Chapter 1

Coal-fired Power Plants in Thailand

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Chapter 1

Coal-fired Power Plants in Thailand

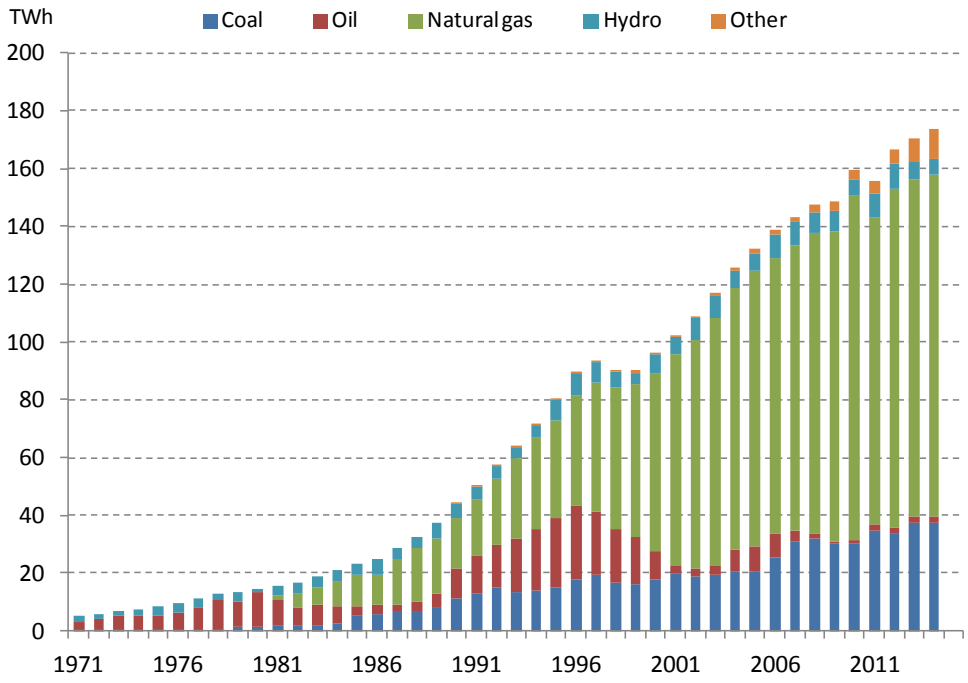
1.1 Coal-Fired Power Plant Development in Thailand

1) Brief Review of Thailand's Energy Status

Figure 1-1 shows how the electricity output in Thailand from 1971 to 2014 has been growing, especially starting from the late 1980s. Of the power sources available, Thailand highly depends on natural gas and coal.

Natural gas has mainly driven the growth in the country's electricity output. Its share in total electricity output is as high as 68% in 2014. Coal has the second largest share of the electricity output (22%).

Figure 1-1. Electricity Output in Thailand

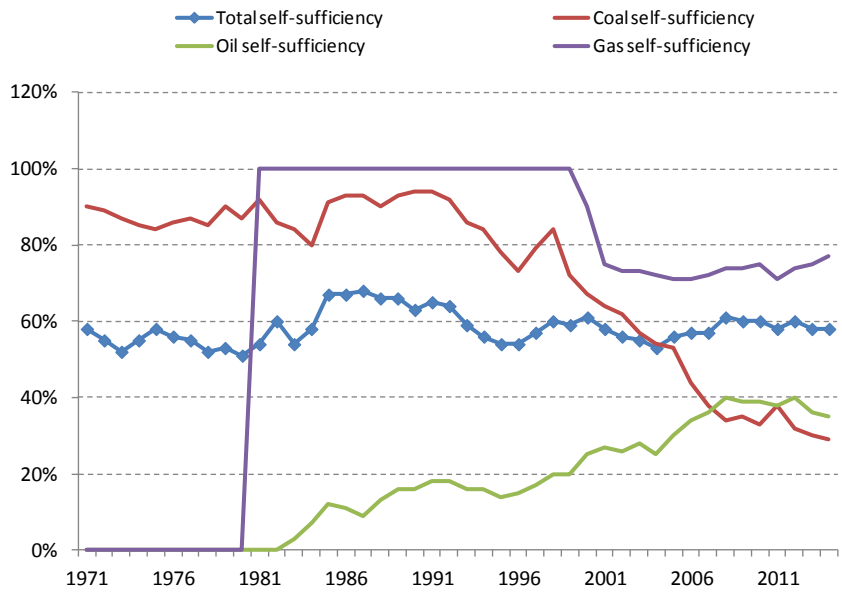


Source: International Energy Agency, World Energy Balance 2016.

Figure 1-2 shows the self-sufficiency rate of Thailand. Natural gas was started to be produced domestically in the 1980s and since then has greatly contributed to the country's stable self-

sufficiency rate (around 60%). However, according to the *BP Statistical Review of World Energy* (Table 1-1), the reserves-to-production ratio of Thailand's natural gas is only 5.5 years. On the other hand, coal has significantly more reserves (81.8 years). How to shift from domestic natural gas to other energy sources, which include domestic coal, is one of the biggest issues in Thailand's energy security.

Figure 1-2. Self-sufficiency Rate of Thailand



Source: International Energy Agency, World Energy Balance 2016.

Table 1-1. Reserves-to-Production Ratio

Resource	Reserves-to-production ratio (in years)
Oil	2.3
Natural gas	5.5
Coal	81.8

Source: BP Statistical Review of World Energy, June 2016.

2) Coal-Fired Power Plants Developed by EGAT

a. Krabi lignite mine and power plant development

Krabi is the first lignite mine developed to fuel a lignite-fired power plant. Located near the mine in Klong Pakasai, Krabi Province, south of Thailand, the Krabi power plant consisted of three units with 20 MW each. It was constructed in 1961 and started commercial operation in 1964. It supplied electricity in the South for almost 31 years before it was decommissioned in 1995 (Note: unit 2 was decommissioned in 1986) and converted to fuel with heavy oil (Table 1-2).

Table 1-2. Krabi Lignite Power Plant

Unit	Capacity (MW)	Commercial Operation	Note
1	20	1964	Decommissioned in 1995
2	20	1964	Decommissioned in 1986
3	20	1964	Decommissioned in 1995

Source: Electricity Generation Authority of Thailand.

b. Mae Moh Lignite-fired power plant

The Mae Moh lignite-fired power plant was part of a national energy development strategy of reducing the country's high dependency on imported oil by developing indigenous energy resources such as natural gas, lignite, and hydropower. The Mae Moh lignite open pit mining and power stations complex, both owned by the Electricity Generating Authority of Thailand (EGAT), are located in Lampang Province in Northern Thailand.

The first Mae Moh lignite-fired power plant with 75 MW began construction in 1975 and was completed in 1978. The next 2 x 75 MW units started commercial operation in 1979 and 1981, respectively.

The 4 x 150 MW plant started commercial operation from 1984 to 1985. Power plant units 8-13 (with 300 MW each) were constructed and commissioned from 1989 to 1995.

In 1999, the facility's unit 3 was decommissioned, while units 1 and 2 were retired in 2000.

Today, the plant has a total of 2,400 MW generating capacity in operation (Table 1-3).

Table 1-3. Mae Moh Power Plants: 225 + 2,400 MW (Fuel: Lignite)

Unit	Capacity (MW)	Commercial Operation	Note
1	75	1978	Decommissioned in 2000
2	75	1979	Decommissioned in 1999
3	75	1981	Decommissioned in 2000
4	150	1984	
5	150	1984	
6	150	1985	
7	150	1985	
8	300	1989	Total 2,400 MW
9	300	1990	
10	300	1991	
11	300	1992	
12	300	1995	
13	300	1995	

Source: Electricity Generation Authority of Thailand.

3) Coal-Fired Power Plants Developed by Independent Power Producers

The Thai government initiated the Independent Power Producers (IPP) and Small Power Producers (SPP) programs with three goals in mind: (i) to attract private capital so as to meet demand growth in power generation; (ii) to encourage the introduction of new technology; and (iii) to capitalize a more efficient, better managed and more competitive electricity market.

Private power plant developers were responsible for the development, construction and operation of the power project with their rights and power to delegate the sale of electricity in power purchasing agreements (PPAs).

The first awarded group of IPPs developed seven projects. Three out of the seven projects were proposed to import coal as fuel.

Table 1-4. Projects Proposed To Use Imported Coal As Fuel

Project	Capacity (MW)	Proposed Location	Note
BLCP	2 x 673.25	Map Ta Phut, Rayong	
Gulf Power	2 x 367	Bo Nok, Prachuapkhirikhan	Changes to natural gas
Union Power	2 x 700	Hin Krut, Prachuapkhirikhan	Changes to natural gas

Source: Electricity Generation Authority of Thailand.

In late 1997, when the financial crisis swept over Thailand, only two of the original seven projects had signed PPAs with EGAT. Additionally, two coal-fired projects represented one-third of the awarded IPP capacity. Gulf Electric/Bo Nok (now Khang Koi II and relocated) and Union Power (now Ratchaburi Power and relocated) were delayed and marred with violent protests from anti-coal non-governmental organizations (NGOs), local villagers as well as opposition groups.

Each plant has subsequently been moved to a new location and converted to natural gas. During the period, EGAT cancelled the construction of the 2,000-MW Thap Sakae power plant, also located in Prajuapkhirikhan. Table 1-5 shows the list of SPP and IPP coal-fired power plants where EGAT had purchased power from since 1999.

Table 1-5. SPP/IPP Power Plants

SPP/IPP	Unit No.	Capacity (MW)	Commercial Operation	Note
Glow	1	160	1999	PPA: 90 MW sold to EGAT
	2	160	1999	PPA: 90 MW sold to EGAT
BLCP Power	1	717	2006	PPA: 673.25 MW sold to EGAT
Co. Ltd	2	717	2007	PPA: 673.25 MW sold to EGAT
GHECO-ONE Co. Ltd	1	700	2012	PPA: 660 MW sold to EGAT

Source: Electricity Generation Authority of Thailand.

4) Environmental Laws and Regulations Concerned in Coal-Fired Development

In 2007, section 67 of the Constitution of the Kingdom of Thailand stated that 'Any project or activities which may seriously affect the community with respect to the quality of the environment, natural resources and health shall not be permitted, unless prior to the operation thereof its impact on the quality of the environment and the public health have been studied and assessed and/on public hearing process having been conducted for consulting the public as well as interested persons and there has been an opinion of an independent organization consisting of representatives from private organizations in the field of environment and health and from higher education institutions providing in the field of the environment, natural resources or health.'

The National Health Act 2007 further protects the rights of individuals or groups by requesting an assessment and participation in the assessment of the health impact of a public policy.

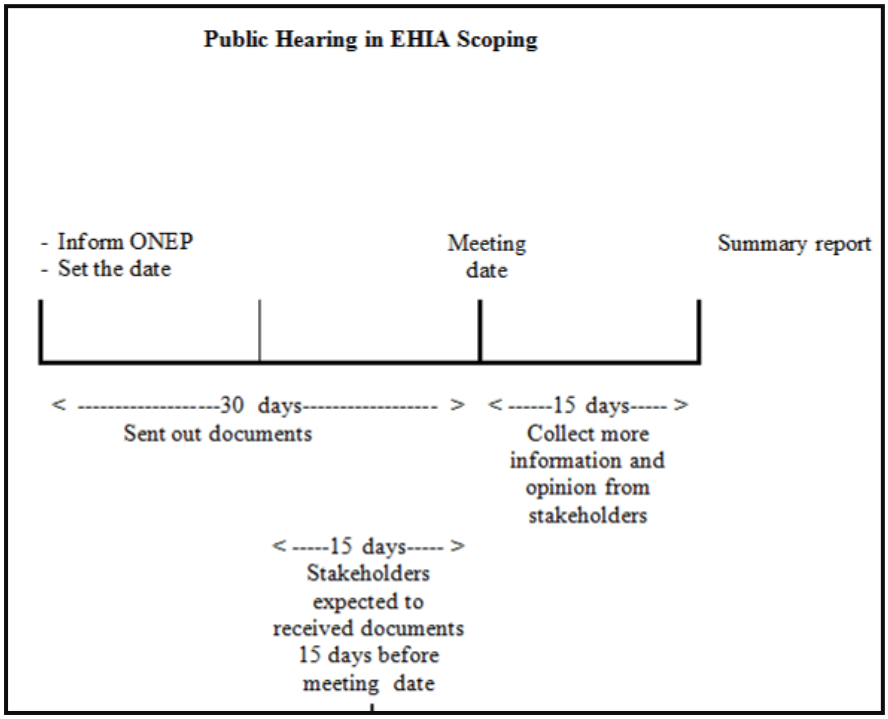
According to the ministerial regulations under the Ministry of Natural Resources and Environment, new coal-fired power plants with capacity of more than 100 MW and coalmines are required to undertake an Environmental and Health Impact Assessment (EHIA). The full EHIA includes a public hearing.

There are six steps for EHIA preparation, each requiring the participation of stakeholders. The steps and the responsible team/agency are:

- **Screening**: Project proponent/ Office of Natural Resources and Environmental Planning (ONEP)
- **Public scoping** (in which the study team or consultant company must allow the public to express concerns on potential impacts): EHIA consultant/ Project proponent/ONEP
- **Assessment or appraisal**: EHIA consultant
- **Public review**: EHIA consultant/ Project proponent/ONEP
- **Decision making**: ONEP/National Environment Board/Cabinet
- **Monitoring**: Project proponent/ONEP

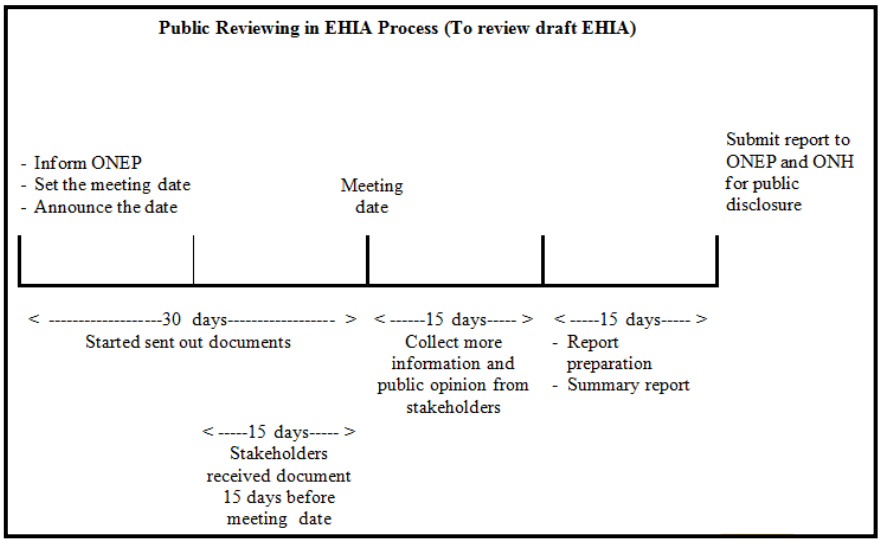
The following figures explain the Public Scoping, Public Review, and Decision-Making processes.

Figure 1-3. Public Hearing on EHIA Scoping



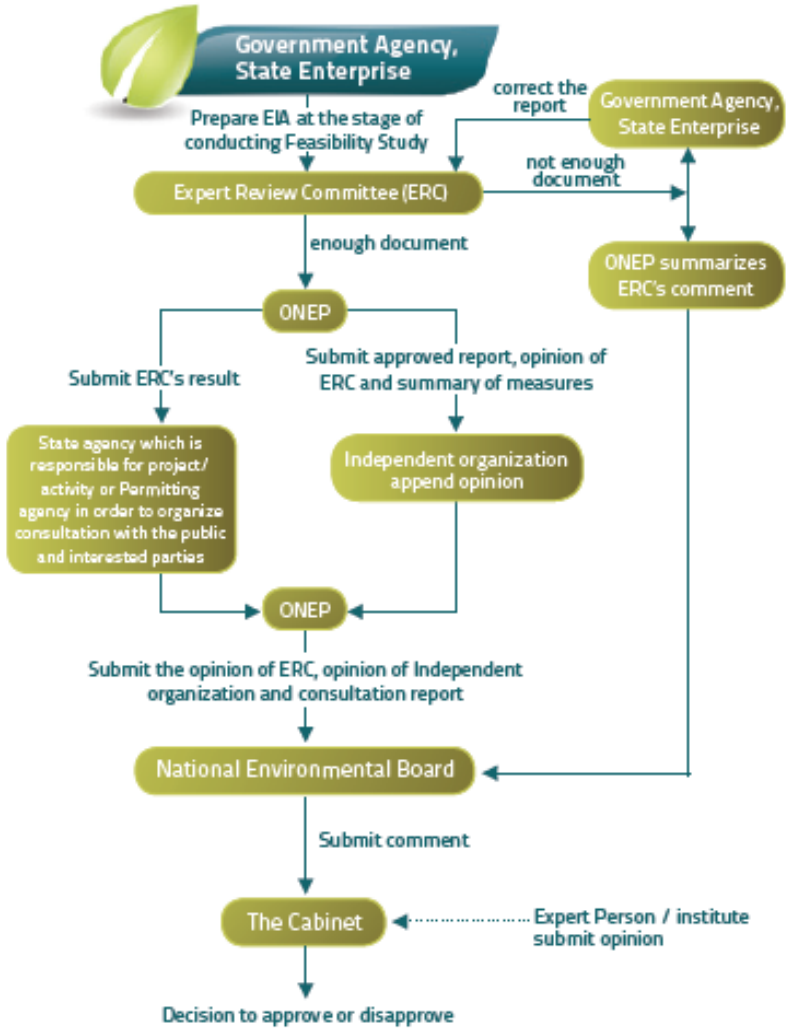
Note: ONEP = Office of Natural Resources and Environmental Planning.
Source: Environmental Impact Assessment in Thailand, Office of Natural Resources and Environmental Policy and Planning, May 2012.

Figure 1-4. Public Review on EHIA Process



Source: Environmental Impact Assessment in Thailand, Office of Natural Resources and Environmental Policy and Planning, May 2012.

Figure 1-5. Approval Process For Projects/Activities* That May Seriously Affect A Community's Environment, Natural Resources, and Health



*Note: Such activities require the approval of the Thai Cabinet.
Source: Environmental Impact Assessment in Thailand, Office of Natural Resources and Environmental Policy and Planning, May 2012.

5) Air Emission Standards

The current air emission standards for new coal-fired power plants are relevant for all plant generators.

The regulated limits for new coal-fired plants are shown in Table 1-6.

Table 1-6. Limits for New Coal-Fired Plants

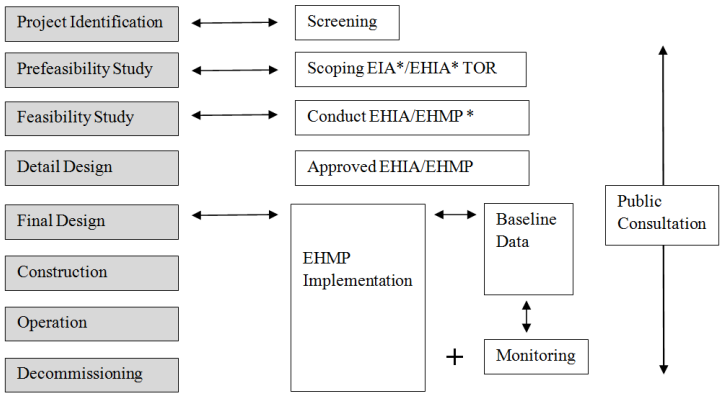
Capacity (MW)	SO_2 (ppm)	NO_X (as NO_2) (ppm)	Particulate Matter (mg/m^3)
≤ 50	360	200	80
> 50	180	200	80

SO_2 = sulphur dioxide; NOx = nitrogen oxide.
Note: Reference conditions are 25°C at 101.3 KPa (1 atm) or 760 mm/Hg on a dry fuel gas basis with 50% of excess air or 7% O_2 during combustion.
Source: Pollution Control Department.

6) Procedure for Commission of Coal Power Plants

While EGAT has long been the main player in the development and construction of power plants, IPPs started to play a key role in the development of power plants from 1997. Figure 1-6 lists the procedure that all developers have to consider.

Figure 1-6. Project Feasibility Versus Environmental and Health Impact Assessment Interaction



EIA = Environmental Impact Assessment; EHIA = Environmental and Health Impact Assessment; EHMP = Environmental and Health Mitigation Plan
Source: Graphic designed by Kitti Kumpeera.

7) Review of Major Players, Regulators, Licensees, And Vendors

The term 'stakeholder' may be understood as any actor—an institution, group or individual—with an interest or a role to play in a societal decision-making process. Stakeholders in coal-fired power plant development and operation from the public sector fall under one of these four groups :

- Power Policy and Planning Agency and Regulator
- National Policy Agency
- Implementation Agency
- Environmental and Health Agency

Table 1-7. Key Players in Power Plant Development

Power Planning and Regulating Agency	National Policy Agency	Implementation Agency	Environmental and Health Agency
Ministry of Energy -Energy Policy and Planning Office -Office of Energy Regulatory Council	National Economic and Social Development Board	Electricity Generation Authority of Thailand Independent Power Producers, and Small Power Producers	Ministry of Natural Resources and Environment -Office of Natural Resources and Environmental Planning Ministry of Public Health

Source: Adapted from the Energy Regulatory Council.

The Energy Policy and Planning Office (EPPO) under the Ministry of Energy (MOE) is responsible for planning and procuring the country's long-term energy, including electrical power. Yet, there is no direct department or government agency—whether within the MOE or in other ministries—that is in charge of looking after coal plants specifically. Thus, the role of providing information or educating the general public rests with the MOE. Meanwhile, the EGAT, a state enterprise that follows the directives from the MOE, is the implementer of the country's power generation plan.

It seems that the MOE is currently doing very little in preparing the groundwork for a new power plant, regardless of the type of energy source. The role of educating the public is pushed to EGAT; thus, EGAT is now taking both the tasks of educating the public and building a new power plant. These roles sometimes are seen to put EGAT in a bind: That is, EGAT's main mandate is to set up new power plants for the power generation sector. Thus, when EGAT tries to proceed to enlighten the public with correct and fair information and knowledge, the target audience would tend to assume that this is merely an action to protect its own interests and thus, does not believe what EGAT says.

The Prime Minister has instructed EGAT to come up with an understanding with the people living close to the coal power plants. Unfortunately, there is little mention of MOE's role in such process.

1.2 Role of CPPs in the Power Development Plan (PDP)

1) The Plan

a. Thailand energy policies

The Thailand Power Development Plan 2015-2036 (PDP2015) is the key energy policy of Thailand that aims to achieve a sustainable and well-balanced energy mix for the future. The PDP2015's framework, which was formulated in line with the Energy Efficiency Development Plan and the Alternative Energy Development Plan, was approved by the National Energy Policy Council on 17 December 2014. The policy includes the following:

- **Energy Security**: Dealing with an increase in power demand by taking into account fuel diversification to lessen the dependency on one particular fuel.
- **Economy**: Maintaining an appropriate cost of power generation and implementing energy efficiency.
- **Ecology:** Reducing environmental and social impacts by lessening carbon dioxide intensity in power generation.

The PDP2015 was formulated in line with social and economic development directions from the office of National Economic and Social Development Board. The Board estimates that the average growth of projected long-term Thai Gross Domestic Products (GDP) was 3.94%. With the PDP2015 and the Energy Efficiency Development Plan's energy efficiency directions, the

expected energy savings would be 89,672 GWh in the year 2036. Moreover, renewable energy—for instance, municipal waste, biomass, biogas, wind, and solar power generation—will be encouraged, according to the Alternative Energy Development Plan. Investments in a transmission and distribution system will accommodate renewable energy and smart-grid development.

b. Power demand forecast

Thailand's new Power Demand Forecast was calculated using the average long-term GDP growth in 2014-2036 at 3.94% by the National Economic and Social Development Board. The average population growth was estimated at 0.03%. In addition, the energy savings target from the Energy Efficiency Development Plan accounts for 89,672 GWh, while the renewable energy development target from the Alternative Energy Development Plan was set at 19,634.4 MW for the year 2036.

Thailand's new Power Demand Forecast would grow 2.67% annually from the year 2014 to the year 2036. By 2036, the expected energy and power demand would be 326,119 GWh and 49,655 MW, respectively.

The Power Demand Forecast of the PDP2010 Revision 3 and the PDP2015 are compared as follows:

Figure 1-7. Power Demand Forecast of the PDP2010 Revision 3 and the PDP2015

Year	PDP2010 Rev3		PDP2015		Change (%)	
	Peak (MW)	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)	Energy (GWh)
2016	31,809	210,619	30,218	197,891	-1,591	-12,728
2026	46,003	304,548	40,791	267,629	-5,212	-36,919
2030	52,256	346,767	44,424	291,519	-7,832	-55,248
2036	-	-	49,655	326,119	-	-

PDP = Power Development Plan.
Source: PDP2015.

The point here is that although PDP2015 includes more energy savings than PDP2010 Revision 3, power demand is estimated to grow significantly (around 65% by 2036). How to expand its power generation capacity is still the main challenge to Thailand's energy sector.

c. Key assumptions and frameworks

On 15 August 2014, the National Energy Policy Council approved the following assumptions and frameworks for PDP2015:

- Ensure power system reliability of subsystem areas in power generation, transmission, and distribution.
- Focus on fuel diversification so as to lessen the dependence on one particular fuel:
  - Reduce natural gas power generation
  - Increase coal power generation via clean coal technology
  - Purchase power supply from neighbouring countries at not more than 20% of the total capacity
  - Encourage renewable power generation
  - Maintain nuclear power plants at the end of the plan.
- Ensure an appropriate level of reserve margin of not less than 15% of the peak power demand.
- Maintain committed IPPs and SPPs according to the PPAs.

d. Generating capacity

Given the above-mentioned assumptions and frameworks, the PDP2015 can be summarized as follows: In 2036, the total capacity will be 70,335 MW, comprising of an existing capacity of 37,612 MW (as of December 2014); new capacity of 57,459 MW; and retired capacity during 2015-2036 of 24,736 MW (Figure 1-8).

Figure 1-8. Generating Capacity in the PDP2015

Generating capacity during 2015 - 2036

- Existing capacity as of December 2014	37,612	MW
- New capacity during 2015-2036	57,459	MW
- Retired capacity during 2015-2036	-24,736	MW
- Total capacity in 2036	70,335	MW

New capacity added during 2015-2036 of 57,459 MW can be classified as follows:

Renewable power plant	**21,648**	**MW**
- Domestic	12,105	MW
- Power purchase from neighboring countries	9,543	MW
Pump-storage hydro power plant	**2,101**	**MW**
Cogeneration power plant	**4,119**	**MW**
Combined cycle power plant	**17,478**	**MW**
Thermal power plant	**12,113**	**MW**
- Coal/Lignite power plant	7,390	MW
- Nuclear power plant	2,000	MW
Gas turbine power plant	1,250	MW
Power purchase from neighboring countries	1,473	MW
Total	57,459	MW

Source: PDP2015.

Consequently, Figure 1-9 shows the estimated fuel requirements for PDP2015.

Figure 1-9. Estimated Fuel Mix for PDP2015

Fuel	Percentage in 2014	Percentage in 2026	Percentage in 2036
Imported hydro power	7	10 - 15	15 – 20
Clean coal including lignite	20	20 - 25	20 – 25
Renewable energy including hydro	8	10 - 20	15 – 20
Natural gas	64	45 - 50	30 – 40
Nuclear	-	-	0 – 5
Diesel/Fuel oil	1	-	-

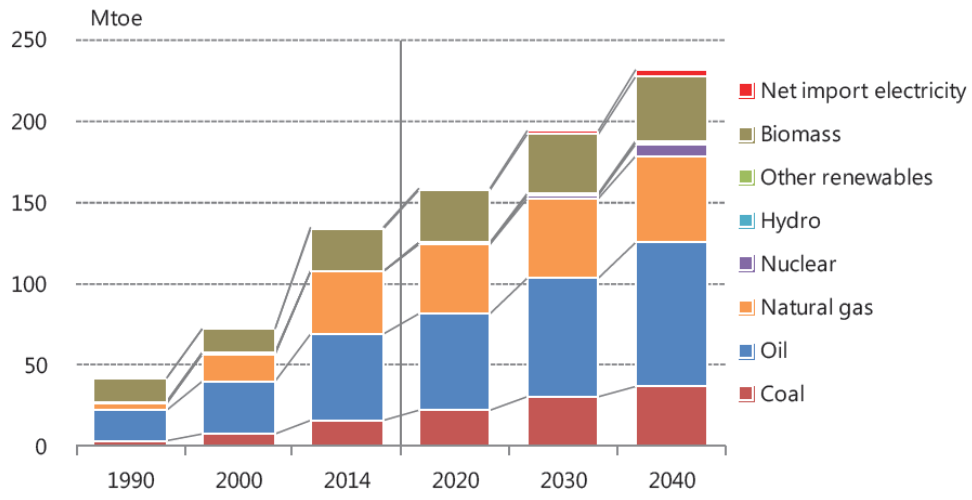
Source: PDP2015.

Encouraging renewable power generation is the main point of PDP2015. Renewable power generation is estimated to grow the most among all power sources during 2015-2036. However, clean coal, including lignite, is still expected to grow by around 7 GW and to keep its place as the second largest share in the energy mix next to natural gas. This statistics highlights the importance of coal generation in achieving a sustainable and well-balanced energy mix in Thailand.

2) Reference: IEEJ's *Asia / World Energy Outlook 2016*

The Institute of Energy Economics, Japan (IEEJ) publishes the *Asia/World Energy Outlook* every year to analyse and show trends and the latest information on future world energy supply and demand. One of the topics of the 2016 edition is the ASEAN energy market, including Thailand's energy market.

Figure 1-10. Outlook of Thailand's Primary Energy Consumption (Reference Scenario)



Source: *Asia /World Energy Outlook 2016*.

Figure 1-10 shows that Thailand's primary energy consumption will increase 1.7-fold by 2040. All the energy sources, including coal, will expand to meet the country's growing energy demand. The IEEJ also estimates that electricity demand will double and one-third of the growth will be covered by coal-fired power plants. It expects more growth in coal compared with the target in PDP2015.

Both PDP2015 and IEEJ's *Asia/World Energy Outlook 2016* demonstrate that coal will sustain or even expand its importance in Thailand's energy mix. Along with the promotion of domestic

renewable power generation, importation of hydro power, and energy conservation, efforts should focus on gaining traction in terms of public acceptance of coal energy, to pave the way for the expansion of its capacity.