy imports, in recent years Thailand has been

aggressively adopting renewable energy.[36] Thailand has abundant renewable energy resources, particularly biomass and solar power. In biomass, Thailand aims to utilize agricultural residual and industrial waste products such as rice, sugar cane, palm oil, and wood offcuts (residual). The northern and central parts of the country have good sites for solar power. For wind power, there are suitable locations in the eastern coastal area, on the Gulf of Thailand in the south, and in the mountains of the south and west. Expectations for future use are high. Thus, to promoted renewable energy usage in Thailand, the Ministry of Energy has planned for the Alternative Energy Development Plan 2012-2021 (AEDP2012-2021); and that plan has already approved by the Cabinet. Against this background, according to "PDP2010: REVISION 3," power plant capacity from renewable energy will expand from 1,058 MW in 2011 to 6,898 MW in 2020 to 9,558 MW in 2030, inaccordance with the AEDP2012-2021, surpassing coal-fired capacity. It is an ambitious plan.

Finally, an overview of international interconnections between Thailand and its neighbors will be presented. International interconnection lines are 500 kV and 230 kV transmission lines to Laos and 132 kV and direct current ±300 kV transmission lines to Malaysia. Electricity import capacity in 2011 was 2,184 MW (1,884 MW from Laotian hydropower and 300 MW from Malaysia's Tenaga Nasional Berhad).

As for future electricity trading, power plant construction projects for electricity exports to Thailand are planned in adjacent countries. Construction of associated international interconnection lines is also planned. The following memoranda have been signed by Thailand and adjacent countries. With Thailand's domestic power demand increasing, the importance of electricity imports from neighbors will probably also increase.

[36] Japan Electric Power Information Center, "Electric utilities in other countries, vol. 1 supplement 2, energy and electricity in major Asian nations," 2011

Table 2-2: MOU for electricity trade with neighboring countries

Partner country	Date of MOU	Amount of power
China	1998.11.12	3,000 MW
Lao PDR	2007.12.22	7,000 MW
Myanmar	1997.07.04	1,500 MW
Cambodia	2000.02.03	Unspecified

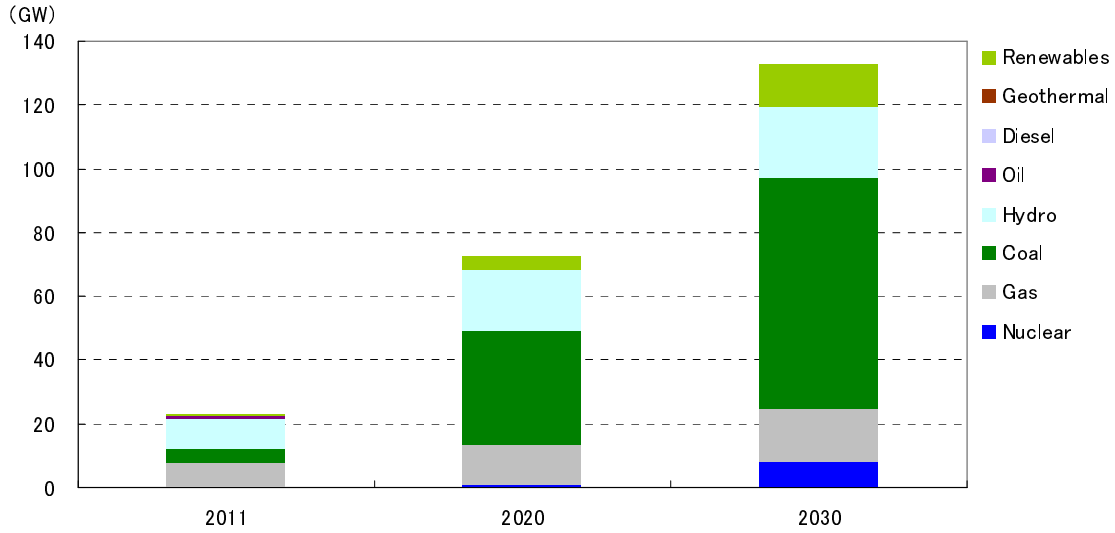
Source: Created from various materials and interviews.

13. Vietnam's power development plan

In Vietnam, domestic energy demand accompanying economic growth in recent years has grown steadily. Peak power grew at an annual rate of 12.3 percent from 2001 to 2010 increasing to 2.8 times as large over 10 years. In order to respond to this booming power consumption, the "7th National Electricity Master Plan" was created in July 2011. Vietnam's power development plan proceeds based on it.

According to the master plan, Vietnam's domestic power plant capacity exclusive of electricity imports will expand from 22,785 MW as of October 2011 to 72,675 MW in 2020. The power source mix will be hydropower (including pumped-storage) 26.3 percent, coal-fired power 49.5 percent, gas-fired power 17.0 percent, nuclear power 1.4 percent, and renewable energy 5.8 percent. A policy of advancing energy source diversification is presented. In 2030, total output exclusive of electricity imports will be 132,608 MW. The projected power source mix is hydropower (including pumped-storage) 16.7 percent, coal-fired power 54.8 percent, gas-fired power 12.5 percent, nuclear power 6.0 percent, and renewable energy 10.0 percent.

Figure 2-13: Power Development Plan toward 2020 and 2030 (Vietnam)



Vietnam (GW)

	2011	2020	2030
Nuclear	–	1.000	8.000
Gas	7.673	12.375	16.614
Coal	4.390	36.000	72.653
Hydro	9.647	19.100	22.106
Oil	0.575	–	–
Diesel	–	–	–
Geothermal	–	–	–
Renewables	0.500	4.200	13.235
Total Supply Capacity	22.785	72.675	132.608

Source: Vietnam's Power Development Master Plan VII.

The power source development plan in the 7th Electricity Master Plan is following these four visions as it proceeds.[37]

1. Electricity production in the north, central, and south areas shall be coordinated for balance. Transmission loss shall be mitigated by supplying stable power to each region. By sharing reserve power sources hydropower plants can be operated efficiently in any season.
2. By rationally developing local power companies nationwide and ensuring the stability of local power supplies, loss from transmission on the national power

[37] JETRO "National power development plan vision through 2030 and decision on ratification in the 2011–2020 national power development plan, " July 21, 2011

grid can be alleviated, ensuring the economy of power-related projects and contributing to national and local socioeconomic development.

3. While developing new power sources, upgrade the technology of operating power plants, and apply modern technology in new power plants to meet environmental protection standards.
4. Diversify forms of investment in power development in accordance with improvements in competitiveness and economy.

Next, future plans by power source type are presented.

For hydropower, the plan is to prioritize development as comprehensive projects of power plants that have the objectives of flood control and irrigation. There is also development of large-scale hydropower, but because such development is limited to locations with good geographical conditions, small- and medium-scale hydropower development is also scheduled in various areas. Under the plan, the installed capacity of 9,647 MW in October 2011 shall be raised to 19,100 MW in 2020 and 22,106 MW in 2030. Within this, pumped-storage power generation shall be researched and developed from the perspective of efficient power grid operation. The plan shall increase installed capacity to 1,800 MW in 2020 and 5,700 MW in 2030.

For thermal power generation, the plan is to carry out development in rational ratios according to fuel supply locations, means, and capacities. A vision is sketched of increasing installed capacity of gas-fired power from 7,673 MW in October 2011 to 12,375 MW in 2020 and 16,614 MW in 2030. Within this, development of power plants that use LNG is planned. Installed capacity is to be 2,000 MW in 2020 and 6,000 MW in 2030. Securing LNG is one strategy for diversifying the sources of fuel needed for electricity production.

For coal-fired power, the plan is to take installed capacity from 4,390 MW in October 2011 to 36,000 MW in 2020 and 72,653 MW in 2030. Coal consumption in those years is projected at 67.3 million tons and 107.1 million tons. The estimated consumption amounts cannot be covered by domestic coal alone, so construction and operation of power plants that use imported coal beginning in 2015 is considered. By region, in power plants in the northern area, use of domestic coal is to be maximized and prioritized to meet thee base load. In the south, on the other hand, much

development with thermal power from imported coal is planned. Coal could be imported from Indonesia and Australia, but the south has many shoals, and there are no large ports where large ships can dock, o tankers cannot be received. Development of a coal center is therefore a major issue.[38]

With future depletion of domestic energy sources assumed, development of nuclear power in order to ensure the stable supply of electricity is planned. In June 2008, the Nuclear Power Basic Law was passed. It set up the legal basis for the promotion of nuclear power in Vietnam. Announcement of a master plan on nuclear power in 2010 indicated the direction of nuclear power development planning through 2030. Under the plan, the aim is for Vietnam's first nuclear power unit (1,000 MW) to go into operation in 2020. Installed capacity in 2030 is to be 10,700 MW, with electricity output of 10.5 billion kWh (10.1 percent of total electricity output). Even after the Fukushima Daiichi nuclear disaster, Vietnam showed no signs of rethinking its nuclear power policy. Temporarily suspended talks between Japan and Vietnam on cooperation on provision of nuclear technology and capital procurement reopened in September 2011.[39] However, as Ministry of Science and Technology Vice-Minister Le Dinh Tien stated, if safety cannot be ensured, the dates of construction and first operation of nuclear power could be delayed.[40]

As for renewable energy, wind power, solar, biomass, etc., are being quickly developed on a priority basis, and the ratio of renewable energy in the power source mix is being gradually increased. Generation through renewable energy is one method of rural electrification in areas that are especially far from a power grid. That role and its developmental potential are recognized. Although wind power currently accounts for only a small percentage of the power source mix, coastal areas, especially islands, have high potential, and foreign investment is increasing. In the 7th Electricity Master Plan, it is therefore planned to increase wind power to 1,000 MW in 2020 and 6,200 MW in 2030, and its share of electricity output to 0.7 percent in 2020 and 2.4 percent in 2030. Biomass at this time is high-cost and difficult to

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[38] Japan Electric Power Information Center, "FY 2011 Report on survey of electric power in Vietnam," March 2012

[39] Jiji Press, September 9, 2011

[40] NNA Asia Keizai Joho, August 17, 2011

make a commercial profit from, so it has not attracted attention from investors. However, the Vietnamese government has indicated a policy of favorable treatment of renewable energy development. The 7th Electricity Master Plan, in addition to sugar factories that use sugarcane as a raw material for biomass power generation, aims to develop other materials for biomass power and bring it to 500 MW in 2020 and 2,000 MW in 2030. That would be 0.6 percent of electricity output in 2020 and 1.1 percent in 2030.

Finally, an overview of international interconnections between Vietnam and neighboring countries will be presented. Neighboring countries involved with electricity trading and transmission line construction with Vietnam are China, Laos, and Cambodia.

Currently, Vietnam imports electricity from China via a 220 kV transmission line. However, Vietnam wants to curb it for two reasons, "an increase in the import price in the latest contract renewal" and "security concerns regarding dependence on China."

The political environment in Laos is extremely good. Vietnam wants electricity, and Laos wants to acquire foreign currency through electricity exports. (With no industry, next to resources export, electricity is Laos's best source of foreign currency.). The two countries' interests match well, so they aim to improve relations.

Electricity rates are high in Cambodia, so Vietnam exports electricity to it. Relations between the countries are stable.

In light of this background, the 7th Electricity Master Plan states, "carry out efficient electricity import/export with countries in the region, ensure benefit to both sides, exchange information with Laos, Cambodia, China, and other countries good at hydropower, ensure a stable transmission grid, and enhance imports." Implementation of cooperation on electricity trading and grid interconnection programs with Southeast Asian (ASEAN) and Mekong sub-region (GMS) nations can be expected.