
**Independent Market Research on the Power Generation
Industry in Thailand; Overview of the Power Generation
Industry in Cambodia, Lao PDR, Myanmar, and Vietnam**

October 2017

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The market research process for this study has been undertaken through secondary or desktop research, as well as detailed primary research, which involves discussing the status of the industry with leading industry participants and industry experts. The research methodology used is the *Expert Opinion Consensus Methodology*. Quantitative market information could be sourced from interviews by way of primary research and therefore, the information is subject to fluctuations due to possible changes in the business and industry climate.

This market research was completed in October 10, 2017.

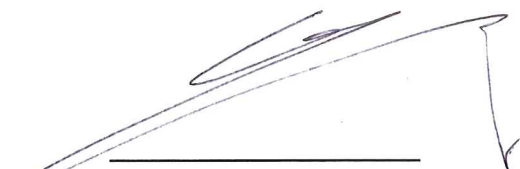
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For further information, please contact:

Frost & Sullivan GIC Malaysia Sdn Bhd
Suite C-11-02, Block C, Plaza Mont' Kiara
2, Jalan Kiara, Mont' Kiara
50480 Kuala Lumpur



Keith Lee

Director

Business & Financial Services, Malaysia

Abbreviations

General Definitions

AEDP	Alternative Energy Development Plan
AP	Availability payment
APAEC	ASEAN Plan of Action for Energy Cooperation
APG	ASEAN Power Grid
BCM	Billion cubic meters
BOT	Build-Operate-Transfer
BTU	British thermal unit
CAGR	Compound annual growth rate
CLMV	Cambodia, Lao PDR, Myanmar, Vietnam
COD	Commercial operation date
CP	Capacity payment
EAF	Equivalent availability factor
EEC	Eastern Economic Corridor
EEDP	Energy Efficiency Development Plan
EEP	Energy Efficiency Plan
EP	Energy payment
FDI	Foreign direct investment
GDP	Gross domestic production
GSP	Gas separation plant
GWh	Gigawatt hour
kW	Kilowatt
kWh	Kilowatt hour
FiT	Feed-in-Tariff
FS	Fuel saving
Ft	Fuel adjustment mechanism
IPP	Independent power producers
JV	Joint venture
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MMSCFD	Million standard cubic feet per day

MSW	Municipal solid waste
MTOE	Million tons of oil equivalents
MW	Megawatt
NGV	Natural gas vehicle
P2P	Power to the Poor
PDP	Power Development Plan
PPA	Power purchase agreement
PV	Photovoltaic
RE	Renewable energy
SCFD	Standard cubic feet per day
SOE	State-owned enterprise
SPP	Small power producers
T&D	Transmission and distribution
TAGP	Trans-SEA Gas Pipeline
THB	Thailand Baht
TOU	Time of use
USD	U.S. Dollar
VSPP	Very small power producers
WTE	Waste-to-energy

Companies, Authorities and Organizations

ADB	Asian Development Bank
AEC	ASEAN Economic Community
ASCOPE	ASEAN Council on Petroleum
ASEAN	Association of Southeast Asian Nations
B.GRIMM	B.Grimm Power Public Company Limited
BANPU	Banpu Public Company Limited
BOI	Board of Investment
BP	British Petroleum
CIA	Central Intelligence Agency
DEDE	Department of Alternative Energy Development and Efficiency
DMF	Department of Mineral Fuels
EDC	Electricite du Cambodge
EDL	Electricite du Laos

EGAT	Electricity Generating Authority of Thailand
EGCO	Electricity Generating Power Company Limited
EGCO Cogen	EGCO Cogeneration Company Limited
EPPO	Energy Policy & Planning Office
ERAV	Electricity Regulatory Authority of Vietnam
ERC	Energy Regulatory Commission of Thailand
EVN	Vietnam Electricity
GBL	Gulf BL Co., Ltd.
GBP	Gulf BP Co., Ltd.
GCC	Gulf Cogeneration Company Limited
GIZ	German International Cooperation
GLOW	Glow Energy Public Company Limited
GNC	Gulf NC Co., Ltd.
GNLL2	Gulf NLL 2 Co., Ltd.
GNPM	Gulf NPM Co., Ltd.
GNRV1	Gulf NRV 1 Co., Ltd.
GNRV2	Gulf NRV 2 Co., Ltd.
GNS	Gulf JP NS Co., Ltd.
GPD	Gulf PD Co., Ltd.
GPG	Gulf Power Generation Co., Ltd.
GPSC	Global Power Synergy Public Company Limited
GSRC	Gulf SRC Co., Ltd.
GTS1	Gulf TS 1 Co., Ltd.
GTS2	Gulf TS 2 Co., Ltd.
GTS3	Gulf TS 3 Co., Ltd.
GTS4	Gulf TS 4 Co., Ltd.
GUT	Gulf JP UT Co. Ltd.
GVTP	Gulf VTP Co., Ltd.
IEA	International Energy Agency
IMF	International Monetary Fund
IRPC-CP	IRPC Clean Power Co., Ltd
JPHT	J-POWER Holding (Thailand) Company Limited
Lao PDR	Lao People's Democratic Republic

KEGCO	Khanom Electricity Generating Company Limited
MEA	Metropolitan Electricity Authority
MEM	Ministry of Energy and Mines
MOE	Ministry of Energy
MOEP	Ministry of Electric Power
MOIT	Ministry of Industry and Trade
NED	Natural Energy Development Company Limited
NEPC	National Energy Policy Council
NKCC	Nong Khae Cogeneration Company Limited
NNEG	Nava Nakhon Electricity Generating Co. Ltd
PEA	Provincial Electricity Authority
PETRONAS	Petroliam Nasional Berhad
PTT	PTT Public Company Limited (formerly Petroleum Authority of Thailand)
RATCH	Ratchaburi Electricity Generating Holding Company Limited
RATCHGEN	Ratchaburi Power Plant
RGC	Royal Government of Cambodia
Roi-Et Green	Roi-Et Green Company Limited
RPCL	Ratchaburi Power Company's Power Plant
RW Cogen	Ratchaburi World Cogen Power Plant
SCC	Samutprakarn Cogeneration Company Limited
SEA	Southeast Asia
SET	Stock Exchange of Thailand
TECO	Tri-Energy Power Plant
THE COMPANY	Gulf Energy Development Public Company Limited
TJ Cogen	Klongluang Utilities Co., Ltd
TP & SK Cogen	Banpong Utilities Co., Ltd
TRIS	Thai Rating and Information Services
UN	United Nations
U.S.	United States of America

GLOSSARY OF TECHNICAL TERMS

Availability Payment	Payment according to the availability of power plant to generate power. If the power plant is ready for operation, EGAT is obliged to pay the AP to the power producer. AP is proposed by the power producer and it reflects the cost of power producer in CAPEX, interests, fixed cost in operation and maintenance, insurance premium, and dividends for shareholders.
Available Capacity	Available capacity refers to the Latest Tested Net Capacity. It is the dependable capacity, modified for equipment limitation at any time
Base Load Power Plant	A power plant which provide sufficient amount of power to meet the minimum demand of consumers.
Bio-Energy	Conversion of biomass resources such as agriculture residues into useful energy carriers including heat, electricity and transport fuels.
Bituminous coal	A relatively soft coal containing a tarlike substance called bitumen. It is of higher quality than lignite coal but of poorer quality than anthracite
Built-Operate-Transfer (BOT) Arrangement	A form of project financing of discrete asset wherein a private entity receives a concession from the private or public sector to finance, design, construct and operate a facility stated in the concession contract over a period of time, before transferring ownership of the facility to project owner.
Capacity Payment	Based on actual kilowatts produced multiplied by a capacity charge covering investment costs plus foreign exchange fluctuations.
Clean Coal Technology	A near-zero emission coal-based power generation that is embedded carbon capture and storage technology.
Coal Supply Transportation Agreement	Agreement between the power generators and the coal supplier
Co-generation	A power system that simultaneously produces both electrical and thermal energy from the same source
Combined Cycle	Configuration of steam turbines that work in tandem from the same source of heat (e.g. natural gas and coal), converting primary energy into mechanical energy, which in turn drives electrical generators.
Concession Agreement	A negotiated contract between a private company and the government that gives the company exclusive rights to operate a specified business under specified conditions.

Contracted Power Generation Capacity	Power generation capacity that is reserved to meet the requirements of the negotiated power supply contracts such as the power purchasing agreement.
Cubic meter	(m3) A volume measurement equal to 1,000 liters or 264. 2 US gallons. One cubic meter of water weighs one ton
Effective Contracted Power Generation Capacity	The effective contracted power generation capacity factors the equity stake of the project developers. Example if in a 100MW power plant a company has 70.0% equity stake, then the effective generation capacity of the company is 70MW
Electricity Consumption Per Capita	Total electricity consumption divided by the total population
Electrification Ratio	Percentage of households with access to electricity
Energy Efficiency (indicator)	Fuel requirement and performance of a power generation system in producing a unit of electricity
Energy Efficiency (policy)	Focus to reduce the consumption of energy in various processes.
Energy Payment	A payment per actual electricity sold to the grid according to amount required by EGAT. EP is proposed by the power producer and reflects the variable cost in operation and maintenance
Energy Security / Independence	Sources of a country's primary energy supply, which consists of either energy produced domestically or imported fossil fuels, which are produced by domestic companies.
Equivalent Availability Factor (EAF)	A measure of power plant availability calculated as the amount of time that a plant is able to produce electricity over a certain period, divided by the total amount of the time in the period
Feed in Tariff	Offers long-term contracts to renewable energy producers, typically based on the cost of generation of each technology, accelerating the integration of renewable energy sources into the grid
Gasification Process	A manufacturing process that converts any material containing carbon into synthesis gas to be burned to produce electricity.
Generation	The production of electricity
Generation Efficiency (indicator)	Performance of a power generation system in producing more units of electricity given a unit of fuel.
Heat Rate	Heat rate is the common measure of system efficiency in a conventional fuel power plant. It is defined as "the energy input to a system, typically in Btu/kWh, divided

	by the electricity generated, in kW.
Independent Power Producer (IPP)	An entity, which is not a public utility, but which owns facilities to generate electric power for sale to utilities and end users. IPPs may be privately held facilities, corporations, cooperatives such as rural solar or wind energy producers and non-energy industrial concerns capable of feeding excess energy into the system
Installed Capacity	Size of a project measured in megawatts (MW). The capacity quoted is usually the installed megawatts (MW) expected when the project becomes operational. While investment figures are either reported on total commitment basis in the year of financial closure or annual flows for some projects, capacity size information is cumulative
Contracted Capacity	The capacity in MW permitted or licensed by the regulator. The power plant developer may install a power plant with a higher capacity than the contracted capacity. The project developer may implement the project in phases.
Lignite	Also known as brown coal, it is composed mainly of volatile matter and moisture content with low fixed carbon, typically has approximately 4,000 kcal/kg of heating value, lower than the higher grade of anthracite and bituminous coal, generally have heating value between 5,000 – 6,000 kcal/kg.
Mega region	A region with a minimum 15 million population
Micro-grid	Localized grid that can be disconnected from the national grid to operate autonomously and help to mitigate grid disturbances and improve the resilience of national grid.
Micro-hydroelectric	Generation of electricity through hydro-electric power by harnessing the natural flow of water.
Mini-hydroelectric	Hydroelectric power plants smaller than 50MW
Original equipment manufacturer	In regards to electricity generation, it is a term used to refer to a company which manufactures a part or a subsystem that is used in power supply system.
On-grid System	When the power generation unit is connected to a utility source or electrical service provider.
Parts Per Million (ppm)	Concentration of a particular substance expressed in the value equivalent to the absolute fractional amount multiplied by one million.
Peak Demand / Load	The term peak demand / load refer to the highest amount of electricity being consumed at any one point in time across the entire network system. The peak

	demand / load is used to calculate the reserve margin
Power Blackouts	Short or long-term loss of electric power to an area.
Power Brownout	Intentional or unintentional drop in voltage in an electrical power supply system.
Power Factor	As power factor measure how effectively total delivered power is being used, utilities impose power factor charges to consumers with low power factor to encourage use of energy efficient appliances and equipment.
Power Purchase Agreement (PPA)	A contract mentioning the commercial terms between two parties one who generates electricity (seller) and the one who is looking to buy electricity (buyer)
Renewable Energy	Energy sources that are recurring and abundance in nature thus allowing it to be exploited for electricity generation without detrimental effects to the environment.
Reserve Margin	Total capacity margin is defined as the amount of installed generation available over and above system peak load $\text{Reserve Margin} = (\text{Installed Capacity} - \text{Peak Demand}) / \text{Peak Demand}$
Small Power Producer	On-grid power producers which installed capacity do not exceed a certain threshold, e.g. 90MW in Thailand.
Solar Photovoltaic (PV)	A technology that converts sunlight into electricity.
SPP Firm	SPP Firm contract is a PPA contract that gives EGAT authority over the decisions on the operation of the power plant. - actually must meet requirements stipulated under the PPA
SPP Non-Firm	It is the opposite of SPP Firm, renewed usually over 5-year period.
Super Clusters	The Super-Cluster is an industrial development initiative introduced by the Thai government designed to link Thailand's industry cluster assets and strengthen the clusters by adding mission critical elements that help businesses become more efficient and competitive.
Transmission Network	The initial stage in delivery of electric power which involves bulk transfer of electrical energy from generating power plants to electrical substations located near demand centers.
Urbanization Rate	Calculated using the World Bank's population estimates and urban ratios from the UN World Urbanization Prospects. Urbanization refers to the increase in the proportion of people living in towns and cities when a country is still developing. Increase in urbanization rates

Waste-to-Energy

creates more demand for goods and services.

Refers to the process of generating electrical energy through direct and indirect combustion due to the primary treatment of waste.

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1 ANALYSIS OF THAILAND POWER GENERATION INDUSTRY

1.1 BACKGROUND OF THE POWER GENERATION INDUSTRY IN THAILAND

The current structure of Thailand's power generation industry was formed during the establishment of Electricity Generating Authority of Thailand (“**EGAT**”) in 1969. Between 1969 and the mid-1970s, power generation in Thailand was expanded significantly to meet the demand for electricity which increased by approximately 10.0% annually. The World Oil Crisis in the 1970s and early 1980s, which resulted in a spike in prices of crude oil, affected the power generation industry in Thailand as the country was heavily dependent on crude oil as a fuel source. This led to the diversification of fuel sources towards natural gas (discovered in the Gulf of Thailand, Nam Phuong District, Khun Kane Province and Land Krabi District), lignite (Mae Moh Mine) and hydroelectricity (Khae Laem Dam and Rajjaprabha Dam).

Thailand's power generation industry consists of EGAT, a state-owned enterprise (“**SOE**”) as well as private power producers. The private power producers can be defined as follows:

Table 1-1: Categories of Private Power Producers in Thailand, 2017

Category	Contracted Power Generation Capacity	Off-takers
Independent Power Producers (“ IPPs ”)	>90.0MW	i. EGAT
Small Power Producers (“ SPPs ”)	10.0MW – 90.0MW	i. EGAT
Very Small Power Producers (“ VSPPs ”)	<10.0MW	i. Metropolitan Electricity Authority (“ MEA ”) ii. Provincial Electricity Authority (“ PEA ”)

Note: For SPPs, 90.0MW is the maximum power generation capacity contracted to EGAT. SPPs may assign capacity dedicated for industrial customers (power, steam and chilled water) in addition to the 90.0MW capacity contract to EGAT

Source: EGAT

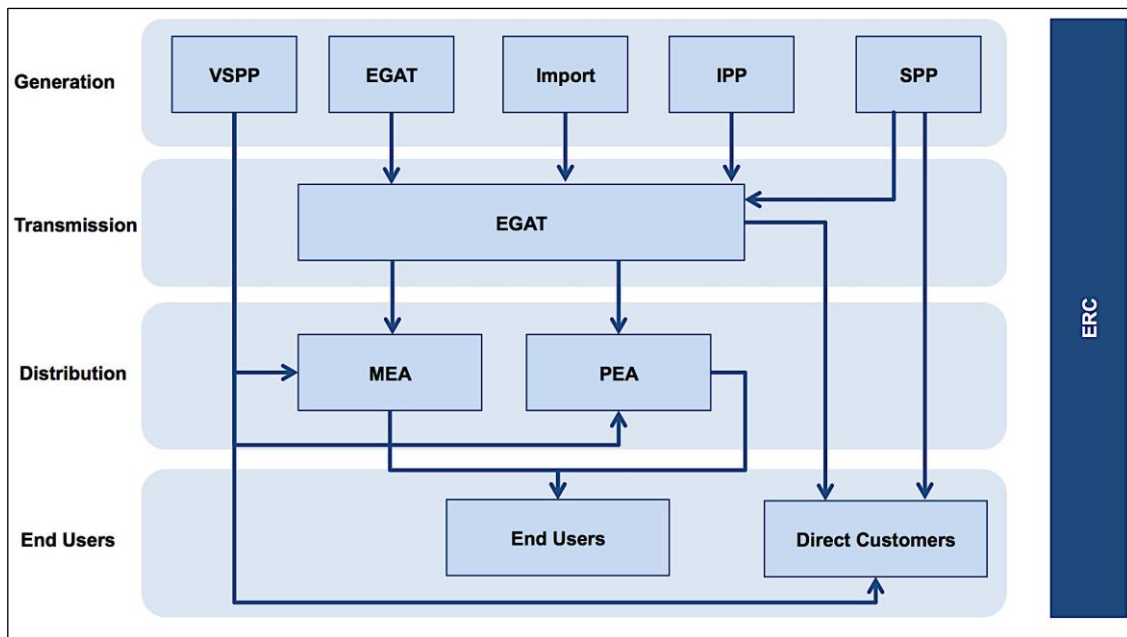
As of December 31, 2016, EGAT represented 39.4% of total installed capacity in Thailand, with private power producers comprising the remaining 60.6%. Thailand also imports electricity from neighboring Lao PDR and Malaysia via grids connected to the EGAT's transmission grid.

Electricity is distributed through two SOEs, namely Metropolitan Electricity Authority (“**MEA**”)¹ for the Bangkok metropolitan area and Provincial Electricity Authority (“**PEA**”)² for other provinces in Thailand. The entire value chain of the power sector in Thailand is governed by the Energy Regulatory Commission of Thailand (“**ERC**”), which is responsible for overseeing regulations encompassing power generation, transmission and distribution (“**T&D**”), electricity tariffs, licensing and approval of Power Purchase Agreement (“**PPA**”).

¹ MEA was established in 1958 to supply power in Bangkok Nonthaburi and Samut Prakan.

² PEA was renamed in 1960 (previously known as Provincial Electricity Organization established in 1954)

Figure 1-1: Power Sector Structure in Thailand



Note: Direct customers are mainly industrial customers located near the SPP power plants using private distribution lines. As of now, SPPs are limited to serving on-site industrial customers only³.

Source: Frost & Sullivan

1.1.1 Pricing Structure

IPP contracts

Since 1994, IPP operators in Thailand are given the rights to build, own and operate large-scale power plants that supply electricity directly to national transmission grid under the conditions of a PPA. Private entities are allowed to participate in the bidding of PPA which states the contracted amount of power generation capacity to be supplied to EGAT. The award of PPA is dependent on the approval of the ERC and largely refers to Thailand's Power Development Plan ("PDP"). During the bidding process, participants can propose the power generation capacity, fuel selection and location, with conditions such as the environmental standards to be met. A PPA, which is signed between the IPP operator and EGAT, sets forth the conditions which confer on EGAT the rights to authorize the commencement of power plant operations or shut down the plant according to the status of the power supply and demand in the grid, but not other aspects, such as fuel sourcing, general operations or maintenance. PPAs usually last through the design life of power plants of about 20 - 25 years. Furthermore, there is a possibility of PPA extension for 5 – 15 years for power plants that have reached the end of the PPA lifespan, depending on power plants' condition and plans for further upgrades and maintenance.

³ World Bank, "Small Power Producers in Thailand"

SPP contract

A SPP contract is a type of PPA that EGAT awards to power producers with contracted power generation capacity not exceeding 90.0MW. Similar to the IPPs, the bidding for PPAs is open for private entities to participate in and usually has a prescribed amount of power generated that EGAT will purchase. The award of SPP contracts is also dependent on the approval of ERC and largely refers to Thailand's PDP. The development of the SPP industry in Thailand stemmed from an initiative to support the development of power generation via selected technologies such as waste to energy, cogeneration and also renewable energy.

An SPP contract can be classified into 2 major categories, namely Firm and Non-Firm contracts. SPP Firm contract is a PPA contract that gives EGAT authority over the decisions to stipulate the power generated by the SPP's power plant. The power producer will also be penalized if it is unable to deliver power according to committed quantity stated in the PPA. Power producers engaged in SPP Firm contract will receive Capacity Payment ("**CP**") and EP in accordance with a dual tariff structure. An SPP Firm contract is usually valid throughout the design life of power plant of around 20 - 25 years and may be extended upon the expiry of the contract. SPP Firm can guarantee availability of electricity supply during the system peak months. Furthermore, SPP Firm plants that are operating on conventional energy receive an unbundled base tariff that includes capacity payment, energy payment and fuel savings payment. According to the Power Purchase from SPP-Firm Cogeneration 2011 revision, CP represents the base capacity payment of the long-run avoided cost of an EGAT large combined-cycle power plant, which is valued at THB420.0 per kW month and adjusted for exchange rate variations compared to the base exchange rate of the particular month. EP represents the base price of gas at THB1.85 per kWh and is adjusted for fluctuations in the gas price at the time it is purchased from PTT Public Company Limited ("**PTT**"). The Fuel Saving ("**FS**") payment represents the efficiency of cogeneration plant as compared to separate conventional electrical and thermal generation through primary energy saving principle. FS incentives are capped at THB0.36 per kWh, depending on primary energy saving achievement. To get full incentives, the plant has to achieve a minimum of 10.0% primary energy saving.

Meanwhile, an SPP Non-Firm contract is another type of PPA arrangement in which the owner of power plants retains decision-making authority over operations and where there is no applicable penalty if the owner is unable to deliver power according to committed quantity. This arrangement attracts the participation of co-generation and renewable energy power generation companies due to the uncertainty in energy output from these power plants. CP will not be applicable under this contractual arrangement. SPP Non-Firm contracts are usually valid for five years on a renewable basis. For SPP Non-Firm, contracted parties may declare the intention to extend their contract at a minimum of 30 days before the expiration period, whereby a five year extension will be applicable automatically in the PPA contract.

The SPP program has provided a limited number of Thailand's industrial power customers to buy power in bulk directly from private suppliers without going through EGAT. SPPs can sell their generated electricity to EGAT, industrial customers or both. For SPP Firm contracted plants, approximately less than 60.0% of their installed capacity is allocated to EGAT's main power grid, with the remaining 40.0% allocated to the industrial sector⁴. As for SPP Non-Firm contracted

⁴ World Bank

plants, at least one-third of the power plants' installed capacity are allocated to EGAT and remaining to industrial customers. SPPs direct customers are typically on-site industrial customers located in proximity with the power plants.

VSPP contract

A VSPP contract is a type of PPA that the MEA and PEA award to power producers for power generation capacity not exceeding 10.0MW. The contract is open for private entities to participate in. Similar to SPP, VSPP has been used to promote specific power generation technologies, such as mini-hydroelectric, micro-hydroelectric and waste-to-energy. Since 2007, the MEA and PEA have introduced incentivized schemes to attract participation in VSPPs.

In 2007, the Adder (Feed-in Premium) policy was introduced for VSPPs using renewable power generation technologies. The technologies supported under this scheme are biomass, biogas, waste, wind, small hydro and solar. The Adder Scheme is a premium price feed-in-tariff that is paid in addition to the wholesale electricity rates for each Renewable Energy (**"RE"**) technology. VSPP contracts under the Adder Scheme are usually valid for five years on a renewal basis.

Subsequently, the Adder tariff was progressively adjusted by the National Energy Policy Council (**"NEPC"**) over the years as they were deemed too high, which eventually resulted in the shift from premium price feed-in-tariff (Adder Scheme) to fixed rate Feed-in-Tariff (**"FiT"**) Scheme in 2014. Under the new scheme, the ERC established a new ruling for MEA, PEA and EGAT to cease offering PPAs to power producers of less than 10.0MW and to be replacing existing PPAs with those based on ERC's FiT Scheme. Other notable changes implemented under the FiT Scheme include amendments in PPA duration and introduction of VSPP selection via competitive bidding. VSPP contracts under the FiT Scheme for all renewable energy are usually valid for 20 years, except for land fill gas generation, which is eligible for 10-year PPAs⁵.

⁵ Watson Farley & Williams: "Thailand shifts from renewable energy adder rates to feed-in-tariffs for VSPPs", March 2015

Table 1-2: Overview of Current FiT Scheme, THB/kWh

RE Technology	FiT (F)	FiT (2017)	Total Calculated FiT	Period of Support	FiT Premium	
					For Bio-Energy (8 years)	Southern Provinces (Project Lifetime)
Industrial Waste						
Existing Waste- to-Energy (“WTE”) Plants	2.39	2.69	5.08	20	0.70	0.50
New WTE Plants	2.39	2.69	6.08	20	0.70	0.50
New WTE Plants using Plasma technology	2.39	2.69	6.08	20	1.70	0.50
Municipal Solid Waste (e.g. incineration, gasification)						
Capacity 1.0MW or less	3.13	3.21	6.34	20	0.70	0.50
Capacity > 1.0 – 3.0MW	2.61	3.21	5.82	20	0.70	0.50
Capacity 3.0MW and above	2.39	2.69	5.08	20	0.70	0.50
Waste						
Landfill gas	5.60	-	5.60	10	-	0.50
Biomass						
Capacity 1.0MW or less	3.13	2.21	5.34	20	0.50	0.50
Capacity > 1.0 – 3.0MW	2.61	2.21	4.82	20	0.40	0.50
Capacity 3.0MW and above	2.39	1.85	4.24	20	0.30	0.50
Biogas						
Wastewater/ Waste Products	3.79	-	3.76	20	0.50	0.50
Energy Crops	2.79	2.55	5.34	20	0.50	0.50
Hydroelectricity						
Capacity 200.0kW or less	4.90	-	4.90	20	-	0.50
Wind Power						
Wind	6.06	-	6.06	20	-	0.50
Solar Power						
Ground Mounted (2016)	4.12	-	-	20	-	0.50
Solar Rooftop (2015)						
Residential Rooftop (0.0 – 10.0kW)	6.85	-	-	20	-	
Commercial Rooftop (10.0 – 250.0kW)	6.40	-	-	20	-	
Commercial Rooftop (250.0 – 1000.0kW)	6.01	-	-	20	-	

Note: Southern Provinces includes Yala, Pattani, Narathiwat and four districts in Songkla provinces (i.e. Chana, Thepa, Saba Yoi and Na Thawi)

Source: German International Cooperation (GIZ), Energy Policy and Planning Office (“EPPO”), ERC

1.1.1.1 Electricity Tariffs

EGAT, MEA and PEA electricity tariffs are regulated by ERC. The electricity tariffs differ by different generator categories namely IPP, SPP and VSPP. The type of contract (i.e. Firm and Non-Firm) and energy source (i.e. conventional and renewable) determine the tariff structure.

Wholesale Tariffs

The wholesale tariffs are determined by the time of consumption and voltage level of electricity cost and transmission fees. EGAT charges wholesale tariffs to MEA, PEA and direct customers.

Table 1-3: Wholesale Electricity Tariff for MEA and PEA based on Time of Use Rate (as of November 2015)

(Baht/kWh)

Voltage Levels	Electricity Cost		Transmission Fee		Wholesale Rate	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
230 kV	3.1192	2.3316	0.2730	-	3.3922	2.3316
69 kV – 115 kV	3.1286	2.3341	0.4913	-	3.6199	2.3341
At the end of transmission line 69 kV – 115 kV ⁶	2.1948	2.3555	0.8528	-	4.0476	2.3555
11 kV – 33 kV	3.2017	2.3567	1.0226	-	4.2243	2.3567

Note:

Time of Use (TOU) Tariff

On Peak: Monday – Friday from 09.00 AM to 10.00 PM

Off Peak: Monday – Friday from 10.00 PM to 09.00 AM

: Saturday – Sunday, National Labour Day and normal public holiday

(Excluding substitution holiday and Royal Ploughing Day) from 12.00 AM to 12.00 PM

Source: EGAT

Retail Tariffs

The structure of retail electricity tariffs differs on the category of end users, consumption and capacity levels. The retail electricity tariffs consist of the following:

- i. Fuel Adjustment Mechanism (“**Ft**”): This mechanism is used for adjusting power tariff to reflect the actual fuel cost for power generation within a specific timeline. Ft surcharge is revised quarterly, taking into consideration EGAT’s fuel costs, power purchase costs and policy measures, established by the Thai government such as Power Development Fund and RE generation subsidies.

⁶ This includes 115:115 kV and 69:69 kV high voltage stations.

Table 1-4: Ft Tariff, 2016 and 2017

Month	Ft Tariff (Baht/kWh)	Average Retail Tariff including Ft (Baht/kWh)
January – April 2016	-0.0480	3.71
May – August 2016	-0.3329	3.42
September – December 2016	-0.3329	3.42
January – April 2017	-0.3729	3.38
May – August 2017	-0.2477	3.51

Source: MEA, EGAT, EPPO, ERC

- ii. Base Tariff: This reflects the cost to construct and operate power plants, transmission lines and distribution lines, including fuel costs. It differs for different consumer groups and consumptions.

The current Thailand electricity tariff structure is as follows:

Table 1-5: Electricity Tariffs in Thailand by Customer Group (as of September 2017)

Schedule 1: Residential Service

1.1 Normal tariff with consumption not exceeding 150 kWh per month			
Monthly Tariff			
Energy Charge			
First 15 kWh (1st – 15th)	2.3488	Baht/ kWh	
Next 10 kWh (16th – 25th)	2.9882	Baht/ kWh	
Next10 kWh (26th – 35th)	3.2405	Baht/ kWh	
Next 65 kWh (36th – 100th)	3.6237	Baht/ kWh	
Next 50 kWh (101st – 150th)	3.7171	Baht/ kWh	
Next 250 kWh (151st – 400th)	4.2218	Baht/ kWh	
Over 400 kWh (up from 401st)	4.4217	Baht/ kWh	
Service charge (Baht/Month):	8.19		
1.2 Normal tariff with consumption exceeding 150 kWh per month			
Monthly Tariff			
Energy Charge			
First 150 kWh (1st – 150th)	3.2484	Baht/ kWh	
Next 250 kWh (151st – 400th)	4.2218	Baht/ kWh	
Over 400 kWh (up from 401st)	4.4217	Baht/ kWh	
Service charge (Baht/Month):	38.22		
1.3 Time of Use Tariff (TOU Tariff)			
Monthly Tariff			
	Energy Charge(Baht/kWh)		Service Charge(Baht/Month)
	On Peak	Off Peak	
1.3.1 : 12 - 24 kV.	5.1135	2.6037	312.24
1.3.2 : Below 12 kV.	5.7982	2.6369	38.22

Schedule 2: Small General Service

2.1 Normal tariff			
Monthly Tariff			
Voltage Level	Energy Charge (Baht/kWh)	Service Charge (Baht/month)	
2.1.1 : 12 - 24 kV	3.9086	312.24	
2.1.2 : Below 12 kV		46.16	
First 150 kWh (1st – 150th)	3.2484		
Next 250 kWh (151st – 400th)	4.2218		
Over 400 kWh (up from 401st)	4.4217		
2.2 Time of use tariff (TOU tariff)			
Monthly Tariff			
Voltage Level	Energy Charge (Baht/kWh)		Service Charge (Baht/month)
	On Peak	Off Peak	
2.2.1 : 12 - 24 kV	5.1135	2.6037	312.24
2.2.2 : Below 12 kV	5.7982	2.6369	46.16

Schedule 3: Medium General Service

3.1 Normal tariff					
Monthly Tariff					
Voltage level	Demand (Baht/kW)	Charge	Energy Charge (Baht/kWh)	Service Charge (Baht/month)	
3.1.1 : 69 kV and over	175.7		3.1355	312.24	
3.1.2 : 12-24 kV	196.26		3.1729	312.24	
3.1.3 : Below 12 kV	221.5		3.2009	312.24	
3.2 Time of use tariff (TOU tariff)					
Monthly Tariff					
Voltage level	Demand Charge (Baht/kW)		Energy Charge (Baht/kWh)		Service Charge (Baht/month)
	On Peak	Off Peak	On Peak	Off Peak	
3.2.1 : 69 kV and over	74.14	0	4.1283	2.6107	312.24
3.2.2 : 12-24 kV	132.93	0	4.2097	2.6295	312.24
3.2.3 : Below 12 kV	210	0	4.3555	2.6627	312.24

Schedule 4: Large General Service

4.1 Time of day tariff (TOD tariff)					
Monthly Tariff					
Voltage level	Demand Charge (Baht/kW)			Energy Charge (Baht/kWh)	Service Charge (Baht/month)
	On Peak	Partial Peak	Off Peak	All Times	
4.1.1 : 69 kV and over	224.30	29.91	0	3.1355	312.24
4.1.2 : 12 - 24 kV	285.05	58.88	0	3.1729	312.24
4.1.3 : Below 12 kV	332.71	68.22	0	3.2009	312.24
4.2 Time of use tariff (TOU tariff)					
MONTHLY TARIFF					
Voltage level	Demand Charge (Baht/kW)		Energy Charge (Baht/kWh)		Service Charge (Baht/month)
	On Peak	Off Peak	On Peak	Off Peak	
4.2.1 : 69 kV and over	74.14	0	4.1283	2.6107	312.24
4.2.2 : 12-24 kV	132.93	0	4.2097	2.6295	312.24
4.2.3 : Below 12 kV	210.00	0	4.3555	2.6627	312.24

Schedule 5: Specific Business Service

5.1 Normal tariff					
Monthly Tariff					
Voltage level	Demand Charge (Baht/kW)	Energy Charge (Baht/kWh)	Service Charge (Baht/Month)		
5.1.1 : 69 kV and over	220.56	3.1355	312.24		
5.1.2 : 12 – 24 kV	256.07	3.1729	312.24		
5.1.3 : Below 12 kV	276.64	3.2009	312.24		
5.2 Time of use tariff (TOU tariff)					
Monthly Tariff					
Voltage level	Demand Charge (Baht/kW)		Energy Charge (Baht/kWh)		Service Charge (Baht/kWh)
	On Peak	Off Peak	On Peak	Off Peak	
5.2.1 : 69 kV and over	74.14	0	4.1283	2.6107	312.24
5.2.2 : 12-24 kV	132.93	0	4.2097	2.6295	312.24
5.2.3 : Below 12 kV	210.00	0	4.3555	2.6627	312.24

Schedule 6: Non-Profit Organization

6.1 Normal tariff					
Monthly Tariff					
Voltage level	Energy Charge (Baht/kWh)	Service Charge (Baht/Month)			
6.1.1 : 69 kV and over	3.4407	312.24			
6.1.2 : 12 – 24 kV 3.2193	3.6107	312.24			
6.1.3 : Below 12 kV		20.00			
First 10 kWh (1st-10th)	2.8271				
Over 10 kWh (up from 11st)	3.9177				
6.2 Time of use tariff (TOU tariff)					
Monthly Tariff					
Voltage level	Demand Charge (Baht/kW)		Energy Charge (Baht/kWh)		Service Charge (Baht/Month)
	On Peak	Off Peak	On Peak	Off Peak	
6.2.1 : 69 kV and over	74.14	0	4.1283	2.6107	312.24
6.2.2 : 12-24 kV	132.93	0	4.2097	2.6295	312.24
6.2.3 : Below 12 kV	210.00	0	4.3555	2.6627	312.24

Schedule 7: Water Pumping for Agricultural Purposes

7.1 Normal tariff					
Monthly Tariff					
Energy Charge	Energy Charge (Baht/kWh)				
First 100 kWh (1st – 100th)	2.0889				
Over 100 kWh (up from 101st)	3.2405				
Service Charge (Baht/month) :	115.16				
7.2 Time of use tariff (TOU tariff)					
Monthly Tariff					
Voltage Level	Demand Charge (Baht/kW)		Energy Charge (Baht/kWh)		Service Charge (Baht/Month)
	On Peak	Off Peak	On Peak	Off Peak	
7.2.1 : 12-24 kV	132.93	0	4.1839	2.6037	228.17

7.2.2 : Below 12 kV	210.00	0	4.3297	2.6369	228.17
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Schedule 8: Temporary Tariff

8.1 Monthly Tariff					
Energy charge (All voltage level)	Baht	6.8283	per kWh		

Note:

Time of Use (TOU) Tariff

On Peak : Monday – Friday from 09.00 AM to 10.00 PM

Off Peak : Monday – Friday from 10.00 PM to 09.00 AM

: Saturday – Sunday , National Labor Day and normal public holiday

(excluding substitution holiday and Royal Ploughing Day) from 12.00 AM to 12.00 PM

Billing Demand

A Billing demand is defined as the maximum 15-minute integrated demand over the monthly billing period measured to the nearest full kilowatt (“kW”) discarding the fraction of up to 0.5 kW.

Minimum Charge

A minimum charge in any monthly billing period shall not be less than 70.00% of the maximum billing demand charge of the previous 12 months.

Power Factor Charge

For a customer with a lagging power factor, if in any monthly billing period during which the customer's maximum 15-minute reactive power demand (kilovar demand) exceeds 61.97% of his maximum 15-minute active power demand (kW demand), a power factor charge of Baht 56.07 will be made on each kilovar in excess, determined to the nearest whole kilovar, discarding the fraction of 0.5 kilovar.

Source: MEA, PEA

1.1.2 Fuel Pass through Mechanism

For projects that rely on imported natural gas as fuel sources, there has been some concern regarding fuel cost fluctuations. Since 1991, the Ft, which incorporates Automatic Fuel Adjustment was introduced to reflect actual costs of the tariffs and to reduce the impact of fuel price volatility on the power utilities' financial status. The risk of fluctuation in natural gas price is treated as pass-through via three stages:

Stage one: pass through from natural gas seller to EGAT/IPP/SPP per Gas Sales Agreement

Price of natural gas in the natural gas procurement contract will have initial base price and formula to limit the highest and the lowest adjustment price. Factors influencing the formula consist of the price of low sulfur heavy fuel oil in Singapore market, foreign exchange rate, and other economic indices, with variable adjustment period. Natural gas price will be passed through to the electricity generating client who procures natural gas from the gas seller.

Stage two: gas price through from IPP/SPP to EGAT per PPA

Payment that is payable by EGAT to IPP/SPP consists of two payment portions, namely availability payment (which covers debt financing cost, foreign exchange rate, major maintenance

costs, and other financial costs) and energy payment (which covers cost of fuel and variable cost of operation and maintenance with inflation indexation and pass through mechanism). In this case, SPP non-firm only gets the energy payment portion.

Stage three: gas price passes through from EGAT to MEA/PEA and from MEA/PEA to consumers

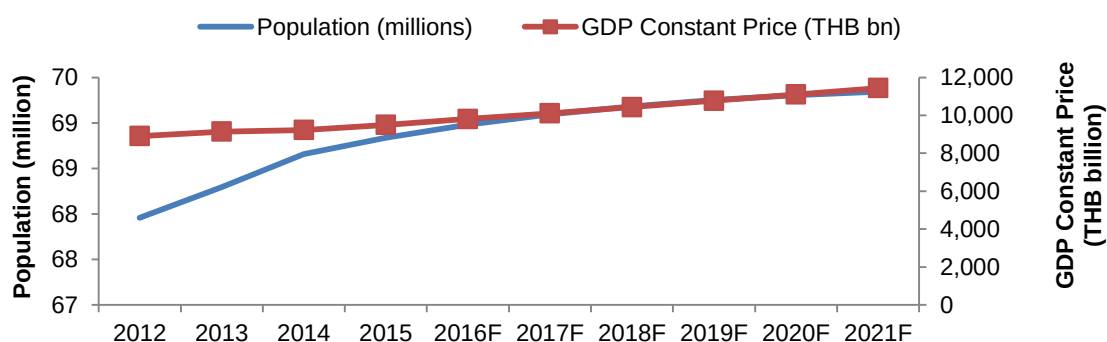
ERC approved that as of November 2015, the electricity price billed to consumers consists of three portions:

1. Electricity base price, which will be adjusted every three to five years to reflect capital investments in generation, transmission, distribution, operating cost, and policy cost.
2. Ft surcharge, which will be adjusted every four months to reflect the cost beyond the control of EGAT/MEA/PEA. The power purchase from IPPs or SPPs, including the energy payment is included in this portion.
3. Value added tax

1.2 DEMAND CONDITIONS

Electricity demand in Thailand is expected to grow in tandem with economic growth. Thailand's population is expected to grow from an estimation of 69.0 million in 2016 to 69.3 million by 2021 at a CAGR of 0.1%. Gross domestic product ("**GDP**") is expected to achieve a CAGR of 3.1% from THB9,808 billion in 2016 to THB11,442 billion in 2021⁷.

Chart 1-1: Population and Real GDP Growth Trend in Thailand, 2012 – 2021F



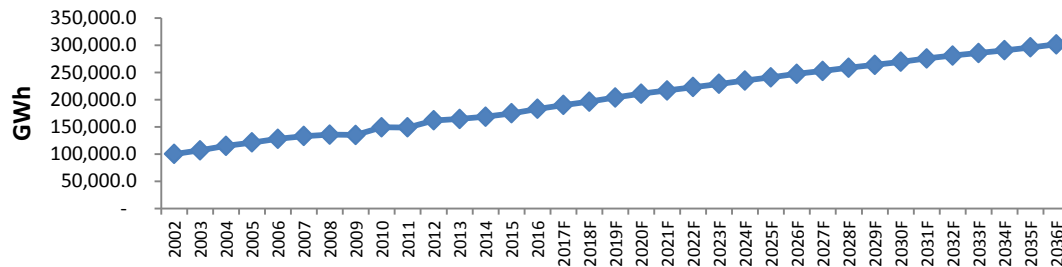
Source: International Monetary Fund ("**IMF**")

According to the Energy Policy and Planning Office ("**EPPO**") Energy Statistics, electricity consumption in Thailand increased at a CAGR of 3.1% from 161,779.0GWh in 2012 to 182,847.4GWh in 2016. Based on the anticipated annual growth of electricity generation requirement as forecasted by PDP 2015, electricity consumption in Thailand will continue growing in the next five years at a CAGR of 3.4% between 2017 and 2021 from 190,015.2GWh in

⁷ IMF, World Economic Outlook Database, April 2017

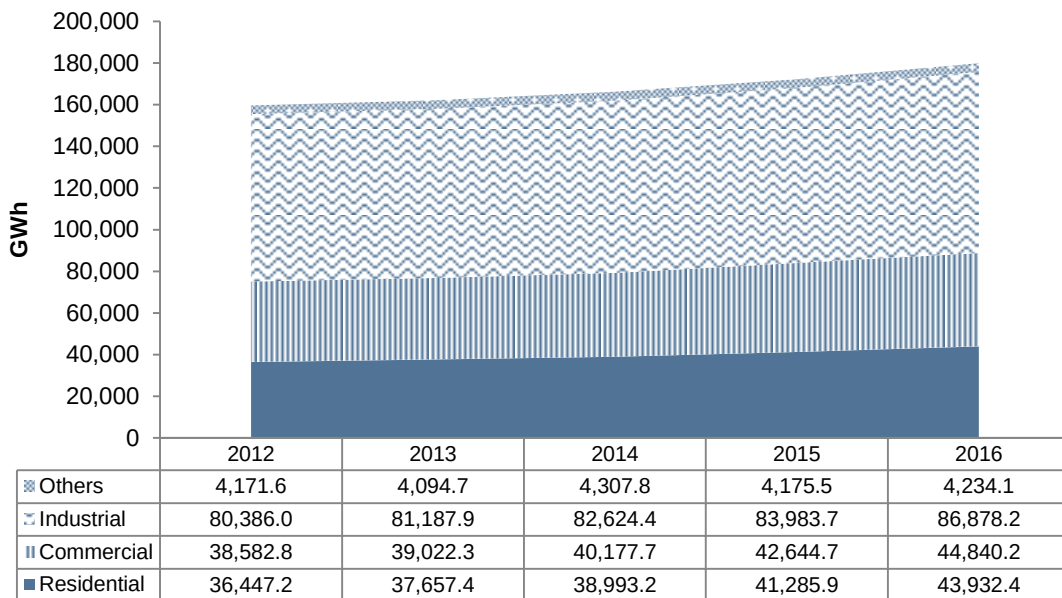
2017 to 216,815.2GWh in 2021. Overall, electricity consumption is expected to grow at a CAGR of 2.5% from 182,847.4GWh in 2016 to 301,326.9GWh in 2036.

Chart 1-2: Electricity Consumption for Thailand, 2002 – 2036F



Source: EPPO, Ministry of Energy Thailand (“MOE”), Frost & Sullivan

Chart 1-3: Total Electricity Consumption by Consumer Group in Thailand, 2012 - 2016

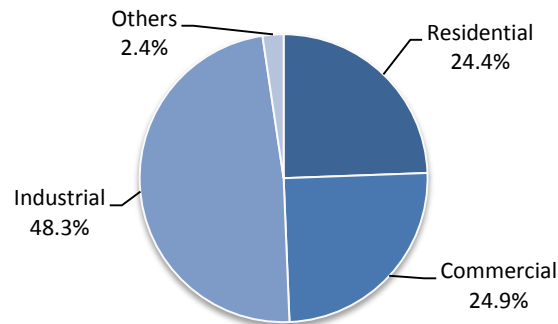


Note:

- (1) Forecast by consumer group is not available under PDP 2015 - 2036.
- (2) Excludes free of charge consumption

Source: EPPO, MOE Thailand

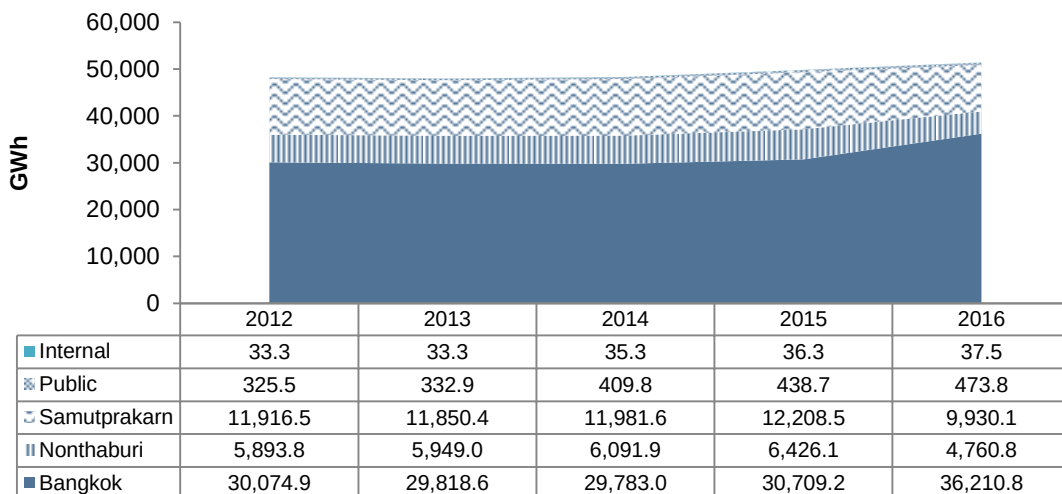
Chart 1-4: Breakdown of Total Electricity Consumption by Consumer Group in Thailand, 2016



Source: EPPO, MOE Thailand, Frost & Sullivan

From 2012 to 2016, electricity consumption was mainly driven by the industrial sector followed by the commercial sector and the residential sector. In the period between 2012 and 2016, electricity consumption by the residential sector grew the fastest from 36,447.2GWh to 43,932.4GWh at a CAGR of 4.8%, closely followed by the commercial sector from 38,582.8GWh to 44,840.2GWh at a CAGR of 3.8%. Electricity consumption in the industrial sector remained strong at a CAGR of 2.0% from 80,386.0GWh in 2012 to 86,878.2GWh in 2016 despite the political uncertainties and the aftermath of the great flood in 2011. Frost & Sullivan expects that the industrial sector will remain as the largest consumer among the three major consumer sectors, with the upcoming establishment of industrial estates within the Special Economic Zones comprising of Mae Sod District in Tak Province, Muang District in Mukdahan Province, Aranyapratet District in Sa-kaew Province, Klong Yai District in Trad Province, Muang District in Nongkai Province and Sadao District in Songkhla Province. Electricity consumption per capita in Thailand increased at a CAGR of 2.3% from 2,348.4kWh in 2012 to 2,570.5kWh in 2016. Moving forward, Frost & Sullivan estimates the electricity consumption per capita in Thailand will grow from 2,705.5kWh in 2017 to 3,076k.0Wh in 2021 at a CAGR of 3.3%.

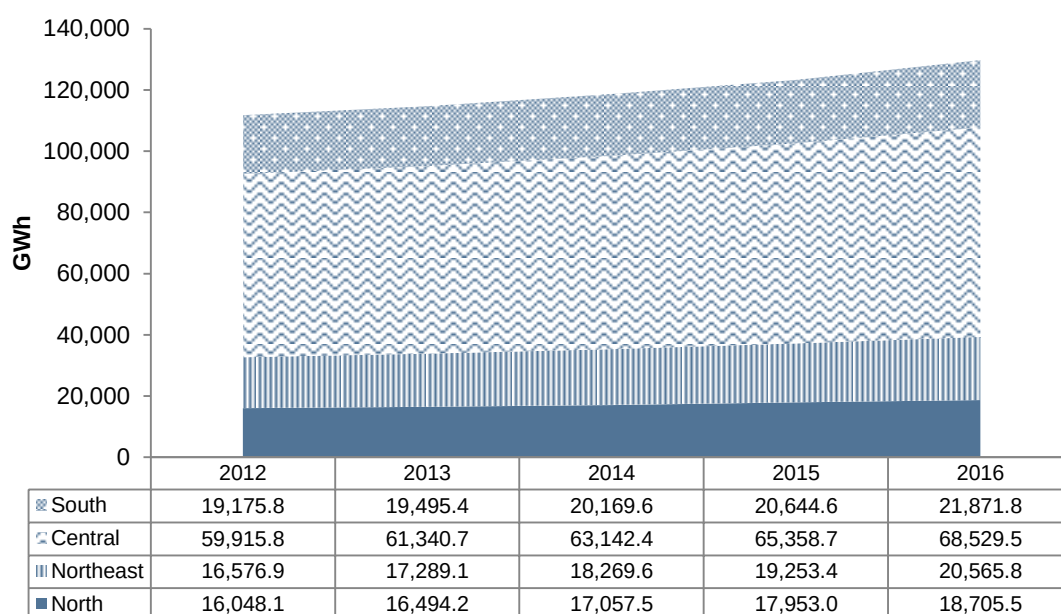
Chart 1-5: Total Electricity Sold by Region (MEA), Thailand, 2012 - 2016



Source: MEA

The total electricity sold in the whole MEA⁸ region experienced a growth trend at a CAGR of 1.6% from 48,244.0GWh in 2012 to 51,412.9GWh in 2016. Within the 3 major MEA provinces, Bangkok grew at a CAGR of 4.8% from 30,074.9GWh in 2012 to 36,210.8GWh in 2016, while Samutprakan and Nonthaburi region decreased at a CAGR 4.5% and 5.2% respectively within the same period. In addition, electricity sales to the public⁹ sector showed a significant increase of 9.8% CAGR from 325.5GWh to 473.8GWh, whereas electricity sold to internal group¹⁰ grew from 33.3GWh to 37.5GWh at a CAGR of 3.0% from 2012 to 2016.

Chart 1-6: Total Electricity Sold by Region (PEA), Thailand, 2012 - 2016



Source: PEA

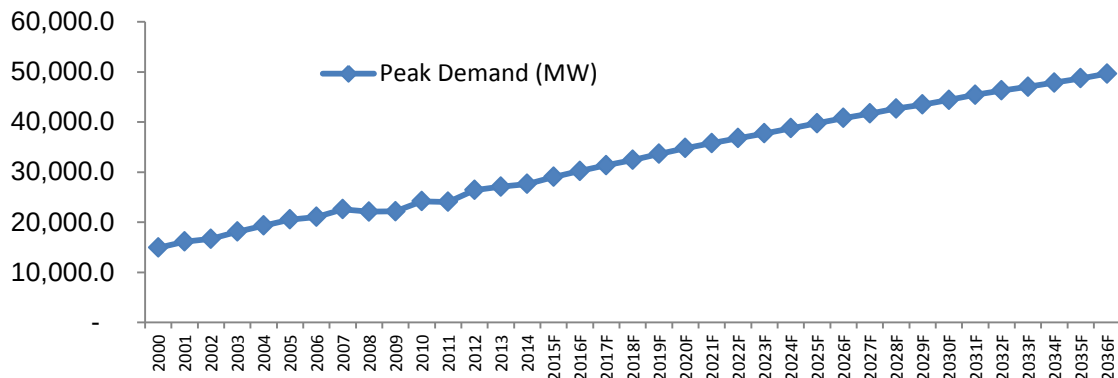
Within provinces serviced by the PEA, the total electricity sold grew at a CAGR of 3.8% from 111,716.6GWh in 2012 to 129,672.6GWh in 2016. The Northeast region recorded the highest CAGR of 5.5% from 16,576.9GWh to 20,565.8GWh. The Central region recorded a CAGR of 3.4% from 59,915.8GWh to 68,529.5GWh within the same period. Similarly, electricity sold in the North region increased from 16,048.1GWh in 2012 to 18,705.5GWh in 2016 at a CAGR of 3.9%, while the South region grew at a CAGR of 3.3% from 19,175.8GWh to 21,871.8GWh from 2012 to 2016.

⁸ MEA has 18 distribution districts.

⁹ Public refers to electricity for public use such as street lighting.

¹⁰ Internal group refers to electricity for MEA internal use such as MEA office lighting and air-conditioning facilities.

Chart 1-7: Peak Power Demand in Thailand, 2000 – 2036F



Source: Thailand Power Development Plan 2008 – 2021, Thailand Power Development Plan 2012 – 2030, Thailand Power Development Plan 2015 – 2036, Ministry of Energy, Frost & Sullivan

In the last two decades, peak power demand has grown at a CAGR of 4.5% where peak power demand reached 29,051.0MW in 2015. As reported by PDP 2015, the peak demand is forecasted to grow at 2.5% from 30,218.0MW in 2016 to 49,655.0MW in 2036. Generally, the peak demand increases along with the rising temperature in April or May due to the hot weather, drought and increased air conditioner use among consumers. Typically in the past, increased peak demand occurred after Songkran festive season, where higher consumption of electricity is experienced in the industrial, services and household sectors annually. In 2016, the central region recorded the highest consumption with 68,529.5GWh of total electricity sold within Thailand.

1.2.1 Key Growth Drivers & Constraints

1.2.1.1 Growth Drivers

Supportive Policies in the Development of Power Generation Industry

Development of various supportive policies for the power generation industry in Thailand is a key growth driver for the industry. For instance, NEPC revised the PDP in August 2014 in order to streamline the latest version of PDP 2015 with the Alternative Energy Development Plan (“AEDP”) and Energy Efficiency Development Plan (“EEDP”). According to EPPO Energy Statistics, Thailand’s electricity consumption reached 182,847.0GWh in 2016 and is expected to grow to 186,936.9GWh in 2017 according to PDP 2015, representing a growth of 2.1%. With the establishment of PDP 2015, Thailand’s power generation industry has attracted many domestic and foreign companies to invest into the power generation business. In 2017, Marubeni Corporation in consortium with Siemens Group was awarded a gas-fired power plant project in Thailand. The 1,200.0MW power plant will replace the existing thermal power plant in Samut Prakan, as it is highly efficient and reduces environmental issues¹¹. Similarly, Sumitomo Corporation was awarded a project to construct a 1,400.0MW gas-fired power plant to upgrade

¹¹ Marubeni Corporation

the Bang Pakong Power Plant. The construction is expected to commence in 2017 and is expected to be completed in 2019.

Meanwhile, the passing of new legislation to streamline the permit application process of investing in the power generation industry in Thailand could also attract more developers and investors into the industry. For instance, the ERC achieved a breakthrough to support renewable energy development in Thailand by cooperating with the Department of Industrial Works to streamline the factory permit process. It was also agreed that rooftop solar photovoltaic (“PV”) system and wind turbine not exceeding 1.0MW in installed capacity are not required to obtain factory permit (Ror Ngor 4) from the Department of Industrial Works. On the other hand, Thai government’s initiatives to support the use of Electric Vehicle technology are also an example of supportive Thai government policy, as switching from conventional automobile fuel to electricity could increase the electricity consumption in Thailand.

From 2017 to 2024, PDP reported several retirements of existing plants (7,299.0MW) and replacements of power plants (6,250.0MW). Among the power plants scheduled for retirement, 1,050.0MW are attributed to IPPs and 1,733.0MW are attributed to SPPs, while 4,516.0MW are attributed to EGAT. Simultaneously, there will also be unit replacements at four power plants namely replacement of Mae Moh, Bang Pakong, South Bangkok and Wang Noi in the pipeline with a contracted power generation capacity of 6,250.0MW during the same period.

Within the same period, there will be three new IPPs scheduled for commencement namely National Power Supply, Gulf SRC and Gulf PD with contracted power generation capacity of 5,270.0MW, while SPPs attribute to 3,658.0MW. This illustrates the Thai government’s commitment to ensuring sustainability of the nation’s power generation capacity.

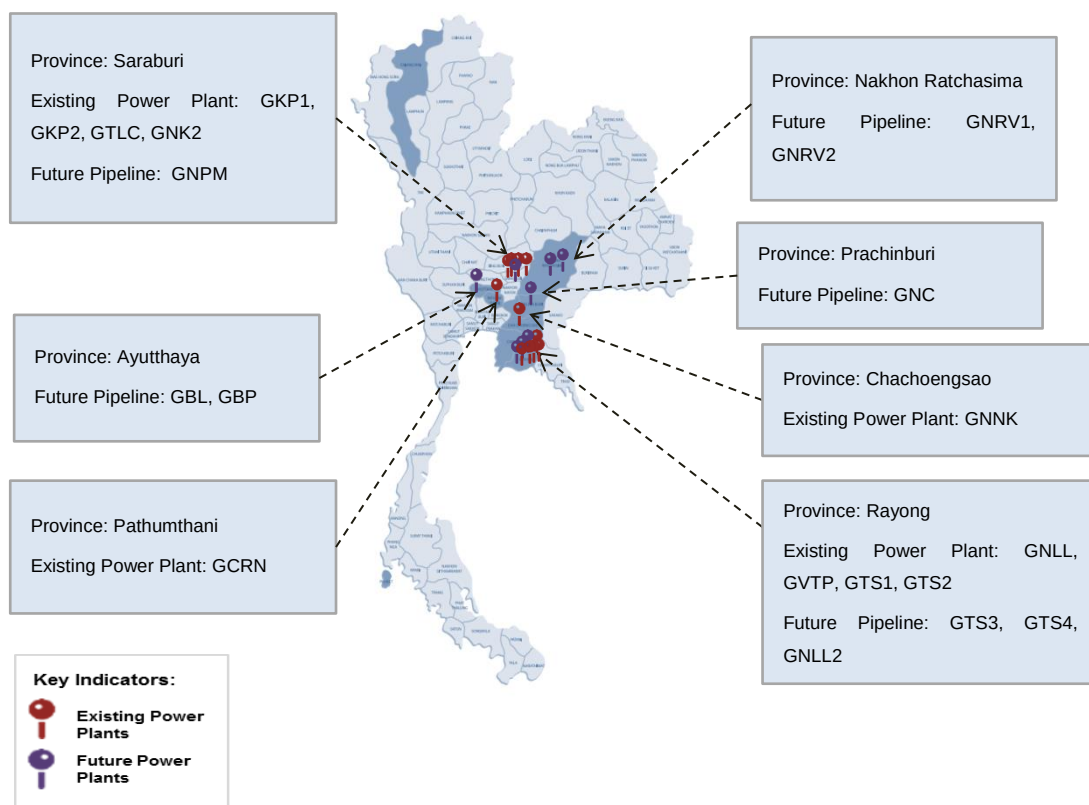
Super Cluster Development and Eastern Economic Corridor to Boost Industrial Electricity Demand

In September 2015, Thailand’s Board of Investment (“BOI”) introduced the Super Cluster policy aimed at promoting economic business activities using advanced technologies and future industries¹². Furthermore, the policy helps to develop the industry within the special economic zones in the form of clusters that could attract domestic and foreign investments into the country. The cluster policy is intended to support investors in Thai industry by offering tax and non-tax incentives, financial support as well as amendment of rules and regulations to facilitate investments. These initiatives are likely to drive the electricity demand from energy-intensive industrial sectors, including automotive & parts and eco-friendly petrochemicals in the cluster with a total generation capacity demand of approximately 37,000.0MW¹³. In this regard, SPPs with co-generation power are likely to benefit as they are able to provide direct supply of electricity and as well as steamed and chilled water to the industrial clusters.

¹² Future industries consist of automotive and parts, electrical appliances, electronics and telecommunication Equipment, eco-friendly petrochemical and chemicals, digital-based, food innopolis and medical hubs clusters. (BOI)

¹³ BOI, “Thailand Moving Ahead with Cluster Development”

Figure 1-2: Location of the Company's Existing and Future Pipeline within the Super Cluster Catchment



Source: Frost & Sullivan

Notably, the Company is likely to benefit from the Supercluster market scenario as all ten of its existing SPP power plants as well as nine future SPP power plants are located within or in close proximity to the Super Cluster catchment areas.

In June 2016, the Thai government approved the development of the Eastern Economic Corridor (**“EEC”**) to drive the economic growth of the country while attracting foreign investors to Thailand. The Eastern Seaboard is known to be Thailand’s major industrial production base for petrochemical, energy and automotive industries. EEC will be divided into an industrial zone, an infrastructure zone and an urban development zone in three eastern provinces of Thailand namely Chonburi, Rayong and Chachoengsao. The Thai government is offering investors “Super Privileges” such as additional corporate and personal income tax privileges, in addition to the existing privileges offered by the BOI¹⁴. The EEC is likely to increase electricity consumption demand from industrial users in the future. EEC will promote the following 10 industries:

¹⁴ The existing privileges offered by BOI to investors in the special economic zone are waiver of corporate income tax will be granted for up to 15 years, the right to lease land for 50 years with an additional 50 years renewal opportunity, 5 year business visa, 3 months PPP procedure and fast-track environmental impact assessment..

Table 1-6: List of Ten S-Curve Industries under EEC

First S-Curve ¹⁵ Industries	New S-Curve ¹⁶ Industries
• Next-Generation Automotive • Smart Electronics • Medical and Wellness Tourism • Agriculture and Biotechnology • Food for the Future	• Robotics • Aviation and Logistics • Biofuels and Biochemical • Digital • Medical Hub

ASEAN Economic Community (“AEC”) Expands Regional Supply and Demand Potentials

In accordance to the AEC Blueprint, South East Asia (“SEA”) has been transformed into an economic region known as the AEC in 2015. Free flow of goods, services, investments, and capitals within the region is expected to drive the economic growth of the SEA region, including that of Thailand, and thereby lead to an increase in electricity consumption. The development of ASEAN Power Grid (“APG”) is also another driver that could promote the growth in power development throughout SEA countries with the creation of an interconnected system of T&D within SEA countries including Thailand. The APG aims at initiating multilateral trade in one sub-region or more in SEA countries by 2018. As of September 2016, Investor Insights reported that there have been increasing numbers of multinational companies are readjusting their investment plans and shifting their focus to SEA countries. This provides a positive outlook for the power generation industry in the targeted SEA countries, including Thailand.

1.2.1.2 Growth Constraints

Negative Public Perceptions against the Construction of New Power Plants

Unlike most developing SEA countries, in Thailand construction of new power plants has faced negative public opinion, especially for coal-fired projects. Power generation from coal is often perceived to be the source of air pollution affecting the health and well-being of residents nearby plant sites. Examples of such public protests in the past include EGAT’s Mae Moh Lignite power plant that was heavily criticized for harmful dust and sulfur dioxide emissions. There was also a protest against a new 800.0MW coal-fired power plant project in Krabi province and also against Nakorn Sri Thammarat’s new city plan, which includes the development of coal-fired power plants and chemical plants within the province. These public demonstrations have led to delays in the construction of new coal-fired power plants.

It is notable that among other conventional fuel technologies, natural gas is likely to remain an important resource for power generation due to its lower health and environmental impacts, efficiency and reliability. Natural gas emits 30.0% less carbon dioxide than petroleum and 45.0% less carbon dioxide than coal¹⁷ when combusted.

¹⁵ S-Curve refers to enhancement and continuation the growth of existing industries by adding value through advanced technologies. (BOI)

¹⁶ New S-Curve refers to developing future industries to accelerate the growth of Thailand’s economy. (BOI)

¹⁷ ADB, “THA: Nong-Saeng Natural Gas Power Project”, January 2011

Economic Uncertainties and Ecological Factors Impacting Electricity Demand

Electricity consumption in the industrial sector in Thailand is correlated to global economic conditions. For example, the United States of America (the “U.S.”) and China are two of Thailand’s largest trading partners in 2016¹⁸, accounting for a total of US\$48.0 billion of trade value. In 2016, top 5 exports from Thailand to the U.S. and China were 66.3% and 58.0% of total trade volume respectively and the sectors involved energy-intensive manufacturing and processing industries. In 2016, both the U.S. and China underwent a slower GDP growth rate of 1.6% and 6.7% respectively, which have slowed demand for Thai exports. This slowdown of exports is expected to affect the growth in electricity consumption by the industrial sector in Thailand due to reduced industrial activities.

Table 1-7: Top 5 Thailand exports to U.S. and China, 2016

No.	Product	Trade Value (US\$ billion)	Percentage of total trade value
United States of America			
1	Machinery, boilers, engines, pumps etc.	6.4	26.4%
2	Electrical and electronic equipment	5.2	21.2%
3	Rubber and articles thereof	2.3	9.3%
4	Pearls, precious and semi-precious stones, metals, etc.	1.2	5.1%
5	Vehicles other than railway or tramway rolling stock, parts and accessories thereof	1.1	4.3%
China			
1	Rubber and articles thereof	3.7	15.7%
2	Electrical and electronic equipment	2.9	12.2%
3	Machinery, boilers, engines, pumps etc.	2.8	12.0%
4	Plastics and articles thereof	2.6	11.1%
5	Optical, photographic, cinematographic, medical or surgical etc.	1.7	7.0%

Source: Trademap, UN Comtrade, Frost & Sullivan

Annual Incidences of Natural Disasters Hinders Electricity Consumption

For over 20 years, Thailand has been experiencing the impact of El-Nino, which leads to severe drought¹⁹ conditions throughout the country. In 2016, water shortages reduced Thailand’s largest reservoirs to a critical water level of below 10.0%, with several major reservoirs below 50.0% of water capacity. This resulted in the delay in agricultural output and subsequently impacted the supply of raw materials for the food processing industry. The shortage of supplies is consequently expected to reduce manufacturing activities in the food processing industry and hence reduce the electricity consumption.

¹⁸ UN Comtrade

¹⁹ Al-Jazeera: “Thailand Hit by its Worst Drought in Decades”, March 2016

In 2017, Thailand was significantly impacted by heavy rainfall during the La Nina season, making it the worst flood in history of 10 years. In January 2017, 12 provinces in Southern Thailand²⁰ suffered from flash floods which caused damages to homes and infrastructures, Electricity and water supplies in the provinces were severely affected, which disrupted daily activities of the residents. As of August 2017, a total of 44 provinces were impacted which affected approximately 1,587,892 people²¹. During the same period, the flood incident in Thailand's northeastern farming region has caused approximately THB10 billion of damage²².

High Reserve Margin²³ Leading to Potential Cancellation or Postponement of Power Generation Projects

According to PDP 2015, Thailand's reserve margin was expected to increase to 40.0% in 2016, as many new projects were scheduled to COD in the pipeline²⁴. Thailand's minimum reserve margin was 35.2% in the same year. As a result, the maintenance of reserve margin buffer will limit new IPP bids and result in tougher negotiations for project extensions. Furthermore, the Thai government is aiming to reduce its minimum reserve margin target towards 15.0% by 2036 with the increase of power imports from overseas countries, expansion of existing power plant capacities and the Thai government's planned initiatives on electricity conservation. Due to these factors, EGAT has requested for PPA awarded power operators to postpone their plants COD on a voluntary basis.

Depletion of Domestic Natural Gas May Hinder Prospects for Gas-Fired Power Generation

After nearly 30 years of reliance on natural gas, the primary sources of Thailand's energy reserves are approaching depletion in the Gulf of Thailand. To counter this issue, Thailand is seeking to increase imports of Liquefied Natural Gas ("**LNG**") and looking at other sources such as coal and renewable energy. Thailand, which generates 70.0% of its energy using natural gas, faces difficulties in securing long-term supplies as output growth and reserve replacements remain lower than ever-rising demands²⁵. Thailand became the first country in SEA to import on LNG in 2011. PTT Public Company Limited ("**PTT**"), the sole gas provider is looking to increase imports of LNG to at least 5.0 million tons in 2017 to meet demands. PTT also plans to increase their LNG terminal capacity from 5.0 million to 11.5 million apart from the plan to build a second terminal that is able to supply approximately 7.5 million tons of LNG yearly. The higher dependency of LNG imports may increase fuel costs. Although the increase of natural gas price can be passed through to consumers as part of the electricity pricing, the relative increase in electricity pricing may result in lower electricity demand in the long term, which does not align with the Thai government's aim to maintain competitive electricity pricing.

²⁰ The 12 provinces in Southern Thailand affected were Chumphon, Surat Thani, Nakhon Si Thammarat, Patthalung, Songkhla, Trang, Pattani, Yala, Narathiwat, Krabi, Ranong and Prachuap Khiri Khan.

²¹ AHA Centre, "Situation Update: North-Eastern Thailand Flood", August 2017

²² Thomson Reuters, "23 dead after Thailand floods wreak havoc, cause an estimated \$300M in damage", August 2017

²³ EIA defines reserve margin as the amount of unused available power generation capacity of an electric power system (at peak load of a utility system) as a percentage of total power generation capacity

²⁴ ThanaChart Securities, "Thailand Utilities Sector", April 2015

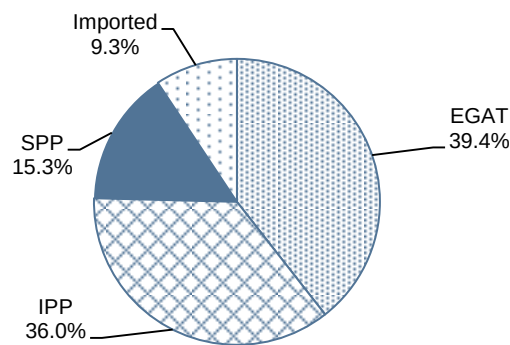
²⁵ Reuters, "UPDATE 1 – Thailand seeks LNG, new energy resources as gas reserves dwindle", January 2014

1.3 SUPPLY CONDITIONS

1.3.1 Power Generation Capacity

According to EPPO Energy Statistics, in 2016, total contracted power generation capacity in Thailand was recorded at 41,557.0MW, of which 39.4% or 16,385.0MW was owned by EGAT. In Thailand, IPPs and SPPs held 36.0% or 14,949.0MW and 15.3% or 6,345.0MW of the total contracted power generation capacity, respectively. The three largest domestic private power generation companies in Thailand based on effective contracted power generation capacity (in operation) as at September 30, 2017 were Ratchaburi Electricity Generating Holding Company Limited (“**RATCH**”) with an effective contracted power generation capacity of 4,674.6MW, J-POWER Holding (Thailand) Company Limited (“**JPHT**”) with an effective contracted power generation capacity of 3,146.7MW, and Electric Generating Public Company Limited (“**EGCO**”) with an effective contracted power generation capacity of 2,735.1MW. Thailand imported 9.3% or 3,878.0MW of its total contracted power generation capacity from Lao PDR and Malaysia. According to PDP 2015, between 2017 and 2024, combined cycle and cogeneration power plant fired by natural gas are still expected to be dominant in Thailand with expected additional contracted power generation capacity of 6,464.0MW from 25,868.0MW in 2017 to 32,332.0MW in 2024. Meanwhile, thermal power plant is forecasted to have additional contracted power generation capacity of 2,750.0MW from 9,107.0MW in 2017 to 11,857.0MW in 2024; renewable energy (excluding large hydroelectricity) is forecasted to have additional contracted power generation capacity of 2,366.0MW from 7,758.0MW in 2017 to 10,124.0MW in 2024.

Chart 1-8: Contracted Power Generation Capacity (MW) by Types of Power Operators in Thailand, 2016²⁶



Total Contracted Power Generation Capacity

Note: Only contracted power generation capacity on EGAT transmission system and direct supply to the industrial sector, but excludes capacity from VSPP due to unavailability of data.

Source: EPPO Energy Statistics

Contracted power generation capacity in Thailand from 2011 to 2016 was dominated by EGAT and IPPs. EGAT maintained its largest share of contracted power generation capacity from

²⁶ As at September 30, 2017, the latest statistics reported by EPPO is 2016.

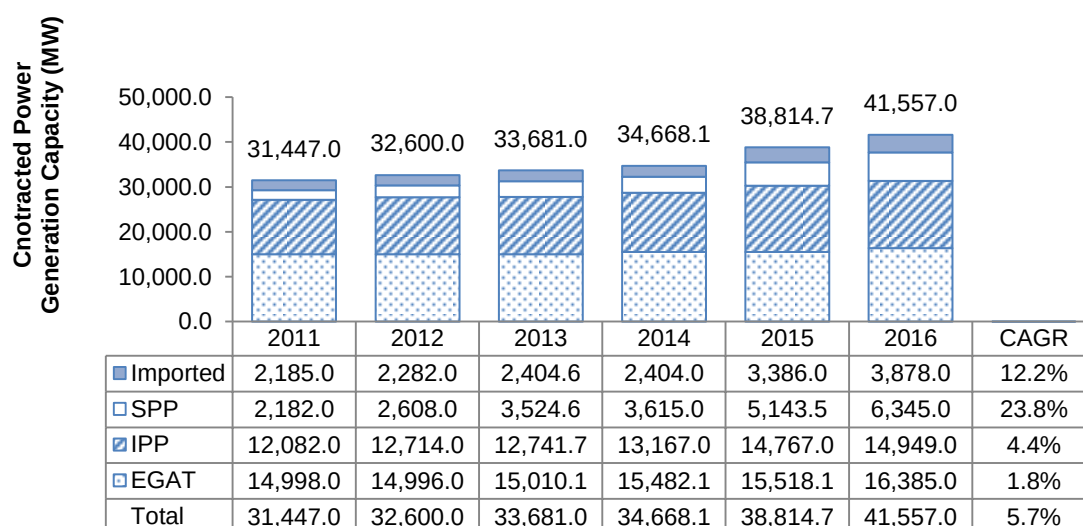
47.7% or 14,998.0MW in 2011 to 39.4% or 16,385.0MW in 2016 with the lowest CAGR of 1.8% among all the power generation players. IPPs maintained its second largest share of contracted power generation capacity from 38.4% or 12,082.0MW in 2011 to 36.0% or 14,949.0MW in 2016 with a CAGR of 4.4%.

The contracted power generation capacity share of SPPs and imported sources has been on the rise from 2011 to 2016. The contracted power generation capacity of SPPs recorded the highest CAGR of 23.8%, having increased from 2,182.0MW in 2011 to 6,345.0MW in 2016. The high growth of SPPs is mainly supported by the PDP that promotes co-generation from SPPs to ensure power system reliability in Thailand.

The contracted power generation capacity from imported sources (Lao PDR and Malaysia) achieved a CAGR of 12.2% over the same period from 2,185.0MW to 3,878.0MW, mainly attributed to capacity added from Hongsa Power Plant in Lao PDR with contracted power generation capacity of 1,878.0MW.

Between January 1, 2017 and September 30, 2017, several power plants have commenced operations namely GVTP, GTS1, GTS2 (owned by The Company), Klongluang Utilities Co., Ltd (TJ Cogen) owned by EGCO and Bangpa-in Cogeneration Company Limited (Project 2) owned by GPSC.

Chart 1-9: Historical Contracted Power Generation Capacity (in MW) in Thailand, 2011 – 2016



Note: Includes only contracted power generation capacity to EGAT's transmission system and industrial sector, but excludes capacity from VSPP due to unavailable historical data.

Source: EPPO Energy Statistics

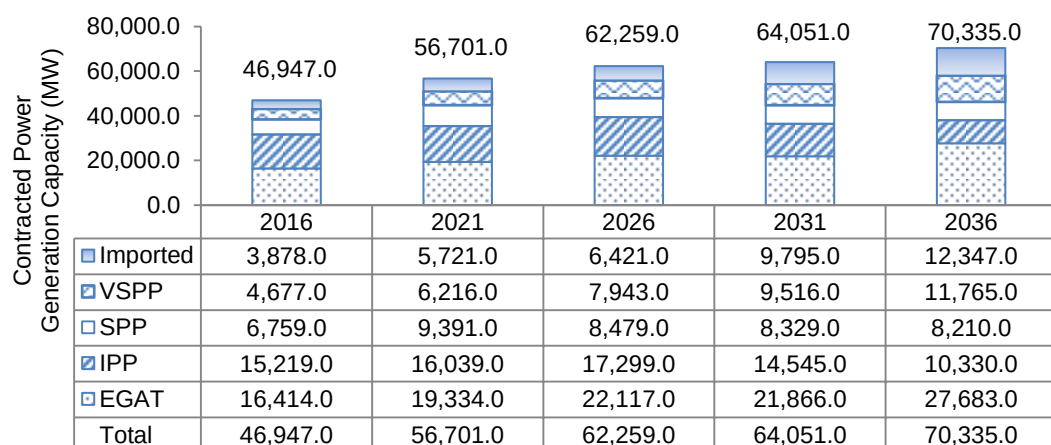
According to PDP 2015, it is estimated that contracted power generation capacity in Thailand (including VSPPs²⁷) will increase from 46,947.0MW in 2016 to 70,335.0MW in 2036 at a CAGR

²⁷ Data collection of power plants linked outside of EGAT system such as VSPPs is not viable due to their large numbers of sites. The installed capacity of VSPPs, which would be used in the calculation on energy requirement of EGAT system and the country was estimated from the AEDP

of 2.0%. Contracted power generation capacity from imported sources is expected to achieve the highest CAGR of 6.0% from 3,878.0MW in 2016 to 12,347.0MW in 2036, mainly contributed by additional hydroelectricity import from Lao PDR and Myanmar during the period.

Contracted power generation capacity of VSPPs is expected to achieve the second highest CAGR of 4.7% from 4,677.0MW in 2016 to 11,765.0MW in 2036, primarily due to addition of renewable power plants. This is expected to be followed by the contracted power generation capacity of EGAT with a CAGR of 2.7% from 16,414.0MW in 2016 to 27,683.0MW in 2036.

Chart 1-10: Projected Contracted Power Generation Capacity (in MW) in Thailand, 2016 - 2036



Source: PDP 2015

EGAT ranks the power plant merit order by fuel costs. Hydroelectric power plants have the highest priority in the order of merit in the power system. All the large hydroelectric power plants are owned by EGAT. The Mae Moh Power Plant, the only large lignite power plant in Thailand, owned by EGAT, has the second order of merit in the power system. Imported coal-fired power plants have the third order of merit in the power system. BLCP Power Plant, being the largest coal-fired power plant with imported coal as fuel source, ranks one of the first in order of merit among IPPs in the power system.

Table 1-8: Merit Order of Power Plants in Thailand

Merit order	Type of fuel use/ Power plants	Description	Top 3 largest by contracted power generation capacity
1	Hydroelectric	Lowest cost due to no fuel cost but operation must be approved by the Department of Irrigation who oversees the agricultural demand of water behind the dam.	1. Bhumibol Dam, 779.2MW (EGAT) 2. Srinakarin Dam, 720.0MW (EGAT) 3. Lam Ta Khong/ Sirikit Hydroelectricity Plant, 500.0MW (EGAT)
2	Lignite	Second lowest cost. EGAT operates these plants all the time, except during maintenance period.	1. Mae Moh Power Plant, 2,180.0MW (EGAT)
3	Imported Coal	BLCP Power Plant and Gheco-One are included in this category.	1. BLCP Power Plant, 1,346.5MW (IPP) 2. Gheco-One, 660.0MW (IPP)
4	Natural Gas	Thailand relies a lot on natural gas. Higher cost than coal.	1. Ratchaburi Power Plant, 3,481.0MW (IPP)

Merit order	Type of fuel use/ Power plants	Description	Top 3 largest by contracted power generation capacity
5	Fuel Oil and Diesel	Highest cost. EGAT only operates these plants when there is insufficient supply of natural gas.	2. Wang Noi Power Plant, 2,660.0MW (EGAT) 3. South Phra Nakhon, 1,588.0MW (EGAT)

Note: Fuel oil and diesel are usually used as supplementary fuels for natural gas power plant

Source: ERC Presentation, 2012²⁸, Frost & Sullivan Analysis

The top 10 largest power plants by contracted power generation capacity (including power plants under construction) are largely dominated by natural gas as the fuel source, with Ratchaburi power plant, which will mainly operate on natural gas, expected to be the largest power plant owned by a private power producer with a contracted power generation capacity of 3,481.0MW by 2024. On the other hand, South Bangkok gas-fired power plant is expected to be the largest power plant owned by EGAT with a contracted power generation capacity of 3,310.0MW by 2024. The Company owns four power plants out of the expected top ten largest power plants in Thailand, based on the contracted power generation capacity by 2024, namely GSRC, GPD, GNS, and GUT.

Table 1-9: List of Top 10 Largest Power Plants in Thailand by 2024

Name	Type	Ownership	Fuel Source	Contracted Power Generation Capacity (MW)	COD
Ratchaburi Power Plant ("RATCHGEN")	IPP	RATCH (99.99%)	Natural Gas or Fuel Oil	3,481.0	2000, 2002
South Bangkok Power Plant	EGAT	EGAT (100.00%)	Natural Gas	3,310.0	2009, 2019, 2022
Bang Pakong Power Plant	EGAT	EGAT (100.00%)	Natural Gas, Fuel Oil, Diesel	3,162.0	1992, 2009, 2019
GSRC	IPP	The Company (51.00%) Mitsui & Co., Ltd. (49.00%)	Natural Gas or Diesel	2,500.0	2021, 2022
GPD	IPP	The Company (51.00%) Mitsui & Co., Ltd. (49.00%)	Natural Gas or Diesel	2,500.0	2023, 2024
Mae Moh Power Plant	EGAT	EGAT (100.00%)	Lignite	2,130.0	1991, 1992, 1995, 2018, 2022
Wang Noi Power Plant	EGAT	EGAT (100.00%)	Natural Gas or Diesel	2,050.0	2014, 2023
Thepa Power Plant	EGAT	EGAT (100.00%)	Coal	2,000.0	2021, 2024
GNS	IPP	JPHT (60.00%) The Company (40.00%)	Natural Gas or Diesel	1,600.0	2014

²⁸ Automatic Variable Tariff, retrieved from

http://www.thammapiban.com/admin/doc/file/Dr_Kamolparn_Ft_Oct_16_2012_v1.pdf

Name	Type	Ownership	Fuel Source	Contracted Power Generation Capacity (MW)	COD
GUT	IPP	JPHT (60.00%) The Company (40.00%)	Natural Gas or Diesel	1,600.0	2015

Note: Top 10 ranking in the order of largest to smallest contracted power generation capacity

Source: EGAT, PDP 2015, Frost & Sullivan Analysis

According to PDP 2015, contracted power generation capacity in Thailand is expected to increase from 46,947.0MW in 2016 to 70,335.0MW in 2036, with a CAGR of 2.0%. Despite a planned decrease in the share of natural gas power generation to diversify electricity generation fuel mix, contracted power generation capacity is still likely to be dominated by natural gas or imported LNG as a fuel source with 59.2% share in 2016 or 27,815.0MW to 37.4% share or 26,298.0MW in 2036 of the total contracted power generation capacity.

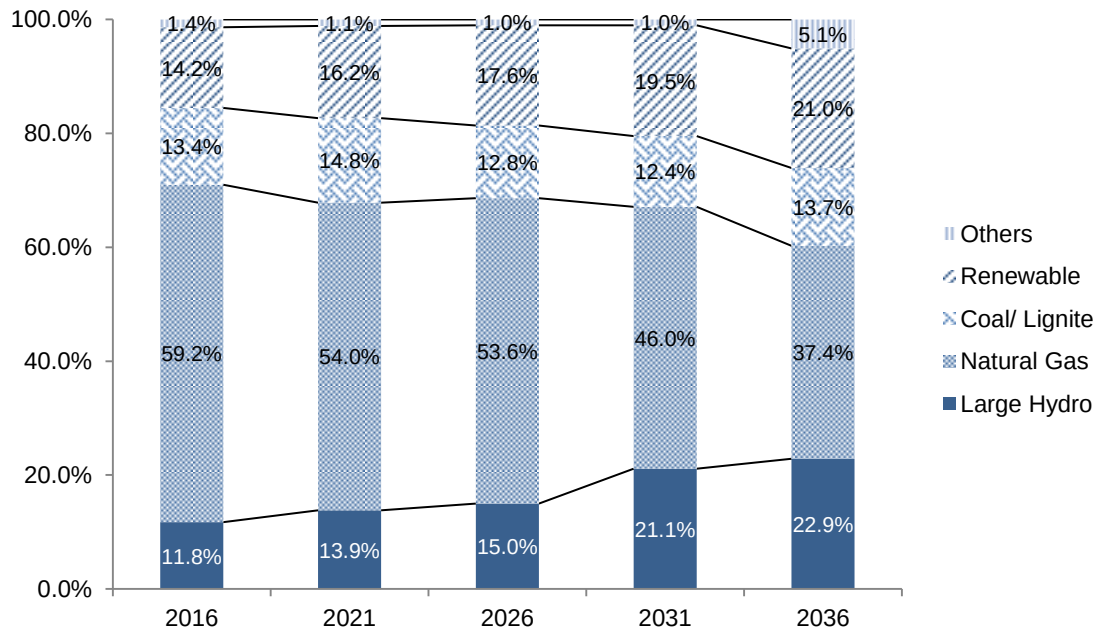
Renewable energy (excluding the large hydroelectricity plant) is projected to constitute the second largest share in contracted power generation capacity according to PDP 2015. Renewable energy as a source of electricity generation is likely to experience strong growth, from 14.2% or 6,656.0MW in 2016 to 21.0% or 14,760.0MW in 2036 with a CAGR of 4.1%. According to the AEDP, solar power is expected to constitute the largest share in new renewable power projects from 2014 to 2036 at 38.7% of total new renewable contracted project capacity, followed by biomass at 24.9%, and wind power at 22.9%.

Share of coal and lignite in contracted power generation capacity are expected to increase marginally from 13.4% or 6,308.0MW in 2016 to 13.7% or 9,606.0MW in 2036, mainly from power generation capacity built by EGAT and import from Lao PDR.

Large hydroelectricity, as a type of renewable source, is expected to gain its share from 11.8% or 5,523.0MW in 2016 to 22.9% or 16,093.0MW in 2036, mainly from the increasing import of electricity from the hydroelectricity plant in Lao PDR and Myanmar.

Meanwhile, nuclear power plant is expected to be commissioned in 2035 with 1,000.0MW of contracted power generation capacity.

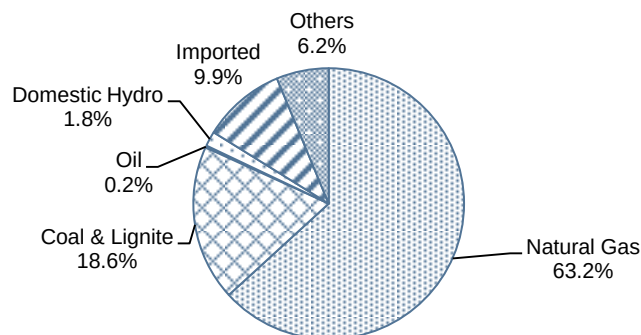
Chart 1-11: Projected Contracted Power Generation Capacity by Fuel Types (%) in Thailand, 2016 - 2036



Source: PDP 2015

According to EPPO Energy Statistics, total electricity generated in Thailand was recorded at 199,566.9GWh in 2016. Electricity generation in Thailand was largely dominated by natural gas, with 63.2% share or 126,149.6GWh. This was followed by coal and lignite, which constituted the second largest share of fuel mix, with 18.6% share or 37,107.2GWh. Imported electricity, with 9.9% share or 19,825.4GWh, was ahead of domestic hydroelectricity generation in terms of electricity generated by different fuel mix with 1.8% share or 3,543.1GWh. The remaining electricity generated in Thailand was from oil with 0.2% share or 491.5GWh, and other generation sources including renewable energy with 6.2% share or 12,450.2GWh.

Chart 1-12: Electricity Generated by Different Fuel Mix in Thailand, 2016



Total Electricity Generated 199,566.9GWh

Note: Numbers may not add up due to rounding

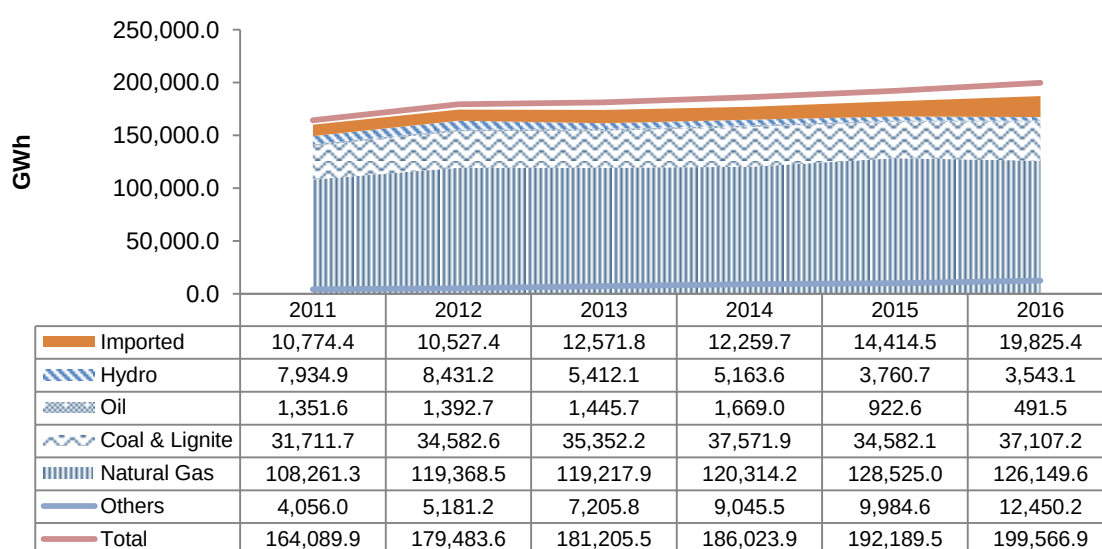
Source: EPPO Energy Statistics

Electricity generation in Thailand has been growing at a CAGR of 4.0% from 164,089.9GWh in 2011 to 199,566.9GWh in 2016. Natural gas remained as the dominant fuel source from 66.0% share or 108,261.3GWh in 2011 to 63.2% share or 126,149.6GWh in 2016 with a CAGR of 3.1%.

The share of electricity generation by coal and lignite plants decreased from 19.3% share or 31,711.7GWh in 2011 to 18.6% share or 37,107.2GWh in 2016 with a CAGR of 3.2%.

Electricity generated from imported sources recorded high growth with a CAGR of 13.0%, from 6.6% share or 10,774.4GWh in 2011 to 9.9% share or 19,825.4GWh in 2016, mainly attributable to the imported electricity from Lao PDR.

Chart 1-13: Historical Electricity Generated by Different Fuel Mix in Thailand, 2011 - 2016



Source: EPPO Energy Statistics

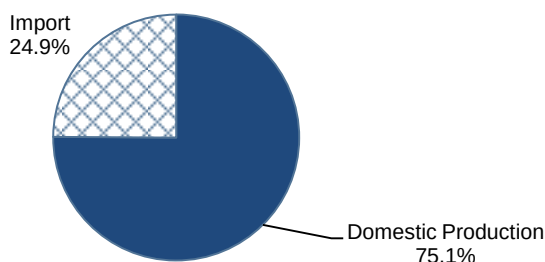
1.3.2 Key Sources of Energy

1.3.2.1 Non-renewable energy

Natural Gas

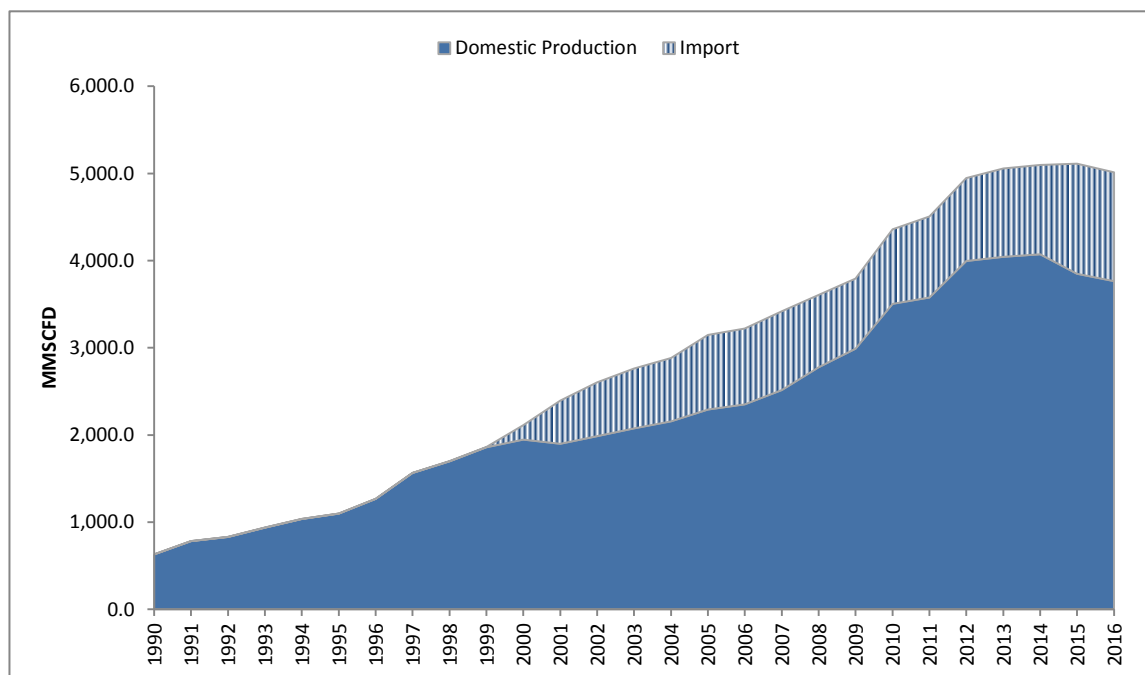
Natural gas has been the dominant energy source for power generation in Thailand over the last three decades. In 2016, there were 5,015.0 million standard cubic feet per day (“mmscfd”) of total domestic Thailand production and import of natural gas, of which 24.9% or 1,249.0 mmscfd were imported from Myanmar and Middle East countries. Domestic natural gas production was 3,766.0 mmscfd in 2016, which achieved a CAGR of 4.2% from 1,948.0 mmscfd in 2000. The import of natural gas has recorded a high growth with a CAGR of 13.5% from 164.0 mmscfd in 2000 to 1,249.0 mmscfd in 2016. The proportion of imported natural gas has grown from 7.8% of the total natural gas supply from 2000 to 24.9% in 2016.

Chart 1-14: Contribution of Domestic Production and Import of Natural Gas Supply in Thailand, 2016



Source: Department of Mineral Fuels (“DMF”), PTT, EPPO

Chart 1-15: Historical Production and Import of Natural Gas in Thailand, 1990 - 2016



Source: Department of Mineral Fuels (“DMF”), PTT, EPPO

PTT, a fully integrated national petroleum and petrochemical company with 51.11% of shares owned by Ministry of Finance Thailand²⁹, covers the entire chain of natural gas that ranges from exploration and production, procurement (domestically and internationally), transportation to gas separation, and marketing. As of end 2016, PTT has engaged into 15 natural gas sales agreements; 12 of which were for indigenous gas fields, namely Pailin, North Bongkot, South Bongkot , Unocal 123, B8/32, Arthit, MTJDA A-18, MTJDA B-17, Nam Phuong, Phu Hom, Sirikit

²⁹ International Energy Agency: Thailand Electricity Security Assessment 2016

(Lankrabue), and Sirikit (Nongtoom A) while 3 were for overseas gas fields, namely Yadana (560 mmscfd), Yetgun (400 mmscfd), and Zawtika (240 mmscfd) in Myanmar³⁰.

Thailand plans to double the size of Map Ta Phut LNG terminal to 13.6 billion cubic meters (“bcm”) per year, with the engineering, procurement and construction contract awarded to PTT. As Myanmar aims to increase the country’s electrification rate, which is expected to drive domestic demand for natural gas and potentially constrain its ability to export natural gas, Thailand also began to diversify its natural gas sourcing policy for LNG beyond the SEA region, by importing LNG from Qatar beginning from 2015 based on 20-year contract for two million tons (2.7 bcm) per annum signed between Qatargas, the largest LNG producer in the world, and PTT in 2012. In December 2016, PTT also signed contract with Shell Eastern Trading (15-year contract) and British Petroleum (“BP”) (20-year contract) for one million tons (1.4 bcm) per annum of LNG from each vendor, commencing in 2017. Furthermore, PTT is also expected to sign a 15-year contract with Petroliaam Nasional Berhad (“PETRONAS”) to import one million tons per annum (1.4 bcm) of LNG in 2017 and 2018, and 1.2 million tons (1.6 bcm) per annum from 2019 onwards.

The foreign sourcing policy resulted in EPPO’s increased target of 34.0 million tons of LNG imports by 2036, up from their earlier planning of 23.0 million tons³¹. Furthermore, PTT Exploration and Production, a subsidiary of PTT, holds 8.50% interest in the Rovuma Offshore Area 1 project in Mozambique, which is one of the richest gas fields in the world. It is also considering signing an agreement with Anadarko, an American-based petroleum and natural gas exploration and production company, to purchase 3.5 bcm of LNG per year from the planned Mozambique LNG project.

PTT distributes the procured natural gas directly to EGAT, IPPs and SPPs through transmission pipeline according to gas purchase agreements signed between PTT and the power producers. Despite the decline in share, sales of natural gas to EGAT constitute the largest share among the power producers from 1,148.0 mmscfd (45.9%) in 2011 to 978.0 mmscfd (33.9%) in 2016. This is followed by sales of natural gas to IPPs from 866.0 mmscfd (34.6%) in 2011 to 962.0 mmscfd (33.3%) in 2016, driven by the commissioning of U-Thai Power Plant in June 2015. Natural gas sales to SPPs have increased more than 50.0% from 462.0 mmscfd (18.5%) in 2011 to 853.0 mmscfd (29.6%) in 2016, largely due to the increase in capacity for cogeneration with natural gas.

According to statistics compiled by EPPO, the total consumption of natural gas in Thailand was 4,714.0 mmscfd in 2016, of which 59.3% or 2,793.0 mmscfd were consumed for electricity generation, resulting in a CAGR of 3.5% from 1,620.0 mmscfd in 2000. From 2000 to 2016, the total consumption for natural gas recorded a CAGR of 5.6%.

Gas separation plants (“GSPs”) were the second largest group of consumers of natural gas, with 20.1% or 948.0 mmscfd consumed in 2016 as well as a high CAGR of 11.1% from 175.0 mmscfd in 2000. The increase was largely driven by the addition of gas separation unit in at PTT plant in Rayong province in 2005 to provide additional petrochemical products such as ethane, propane and liquefied petroleum gas (“LPG”) for the industry.

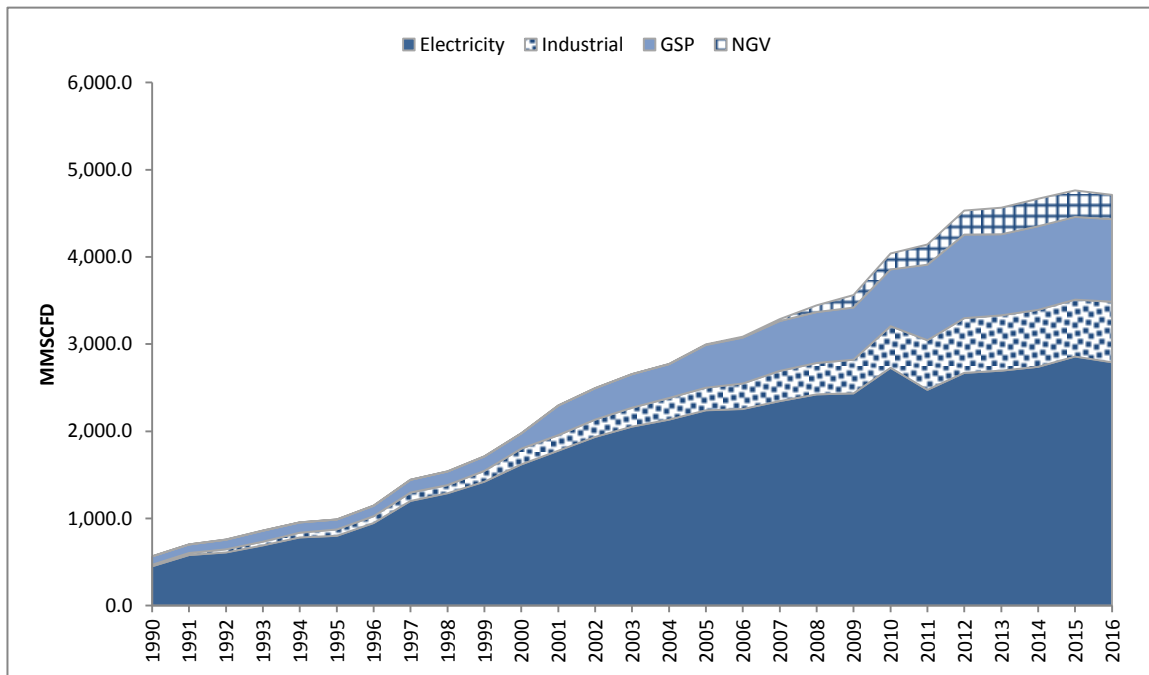
³⁰ “PTT may see less gas supply from Myanmar”, The Nation, February 2015

³¹ Energy World, retrieved from <http://energy.economictimes.indiatimes.com/news/coal/thailand-ups-long-term-lng-imports-due-to-coal-fired-plant-delays/55592479>

There was an increasing consumption of natural gas by the industrial sector, which achieved a CAGR of 6.4%, from 478.0 mmscfd in 2010 to 694.0 mmscfd in 2016, mainly attributable to the expansion of the industrial sector.

Since the introduction of Natural Gas Vehicle (“NGV”) in 2004, the NGV sector has emerged as a significant sector for natural gas consumption with 5.9% share or 278.0 mmscfd of the total natural gas consumption by sector in Thailand in 2016. The NGV sector witnessed an exponential growth with CAGR of 45.9% from merely 3.0 mmscfd in 2004 due to the strong Thai government push for the utilization of natural gas in vehicles and the expansion of NGV refueling stations in Thailand.

Chart 1-16: Historical Consumption Share of Natural Gas by Sector in Thailand, 1990 - 2016



Source: EPPO

Due to the high level of dependency on natural gas in Thailand's electricity generation, domestic natural gas reserves are forecasted to be depleted by 2022 at the current rate of natural gas extraction of 4,075.0 mmscfd³². However, expanding gas-fired power generation remains as one of the most attractive options to meet growing power demand due to its cleanliness and efficiency, as well as various challenges faced in developing power plants using other major fuel sources. To address this, the Ministry of Energy Thailand developed the Gas Plan (one of five plans under the Thailand Integrated Energy Blueprint 2015-2036) with the following objectives:

- Reduce usage of natural gas whose costs rise due to LNG imports by:

³² Platts Report on Thailand Oil Gas Exploration, 2015

- introducing price signal and adjusting pool pricing for new natural gas consumers, which is to be based on the imported LNG prices instead of the average gas prices from Gulf and imported gas, collectively known as pool price;
 - reducing the dependency on natural gas for electricity generation by diversifying fuel type with increased proportion of electricity generated from clean coal technology and renewable energy; and
 - accelerating energy efficiency measures to optimize usage of natural gas in industrial sector to comply with the Energy Efficiency Plan 2015 (“**EEP2015**”), which would help reduce the electricity consumption by 89,672 units during 2014 to 2036;
- Maintain level of domestic production by urging exploration and production activities in domestic fields by:
 - opening new rounds of bidding for petroleum exploration and production concessions;
 - managing the expiring concessions to maintain natural gas production of major gas fields in the Gulf; and
 - managing natural gas resources from Gulf through lowering gas bypass volume at GSPs;
- Procure and manage LNG efficiently by:
 - increasing the number of LNG suppliers and distributors to build domestic competition, where the LNG import is expected to increase from two million tons per year in 2015 to 24.0 million tons per year by 2035, reaching about 70.0% of natural gas supply by then; and
 - strengthening cooperation in the LNG supply in the ASEAN Economic Community (“**AEC**”) level via ASEAN Council on Petroleum (“**ASCOPE**”), including the establishment of AEC LNG Buyer Club;
- Develop the necessary import and distribution infrastructure to support LNG import beyond 2022 as the existing infrastructure and those currently under construction can only support LNG import of up to 10.0 million tons per year, until 2022.

By following the four aspects described above, it is expected that the import of LNG will be reduced by more than 25.0 million tons per year by 2036, which is much lower than the figure predicted earlier that Thailand would need to rely 100.0% on imported LNG or more than 47.0 million tons per year by 2036. The MOE also prepared a long-term natural gas supply plan for NEPC’s consideration with three scenarios:

- Base case (as formulated in PDP 2015)
 - Demand for natural gas will increase from 4,810.0 mmscfd in 2015 to 5,099.0 mmscfd in 2019, before declining to 4,344.0 mmscfd in 2036;
 - Domestic natural gas supply will be at 3,300.0-3,400.0 mmscfd until 2022, before declining to 1,270.0 mmscfd in 2036, while natural gas imported from Myanmar will decline steadily after 2015 and eventually terminate in 2029;
 - Imported LNG will increase from 484.0 mmscfd in 2015 to 3,073.0 mmscfd (or 21.4 million tons per year) in 2036, constituting 70.8% of total natural gas supply by then
- Case that takes into account the risks of delay in coal-fired power plant projects
 - The demand for natural gas will increase from 4,810.0 mmscfd in 2015 to 5,528.0 mmscfd in 2019, and continue growing at a moderate pace to reach 5,658.0 mmscfd in 2036;

- Domestic natural gas supply will be around 3,300.0-3,400.0 mmscfd until 2022, before declining to 1,270.0 mmscfd in 2036, while natural gas imported from Myanmar will decline steadily after 2015 and eventually terminate in 2029;
- Imported LNG will increase at a higher rate than the base case from 484.0 mmscfd in 2015 to 4,382.0 mmscfd (or 30.6 million tons per year) in 2036, constituting 77.5% of total natural gas supply by then
- Case that takes into account the concessions that are due to expire in 2022-2023 and its risks of production disruption
 - Demand for natural gas is assumed to be similar as base case, which will increase from 4,810.0 mmscfd in 2015 to 5,099.0 mmscfd in 2019, before declining to 4,344.0 mmscfd in 2036;
 - Imported LNG will increase at a higher rate than the above two scenarios to replace the reduction in supply of natural gas due to the expired concessions. The LNG import will increase from 484.0 mmscfd in 2015 to 2,580.0 mmscfd (or 18.0 million tons per year) in 2022.

In 2015, the NEPC approved plans to expand the natural gas transmission system and infrastructure to be implemented by PTT. PTT plans to spend capital expenditure of THB210.0 billion from 2016 to 2020 in expanding their gas business via expansion of its natural gas pipeline, LNG receiving terminal, a floating storage regasification unit, and setting up a new energy service company. The new natural gas pipeline is expected to help link supplies between the eastern and western regions of Thailand, as well as facilitate transfers from its gas fields in Myanmar to its LNG receiving terminal in the Gulf of Thailand³³.

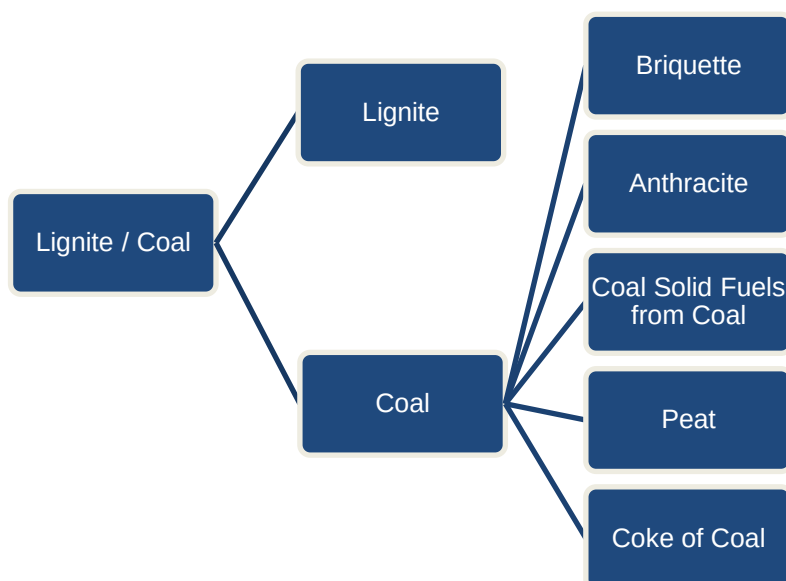
Coal

Lignite and coal³⁴ are used as sources of energy in Thailand for the power generation and industrial sectors. Lignite is produced domestically in Thailand mainly from mines owned by EGAT. There are a few private producers including Banpu PCL, Siam Cement Group and Green Yellow Company Ltd, which are involved in lignite mining. Coal is fully imported and consists of briquette, anthracite, coal solid fuels, peat and coke of coal.

³³ Bangkok Post: PTT to spend B210bn on expansion

³⁴ Lignite, also known as brown coal, composed mainly of volatile matter and moisture content with low fixed carbon, typically has approximately 4,000.0 kcal/kg of heating value, lower than the higher grade of anthracite and bituminous coal, which generally has heating value between 5,000.0 – 6,000.0 kcal/kg.

Figure 1-3: Type of Lignite / Coal as source of energy in Thailand



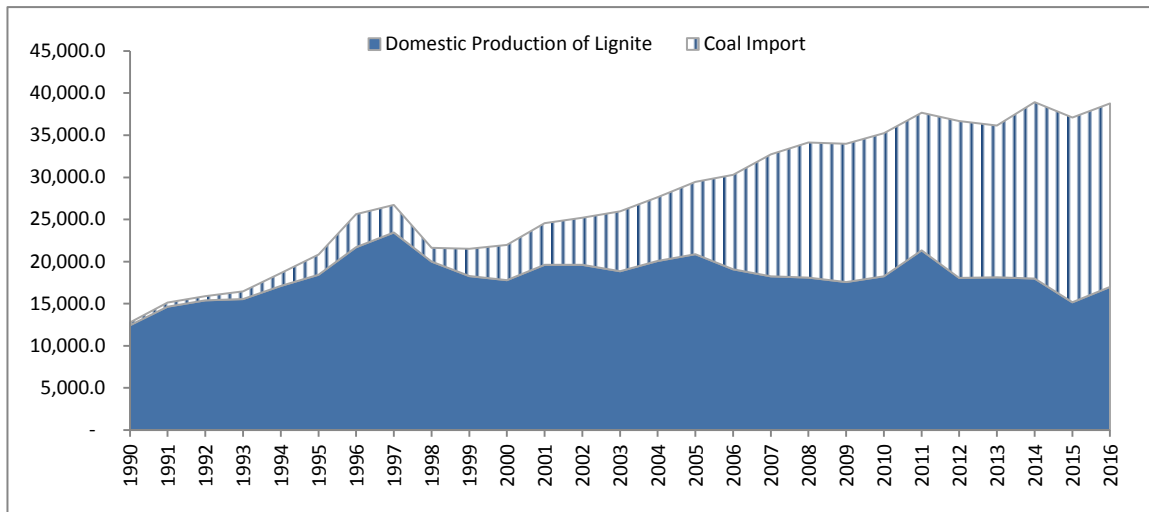
Source: EPPO, Frost & Sullivan

There were 38.8 million tons of domestic productions of lignite and coal import in 2016 with a CAGR of 3.6% from 22.0 million tons in 2000. The share of domestic lignite production and coal import in 2016 were 43.8% or 17.0 million tons and 56.2% or 21.8 million tons respectively. The domestic production of lignite remained considerably flat with a CAGR of -0.3% from 17.8 million tons in 2000 to 17.0 million tons in 2016 with the shutting down of Krabi mine in 2008. The Mae Moh lignite mine is the largest coal mine in Thailand with total coal reserves of approximately 1,140.0 million tons, of which 825.0 million tons are mineable³⁵. The mine is expected to approach depletion by 2047 at current extraction rate of 45,000.0 tons per day.

The coal import recorded a high growth with a CAGR of 10.9% from 4.2 million tons in 2000 to 21.8 million tons in 2016, surpassing the amount of local production of lignite mainly due to the increasing usage of coal in the power generation sector by IPPs and SPPs and industrial sector. Other drivers for the increasing coal import can be attributed to the flat growth of production of lignite due to expiring concessions, which could not meet the demand for coal.

³⁵“Expression of Interest – Technologies for deep open-cut coal mining”, The Australian Government, retrieved from <http://www.austmine.com.au/Portals/25/Content/Documents/Thailand%20Expression%20of%20Interest%20-%20Technologies%20for%20deep%20open-cut%20coal%20mining.pdf>

Chart 1-17: Historical Production of Lignite and Coal Import in Thailand, 1990 – 2016



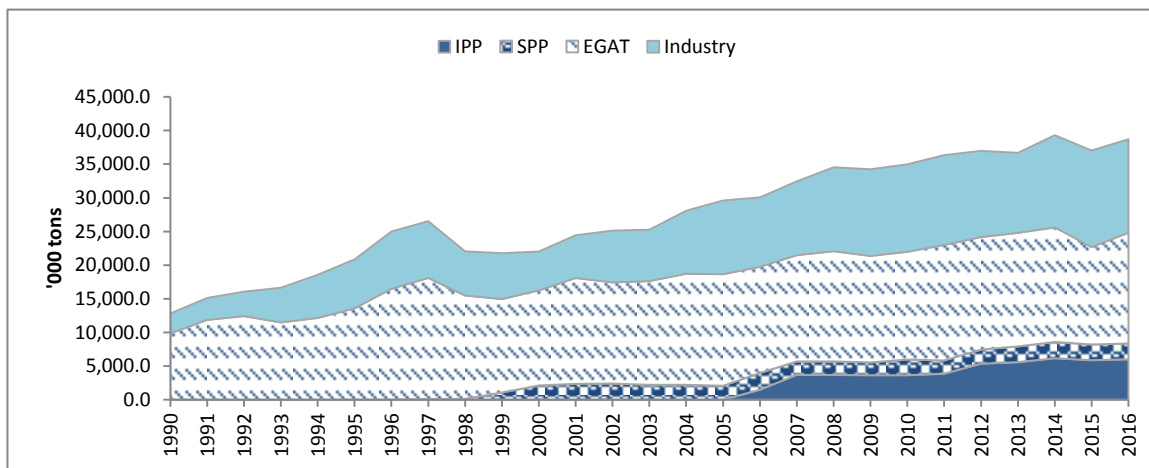
Source: Department of Mineral Resources and EPPO

The coal and lignite consumption in Thailand was 38.7 million tons in 2016, and recorded a CAGR of 3.6% from 22.0 million tons in 2000.

Lignite and coal were mainly used for power generation, and accounted for 64.1% or 24.8 million tons of the total consumption in 2016, of which IPP and SPP consumed 6.0 million tons and 2.4 million tons of coal respectively and EGAT consumed 21.8 million tons of lignite. The consumption of lignite and coal for power generation achieved a CAGR of 2.7% from 16.3 million tons in 2000 to 24.8 million tons in 2016.

The industrial sector consumed 13.9 million of lignite and coal as fuel source in 2016, and logged a CAGR of 5.6% from 5.8 million tons in 2000.

Chart 1-18: Historical Consumption of Coal and Lignite by sector in Thailand, 1990 - 2016



Source: EPPO

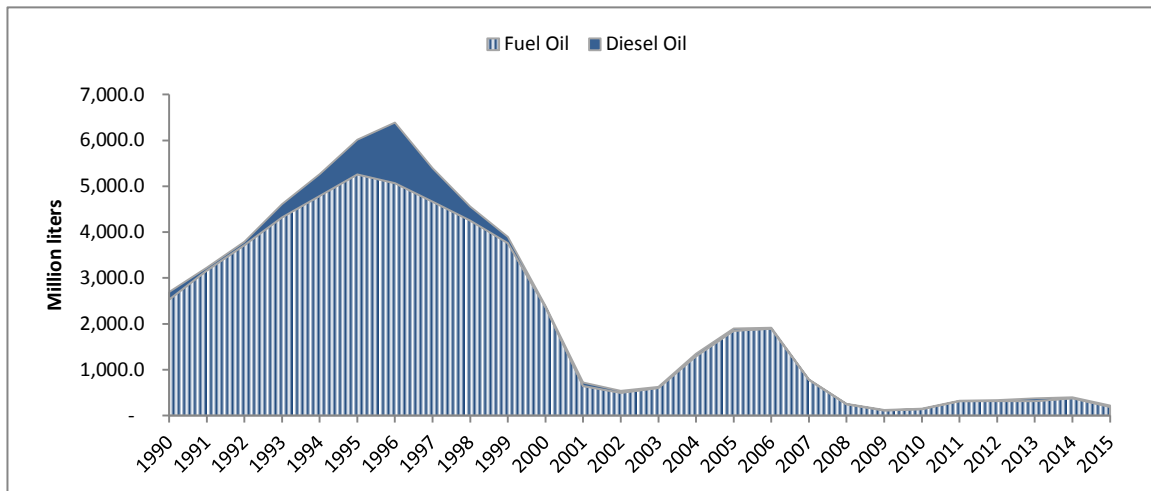
Oil

Fuel oil and diesel oil were consumed by EGAT in four power plants in Thailand, namely Bang Pakong Power Plant, Krabi Power Plant, Surat Thani Power Plant and Wang Noi Power Plant.

In 2015, a total of 221.0 million liters of oil were consumed by EGAT for power generation, of which 86.9% or 192.0 million liters were fuel oil supplied by PTT.

EGAT has been continuously reducing the fuel consumption in its oil-fired power plant since the peak in 1996 due to the increasing oil prices, in order to minimize its operating costs. Hence, the utilization of oil for power generation has been on decline with a CAGR of -14.7% from 2,393.0 million liters in 2000 to 221.0 million liters of oil in 2015.

Chart 1-19: EGAT Fuel Consumption in Power Generation in Thailand, 1990 - 2015



Source: EGAT

1.3.2.2 Renewable energy

The development of renewable energy is one of the main focuses in PDP 2015 to gradually reduce the reliance on natural gas power generation. According to PDP 2015, renewable power generation is projected to increase from 16,056.0GWh (8.1% share) in 2016 to 58,499.0GWh (17.9% share) in 2036. The AEDP, which was formulated along with PDP 2015, intends to address environmental issues such as municipal and agricultural pollution by encouraging power generation with waste, biomass and biogas. The implementation of FiT in 2014 has also facilitated the renewable power generation among VSPPs, particularly in solar, wind, small hydroelectricity, waste and bioenergy.

Hydro Power

According to EGAT statistics, under the EGAT's power generation fleet, there were 25 hydroelectricity plants with a total contracted power generation capacity of 3,488.2MW in 2016. Between 2000 and 2016, the contracted power generation capacity for hydroelectricity plant achieved a CAGR of 1.2% from 2,880.0MW in 2000. The major addition in the contracted power

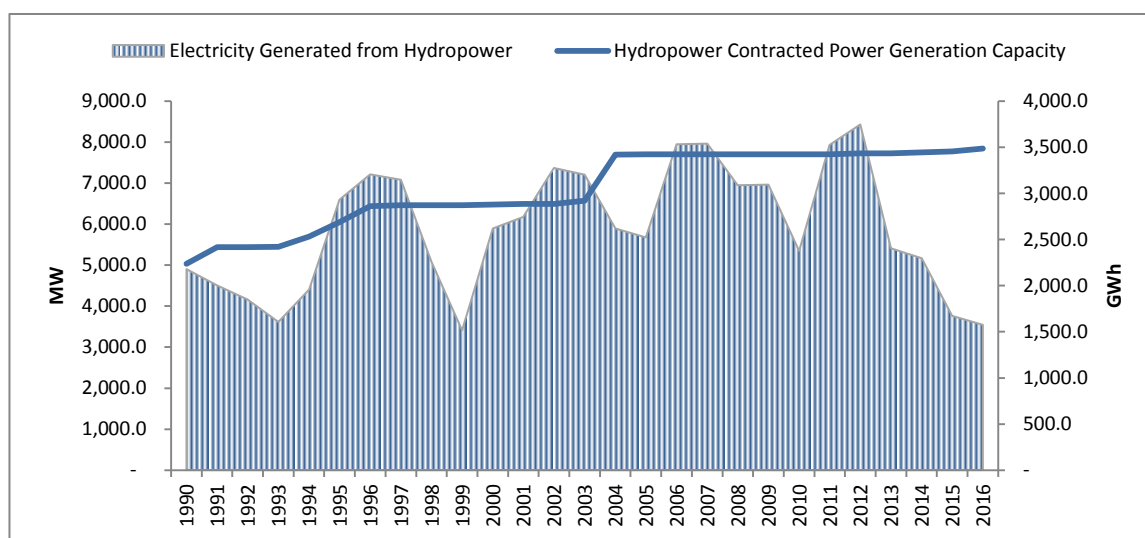
generation capacity is attributable to the Lam Ta Khong Dam Hydroelectricity Plant with a capacity of 500.0MW in 2004.

EGAT added two hydroelectricity plants in 2015, namely Khwae Noi Bamrungdan Dam hydroelectricity plant in Phitsanulok Province with 30.0MW contracted power generation capacity, and Khun Dan Prakanchon Dam hydroelectricity plant in Nakhon Nayok Province with 10.0MW contracted power generation capacity.

Beyond 2017, EGAT has obtained approval for six hydroelectricity plants that are scheduled for commercial operation between 2018 and 2020, namely Lam Ta Khong Jolabha Vadhana Hydroelectricity Plant in Nakhon Ratchasima Province with contracted power generation capacity of 500.0MW, Ban Chan De Hydroelectricity Project in Kanchanaburi Province with contracted power generation capacity of 18.0MW, Kiew Kor Mah Dam in Lampang Province with contracted power generation capacity of 5.5MW, Klong Tron Hydroelectricity Project in Uttaradit Province with contracted power generation capacity of 2.5MW, and Chulabhorn Downstream Hydro Power Plant in Chaiyaphum Province with contracted power generation capacity of 1.3MW.

The electricity generated from hydroelectricity plants was recorded at 3,543.1GWh in 2016, which accounted for only 1.8% of the total electricity generated by various fuel mixes in Thailand. Due to its generation flexibility, the electricity generated from hydroelectricity plant is able to accommodate electricity demand and match supply from less flexible electricity sources and variable renewable sources³⁶. The electricity generated from hydroelectricity from 1990 – 2016 has been in a fluctuating trend due to periodical drought conditions that happened every 5 to 7 years.

Chart 1-20: Hydroelectricity Contracted Power Generation Capacity and Electricity Generated by EGAT in Thailand, 1990 - 2016



Source: EGAT

³⁶ IEA: Hydroelectricity Essentials

Solar

Thailand has high renewable power generation potential for solar energy, as the average daily exposure is between 18.0 – 20.0 MJ/m²-day, higher compared to 13.0 MJ/m²-day in Japan³⁷. The north eastern and northern regions receive an average of 2,200 to 2,900 hours of sunshine a year (equivalent to 6 – 8 hours of sunshine per day)³⁸.

According to the PDP 2015, the solar power installed capacity in 2014 was recorded at 1,298.5MW. Based on the alternative energy target established under the AEDP, solar power is targeted to have an installed capacity of 6,000.0MW or 30.6% of the total installed capacity for renewable energy by 2036.

The AEDP has also outlined a proposal to provide 25-year FiT for rooftop solar at households (not exceeding 10.0kW), businesses (not exceeding 1.0MW), Thai government and agricultural cooperatives (not exceeding 5.0MW), as well as additional solar farms (not exceeding 90.0MW).

Bioenergy

According to the initial statements of AEDP 2015 – 2036, announced in conjunction with the PDP 2015 by EPPO, the cumulative installed capacity for power generated from bioenergy is expected to be 7,350.0MW in 2036, of which 75.8% or 5,570.0MW will be biomass from various agricultural sources, such as rice (rice straw and rick husks), sugar cane (leaves and tops, and bagasse), corn (stems, leaves, corn, and corn cob), cassava (cassava roots), palm crude oil tree (palm trunk, palm leaves, palm shell, and palm fiber), rubber tree (or also known as para wood) (roots and leaves of branches, small rubber wood, slab rubber wood, rubber wood chips and sawdust), soybean (top, leaves and stems), and peanut (top, leaves and stems)

Biogas as source of bioenergy for electricity generation is targeted to be 1,280.0MW or 17.4% by 2036, of which 600.0MW will be generated from industrial waste and livestock farms. The remaining is expected to be generated from energy crops.

According to a study done by the Department of Alternative Energy Development and Efficiency (“DEDE”)³⁹, rubber wood chips and sawdust have the potential to generate electricity of 176,957,475.0kWh a year through its annual volume of 484,815.0 tons from the rubber wood processing industry in Thailand. In addition, slab rubber wood has potential to generate electricity of 707,829,900.0kWh a year, with its volume of 1,939,260.0 tons in a year from the rubber wood processing industry in Thailand as well.

The average price of rubber wood⁴⁰ and rubber wood chips⁴¹ was at a declining trend from 2011 to 2015, mainly due to high mature area of rubber wood plantation at 796,000.0 hectares that leads to high supply of rubber wood for replantation purposes and conversion into other crops⁴².

³⁷ Areas with solar power potential, Ministry of Energy, retrieved from <http://weben.dede.go.th/webmax/content/areas-solar-power-potential>

³⁸ Thailand (2014), retrieved from <http://www.reeep.org/thailand-2014>

³⁹ Biomass Database Potential in Thailand

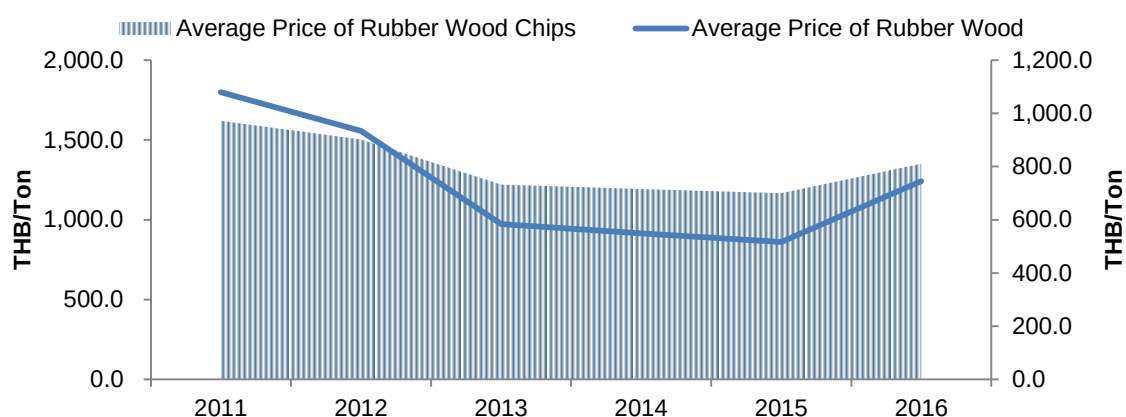
⁴⁰ Average of price of rubber wood with diameter of less than six inches from four locations that have biomass power plant located nearby, namely Trang Province, Songkhla Province, Nakornsritammarat Province, and Yala Province

⁴¹ Average of price of rubber wood chips derived by taking 25.0-33.0% of average rubber wood price, added with THB400.0-500.0 for shredding and transportation cost

⁴² Rubber Asia: Natural Rubber: It's time for a paradigm shift <http://rubberasia.com/2016/12/15/nr-time-paradigm-shift/>

In 2016 however, the production of fuel wood dropped 31.8% from 31.1 million tons in 2015 to 21.2 million tons in 2016⁴³. The drop in supply led to increase in the average price of rubber wood, along with increase in installed capacity of electricity generation by biomass from 2,452.0MW in 2014 to 2,727.0MW in 2015 that leads to surge in demand for rubber wood⁴⁴.

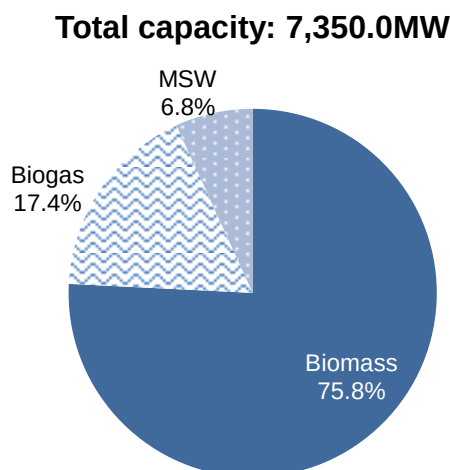
Chart 1-21: Historical Price of Rubber Wood and Rubber Wood Chip, 2011 - 2016



Source: Rubber Authority of Thailand, Frost and Sullivan Analysis

The AEDP target for waste to energy from municipal solid waste ("MSW")⁴⁵ is expected to contribute 500.0MW or 6.8% to the total bioenergy target for electricity generation by 2036.

Chart 1-22: Bioenergy Target for Electricity Generation by 2036 in Thailand



Source: PDP 2015, EPPO

⁴³ DEDE: Table of Thailand Energy Balance 2016

⁴⁴ Thailand – Bioenergy Policy Update 05/2016, retrieved from <http://www.thai-german-cooperation.info/admin/uploads/publication/b37f836e88f667d3e74376110293f797th.pdf>

⁴⁵ Waste to energy from MSW is categorized under bioenergy in the AEDP target.

Wind

Besides solar energy, Thailand foresees the potential of wind energy as one of the renewable alternatives in substituting the fossil-based energy, with wind energy potential of 14,141.0MW at area with mean wind speed of 6.0 meters per second⁴⁶.

According to the AEDP 2015, the wind power installed capacity in 2014 was recorded at 224.5MW. Based on the alternative energy target established under the AEDP, wind power is targeted to have an installed capacity of 3,002.0MW or 15.3% of the total installed capacity for renewable energy by 2036.

1.3.3 Evolution of Fuel Mix

According to EPPO Energy Statistics, electricity generation in Thailand reached 199,566.9GWh in 2016 and was projected by PDP 2015 to reach 234,654.0GWh in 2021 with a CAGR of 3.3%. In 2016, electricity generation continued to be dominated by natural gas as a fuel source with 63.2% share or 126,150.0GWh of the total electricity generated. As PDP 2015 was formulated to diversify Thailand electricity generation fuel mix, fuel dependency on natural gas or LNG imports is expected to decrease from 63.2% in 2016 to 46.6% in 2021 and eventually to 36.8% in 2036.

Coal is seen as a potential replacement for the heavy dependency on natural gas. The electricity generation from lignite and imported coal is expected to increase from 19,059.4GWh (9.6% share) and 18,047.7GWh (9.0% share) in 2016 to 17,320.0GWh (7.4% share) and 35,579.0GWh (15.2% share) in 2021 respectively. Driven by the promotion of clean coal technology, the share of imported coal as electricity generation source is expected to further increase to 16.7% in 2036. However, public acceptance of coal-fired power plant is still questionable, as evidenced by opposition from residents, activists, and even Thai news organizations on building of Krabi coal-fired power plant with planned contracted power generation capacity of 800.0MW, which was originally scheduled to be in operation in 2019. As a result of the opposition, the plan is put on hold and will be reviewed, which would take two and a half years or more, according to the deputy governor of EGAT⁴⁷. In the event that the plan for coal-fired power plant is called off, it could be replaced by gas-fired power plant to ensure power stability in the southern region⁴⁸, fueled by imported gas and LNG from Myanmar and other countries.

Large hydroelectricity, as a type of renewable source, is expected to increase its share from 1.8% or 3,543.1GWh in 2016 to 2.1% or 6,964.0GWh in 2036, contributed by hydroelectricity plants of EGAT. The share of large hydro is expected eventually to increase to 17.6% in 2036 with the new import of electricity from Myanmar and China.

According to EPPO Energy Statistics, the share of renewable energy as a source of electricity generation stood at 6.2% or 12,450.0GWh in 2016 and is projected by PDP 2015 to reach 15.0% or 35,276.0GWh in 2021 with a high CAGR of 23.2%, and a further increase to 17.9% or

⁴⁶ Department of Alternative Energy Development and Efficiency: Annual Report 2010

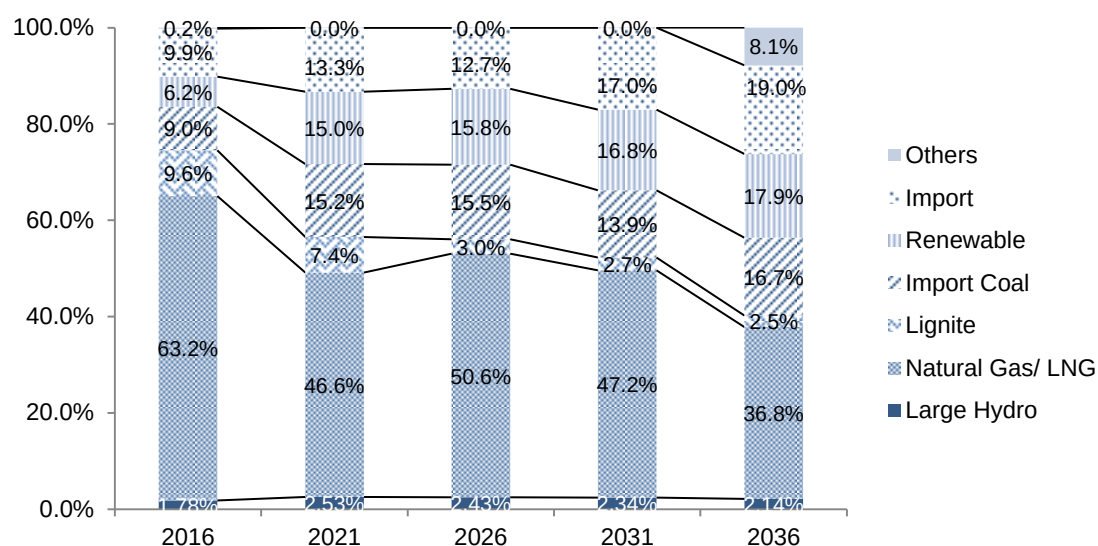
⁴⁷ Nikkei Asian Review: Protests upend a coal-fired power plant in Southern Thailand
<http://asia.nikkei.com/magazine/20170309/Business/Protests-upend-a-coal-fired-power-plant-in-southern-Thailand?page=1>

⁴⁸ The Nation: Coal-fired plants, emissions targets to be decided shortly, retrieved from <http://www.nationmultimedia.com/news/national/30303356>

58,499.0GWh in 2036. A large addition to electricity generation from renewable sources by VSPPs is expected with favorable FiT introduced at the end of 2014.

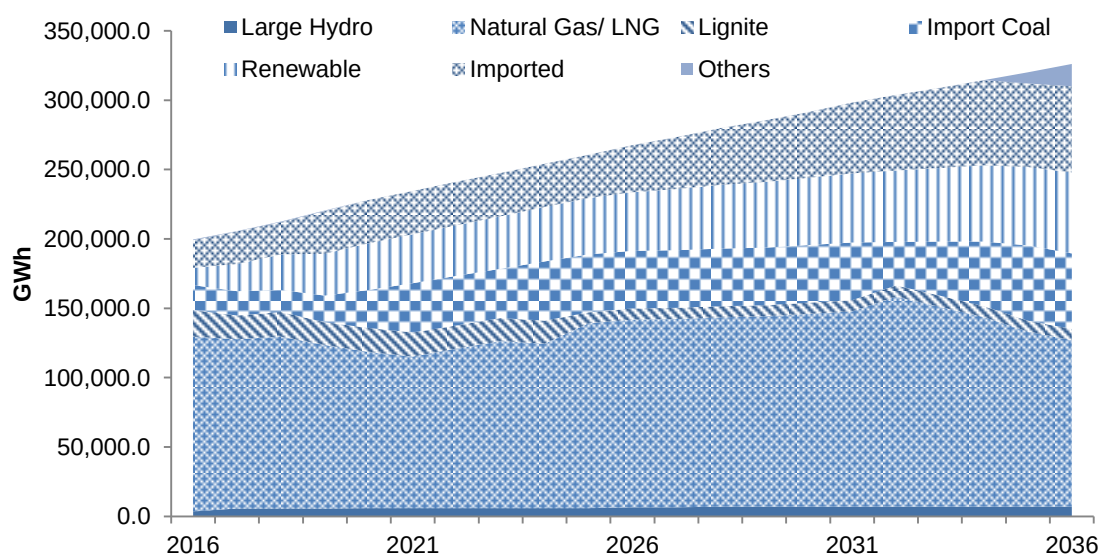
A nuclear power plant is expected to be commissioned in 2035, contributing 8,024.0GWh of electricity.

Chart 1-23: Projected Electricity Generation by Fuel Types (%) in Thailand, 2016 - 2036



Source: EPPO, PDP 2015

Chart 1-24: Projection of Electricity Generation by Fuel Types in Thailand, 2016 - 2036



Notes:

- (1) Electricity generation by large hydro and lignite exclude import of electricity from Lao PDR and Myanmar
- (2) Others include heavy oil, diesel, and nuclear

Source: EPPO, PDP 2015

EGAT has signed PPAs with three major IPP projects amounting to a total contracted power generation capacity addition of 5,270.0MW with COD from 2017 to 2024. Natural gas-fired power projects (represented by the GSRC Power Project and GPD Power Project) dominate the new contracted power generation capacity addition in the IPP sector during the period, which accounts for 94.9%, while coal-fired project (represented by National Power Supply Co., Ltd) accounts for the remaining 5.1%. Similarly, out of the five EGAT power plant replacement projects amounting to a total planned contracted power generation capacity of 5,650.0MW, natural gas-fired power projects represent approximately 92.0% (namely Bang Pakong Thermal Power Plant, South Bangkok Thermal Power Plant, South Bangkok Combined Cycle Power Plant, and Wang Noi Combined Cycle Power Plant), while lignite-fired power projects accounts for the remaining 8.0% (namely Mae Moh Power Plant).

The PPAs with SPPs (with COD from 2017 to 2024) will have a total contracted power generation capacity of 6,248.0MW, which comprise of 3,658.0MW co-generation projects and 2,590.0MW renewable energy projects. EGAT is expected to import 1,843.0MW of contracted power generation capacity from three projects in Lao PDR during the same period. Notably, as of September 30, 2017, the Company's addition of nine co-generation SPP power plants during the period constitutes 810.0MW of total contracted power generation capacity, which represents approximately 22.1% of the total contracted power generation capacity addition in the SPP co-generation segment.

Table 1-10: Selected Planned New and Replacement Power Plants in Thailand from 2017 to 2024, as of September 30, 2017

Expect ed COD	Name	Effective Ownership	Location	Type	Fuel Source	Contracted Power Generation Capacity (MW)
2017	National Power Supply Co., Ltd. (Unit 3 & 4)	National Power Supply Public Co., Ltd.	Chachoengsao	IPP	Coal	270.0
2017	Lam Ta Khong Wind Turbine, Phase 2	EGAT	Nakhon Ratchasima	EGAT	Wind	24.0
2017	GTS3	The Company (52.49%)	Rayong	SPP	Natural Gas	90.0
2018	Lam Ta Khong Jolabha Vadhana Hydroelectricity Plant, Units 3-4	EGAT	Nakhon Ratchasima	EGAT	Hydro	500.0
2018	Kiew Kor Mah Dam	EGAT	Lampang	EGAT	Hydro	6.0
2018	Klong Tron Dam	EGAT	Uttaradit	EGAT	Hydro	3.0
2018	GTS4	The Company (52.49%)	Rayong	SPP	Natural Gas	90.0
2018	GBP	The Company (52.50%)	Ayutthaya	SPP	Natural Gas	90.0
2018	GBL	The Company (52.50%)	Ayutthaya	SPP	Natural Gas	90.0
2018	GNC	The Company (70.00%)	Prachinburi	SPP	Natural Gas	90.0
2019	Chulabhorn Downstream Hydro Power Plant	EGAT	Chaiyaphum	EGAT	Hydro	1.0
2019	Krabi Coal-Fired Power Plant	EGAT	Krabi	EGAT	Coal	800.0
2019	Replacement for Bang Pakong Thermal Power Plant (unit 1 & 2)	EGAT	Chachoengsao	EGAT	Natural Gas	1,300.0
2019	Replacement for South Bangkok Thermal Power	EGAT	Samut Prakan	EGAT	Natural Gas	1,300.0

Expected COD	Name	Effective Ownership	Location	Type	Fuel Source	Contracted Power Generation Capacity (MW)
	Plant (unit 1-5)					
2019	GNPM	The Company (70.00%)	Saraburi	SPP	Natural Gas	90.0
2019	GNRV1	The Company (70.00%)	Nakhon Ratchasima	SPP	Natural Gas	90.0
2019	GNRV2	The Company (70.00%)	Nakhon Ratchasima	SPP	Natural Gas	90.0
2019	GNLL2	The Company (52.49%)	Rayong	SPP	Natural Gas	90.0
2019	Xe-Pian Xe-Namnoy	Xe-Pian Xe-Namnoy Power Co., Ltd.	Lao PDR	Import	Hydro	354.0
2019	Nam Ngiep 1	Nam Ngiep 1 Power Company	Lao PDR	Import	Hydro	269.0
2019	Xayaburi	Xayaburi Power Company Ltd.	Lao PDR	Import	Hydro	1,220.0
2020	Ban Chan De Hydroelectricity	EGAT	Kanchanaburi	EGAT	Hydro	18.0
2021	Thepa Coal-Fired Power Plant (unit 1)	EGAT	Songkla	EGAT	Coal	1,000.0
2021	GSRC (Unit 1 & 2)	The Company (51.00%)	Chon Buri	IPP	Natural Gas	1,250.0
2022	GSRC (Unit 3 & 4)	The Company (51.00%)	Chon Buri	IPP	Natural Gas	1,250.0
2022	Replacement for South Bangkok Combined Cycle Power Plant (Unit 1 & 2)	EGAT	Samut Prakan	EGAT	Natural Gas	1,300.0
2022	Replacement for Mae Moh Power Plant (Unit 8 & 9)	EGAT	Lampang	EGAT	Lignite	450.0
2023	GPD (unit 1 & 2)	The Company (51.00%)	Rayong	IPP	Natural Gas	1,250.0
2023	Replacement for Wang Noi Combined Cycle Power Plant (Unit 1 & 2)	EGAT	Ayutthaya	EGAT	Natural Gas	1,300.0
2024	GPD (unit 3 & 4)	The Company (51.00%)	Rayong	IPP	Natural Gas	1,250.0
2024	Thepa Coal-Fired Power Plant (unit 2)	EGAT	Songkhla	EGAT	Coal	1,000.0

Note: The Company's effective ownership reflected above is based on the Company's equity stake in GSRC (unit 1,2,3&4) and GPD (unit 1,2,3&4) of 51.00% as of September 30, 2017. On November 13, 2017, the Company increased its equity stake in these projects to 70.00%.

Source: EGAT, PDP 2015, Frost & Sullivan Analysis

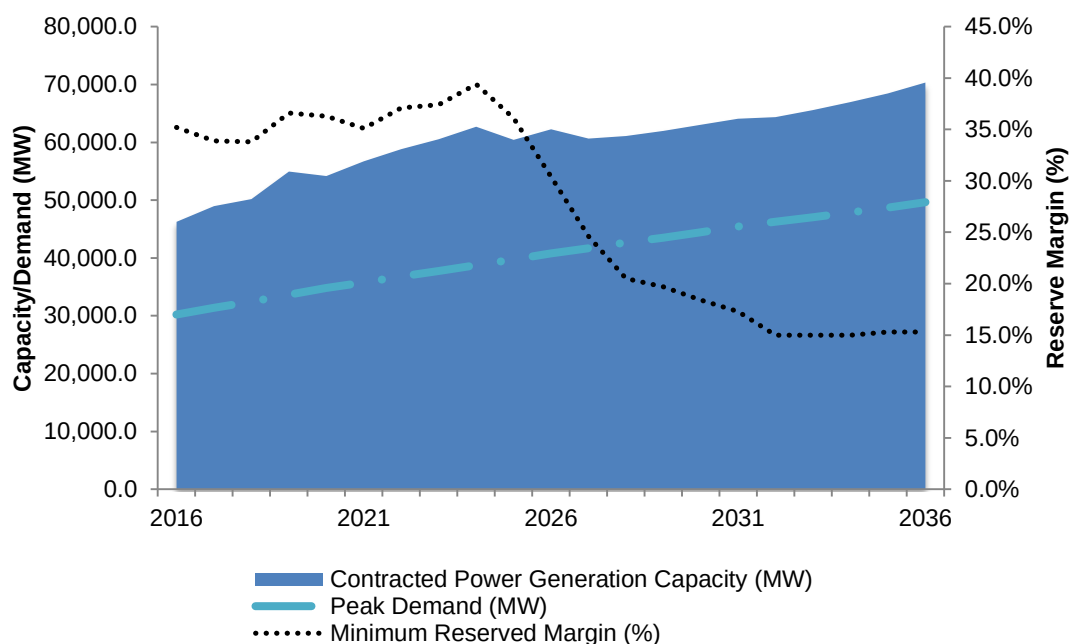
1.3.4 Reserve Margin

According to PDP 2015, a minimum reserve margin of 15.0% above peak power is targeted to ensure minimal disruption of electricity supply in the country.

The minimum reserve margin in Thailand is estimated to be 35.2% in 2016. It is projected to peak at 39.4% in 2024 before falling to around 15.0% from 2033 onwards. The increase in the minimum reserve margin in Thailand is mainly supported by the addition of 14,878.0MW of combined cycle power plant between 2015 and 2026 and 10,644.0MW of renewable energy power plant (excluding large hydro) during the same period. Comparatively, Thailand's actual

reserve margin was reported at 41.9% in 2015⁴⁹, which is above the minimum target. Excess capacity in power generation may potentially create an entry barrier for new power projects in addition to the planned capacity under PDP 2015.

Chart 1-25: Contracted Power Generation Capacity (MW), Peak Demand (MW) and Minimum Reserve Margin (%) in Thailand, 2016 - 2036



Source: PDP 2015, Frost & Sullivan Analysis

1.3.5 Operational Performance

Heat Rate

Heat rate is a measurement of the efficiency of a power plant in converting fuel into heat and into electricity. A low heat rate translates into high efficiency in a power plant as the amount of energy (British thermal unit, “BTU”) used in a power plant to generate one kWh of electricity is low.

PPAs stipulate various plant efficiency indicators, such as heat rate, and failure to meet such performance requirements would result in higher than anticipated cost of operation specified in the PPA.

Within conventional fuel power generation, the average heat rate of key power plants in Thailand generally improved from 8,643.9BTU/kWh in 2011 to 8,343.2BTU/kWh in 2016. Gas-fired power plants are observed to be more efficient among the various conventional fuel types with an

⁴⁹ RAM Ratings: Regional Commentary – ASEAN-5 Power Sectors, October 2016

average heat rate of 7,924.7BTU/kWh in 2016, compared to coal-fired power plants at 9,433.1BTU/kWh. With all of the Company's power plants in operation being gas-fired power plants, they achieved an average heat rate of 6,952.6BTU/kWh from 2014 to 2016 for its IPP plants and 7,809.8BTU/kWh from 2013 to 2016 for its SPP plants. This performance compares favorably to the industry average among peers of 8,062.4BTU/kWh⁵⁰ and 8,230.9BTU/kWh⁵¹ for gas fired power generation IPP and SPP plants, respectively, during the same periods.

Table 1-11: Heat Rate of Selected Power Plant from 2011 to 2016

Type of Fuel	IPP/S PP	Power Producer	2011	2012	2013	2014	2015	2016
			(BTU/kWh)					
EGAT			8,240.3	8,210.0	8,170.2	8,059.3	7,853.6	N/A
Gas	IPP	The Company	N/A	N/A	N/A	6,887.7	6,988.6	6,981.4
		Glow	6,924.0	6,930.0	6,946.0	6,980.0	7,054.0	7,400.0
		Ratchaburi Thermal Units	10,060.0	10,196.0	10,359.0	10,352.0	9,947.0	10,200.0
		Ratchaburi Combined Cycle Units	7,222.0	7,241.0	7,246.0	7,178.0	7,137.0	7,080.0
		EGCO	N/A	8,647.0	8,631.0	8,339.2	7,800.0	7,282.0
	SPP	The Company	N/A	N/A	7,898.7	7,813.5	7,781.1	7,745.8
		Glow	8,621.0	8,091.0	8,105.0	8,140.0	8,076.0	8,094.0
		EGCO	N/A	8,945.0	8,797.0	8,564.0	8,685.5	8,680.3
		B.Grimm	N/A	N/A	7,884.8	7,951.3	7,933.8	7,859.0
Coal	IPP	Glow	N/A	9,094.0	9,183.0	8,940.0	8,895.0	9,021.0
		EGCO	N/A	N/A	N/A	9,414.0	9,393.0	9,418.0
		Banpu BLCP	N/A	N/A	9,027.5	8,922.7	8,902.8	8,930.3
	SPP	Glow	10,796.0	10,420.0	10,513.0	10,437.0	10,389.0	10,363.0

N/A – Not available

Notes:

- (1) Data for EGCO gas-fired in 2011 is not available
- (2) Data for B.Grimm SPP from 2011-2012 is not available
- (3) Data for EGCO coal-fired from 2011-2013 is not available
- (4) Data for the Company from 2011-2013 for IPP and 2011-2012 for SPP is not available
- (5) Data for EGAT in 2016 is not available
- (6) Simple average method was adopted to derive the average heat rate

Source: EGAT, respective annual reports, TRIS Rating

Equivalent Availability Factor

⁵⁰ Derived based on the averaging of 2014 to 2016 heat rate for the Gas-fired IPPs outlined in Table 1-11.

⁵¹ Derived based on the averaging of 2013 to 2016 heat rate for the Gas-fired SPPs outlined in Table 1-11.

Equivalent availability factor (“**EAF**”) is a measure of power plant availability calculated as the amount of time that a plant is able to produce electricity over a certain period, divided by the total amount of time in the period. The volatility in EAF is affected by unplanned outages due to an unexpected breakdown in a power plant, as well as planned outages for scheduled maintenance.

The average EAF of key IPP power plants in Thailand generally improved from 91.9% in 2011 to 95.1% in 2016; while the average EAF of SPP power plants in Thailand also increased slightly from 94.6% in 2011 to 94.7% in 2016. The Company achieved average EAF of 97.5% from 2014 to 2016 for its IPP plants and average EAF of 96.5% from 2013 to 2016 for its SPP plants. The Company’s EAF was superior compared to the industry average among peers in IPP and SPP segments, which stood at 92.8%⁵² and 93.9%⁵³, respectively, during the same periods.

Table 1-12: EAF of Selected Power Plant from 2011 to 2016

IPP/SPP	Power Producer	2011	2012	2013	2014	2015	2016
		(%)					
EGAT		92.8%	90.5%	92.1%	92.8%	92.9%	N/A
IPP	The Company	N/A	N/A	N/A	97.5%	97.3%	97.7%
	Glow	96.3%	84.8%	88.4%	96.2%	87.2%	91.8%
	Ratchaburi Thermal Units	87.8%	97.0%	81.9%	99.4%	87.3%	97.1%
	Ratchaburi Combined Cycle Units	90.1%	90.0%	88.3%	90.3%	84.3%	91.6%
	EGCO gas-fired	91.9%	93.3%	91.0%	94.3%	94.5%	95.3%
	EGCO coal-fired	93.3%	93.5%	91.4%	93.0%	92.2%	95.3%
	GPSC Sriracha Combined Cycle	N/A	N/A	93.00%	87.0%	96.0%	97.0%
SPP	The Company	N/A	N/A	97.9%	97.4%	96.9%	93.9%
	Glow	95.3%	95.9%	97.5%	95.7%	94.4%	95.9%
	EGCO gas-fired	98.3%	76.1%	97.2%	97.8%	91.3%	96.3%
	EGCO biomass	90.2%	91.1%	86.4%	88.1%	89.9%	91.3%
	B.Grimm	N/A	N/A	94.6%	95.1%	94.2%	96.3%

N/A – Not available

Notes:

- (1) Data for EGAT in 2016 is not available
- (2) Data for GPSC Sriracha Combined Cycle from 2011-2012 and GPSC SPP cogeneration power plant is not available
- (3) Data for B.Grimm from 2011-2012 is not available
- (4) Data for the Company from 2011-2013 for IPP (Gas) and 2011-2012 for SPP is not available

Source: EGAT, respective annual reports, TRIS Rating

⁵² Derived based on the averaging of 2014 to 2016 EAF for the IPPs outlined in Table 1-12.

⁵³ Derived based on the averaging of 2013 to 2016 EAF for the SPPs outlined in Table 1-12

1.3.6 Industry Risks and Challenges

Political Uncertainty

Political uncertainty may affect the implementation of the PDP. However, the launch of PDP 2015 in June 2015 has shown that the major power-related policies are taken up by the military ruled Thai government. There was no major policy change in the PDP 2015, as compared to PDP 2010 which was drafted from the previous Thai government. In addition to that, there is no report of default payment from EGAT on its PPA terms even with the change of Thai government⁵⁴.

Availability of Fuel Supply

High dependency on imported natural gas and coal could cause insecurity in the power system, if there is any natural gas and coal supply disruption. The maintenance shutdown of Yadana and Yetagun fields in Myanmar in 2014, Thailand's main source of natural gas for its gas-fired power plant, has raised concerns about power security. Though there was no power disruption during the natural gas field shutdowns, availability of fuel supply remains a risk for Thailand due to the high dependency on fuel imports. However, Thailand has formulated Gas Plan 2015 where one of its objectives is to develop LNG import infrastructure to support long-term demand for LNG. In addition, PTT has signed a 20-year contract with Qatargas to import LNG from Qatar in 2012, 15-year contract with Shell Eastern Trading, 20-year contract with BP, and also plans to sign a long-term contract with PETRONAS and Anadarko. These contracts are expected to alleviate the risk of LNG shortages in the medium- to long-term.

1.3.6.1 Barriers to Entry

SOEs Monopoly

EGAT, as an SOE, is responsible for the generation and transmission of electricity in Thailand and has remained as the single largest power producer in the country. The liberalization of the power sector has permitted the establishment of private power producers, such as IPPs, SPPs and VSPPs in the electricity sector. However, all the electricity generated by private power producers are to be sold through EGAT (for IPP and SPP generated electricity) as well as MEA and PEA (for VSPP generated electricity). There is still a monopolistic element by SOEs in the buying of electricity from private producers.

Furthermore, the Thai Competition Act B.E. 2542 (1999) provides enforcement exemption to SOEs.⁵⁵ There could be risks to new private market entrants when they have to operate at competitive rates with the three SOEs. If there is market abuse by the SOEs, there is insufficient legal protection against any unfair monopolistic conduct.

⁵⁴ Credit Suisse Equity Research on Thailand Power Utilities Sector

⁵⁵ Competition Act, B.E. 2542 (1999)

Furthermore, current IPPs who operate gas-fired power plants are heavily dependent on the natural gas supply from PTT, which is majority-owned by the Thai government and also has an effective monopoly with respect to the supply of natural gas in Thailand.

Environmental Concerns

Construction of power plants may result in air pollution and raise environmental concerns. New market entrants may face strong local community objections from new power plant projects at the targeted districts. Additional environmental and health impact assessments need to be conducted to secure final approval for the construction of new power plants. Potential kickback and prolonged review process may potentially result in delay of the construction of new power plants.

However, in comparing gas-fired with coal-fired power generation plant, natural gas is cleaner than coal as it emits fewer particulates and less carbon. According to a study done by European Climate, the carbon dioxide released from a coal-fired plant with the most efficient technology at 750.0gCO₂e/kWh is still two times higher than that of a gas-fired plant at 350.0gCO₂e/kWh⁵⁶. Coal-fired power plants are strongly resisted by Thailand residents, mainly due to the negative image formed from the Mae Moh lignite-fired power station when it severely impacted the surrounding environment and the health of residents nearby in the 1990s.

1.3.6.2 Product Substitution

There is no specific substitution for power generation activity. However, the Thailand power generation industry faces risk of low availability of fuel supply as the country relies heavily on certain imported fuel sources such as natural gas and coal. Fluctuating natural gas prices and coal prices may cause the replacement of certain fuel sources, making way for alternative fuel sources such as nuclear power.

According to PDP 2015, the Thai government has considered nuclear power as a source of fuel for power generation. It is expected to add two nuclear power plants with total contracted power generation capacity of 2,000.0MW towards the end of the PDP in 2035 – 2036.

1.4 COMPETITIVE LANDSCAPE

In view of the rising demand for electric power, since 1994, Thailand has taken steps to solicit IPP bids for the construction of new power generation plants. The SPP program was launched in 1992 and is designed for smaller power plants with contracted power generation capacity of under 90.0MW. Both the IPP and SPP markets are open to private operators to generate and sell electricity to EGAT.

As of December 31, 2016, Thailand's total domestic private contracted power generation⁵⁷ capacity in operation was 21,294.0MW. IPPs represented 70.2% or 14,949.0MW of Thailand's

⁵⁶ Greenpeace: Human Cost of Coal Power: How coal-fired power plants threaten the health of Thais

⁵⁷ Domestic private power generation includes IPPs and SPPs contracted capacity to EGAT based on PPAs

total private contracted power generation capacity in operation while SPPs accounted for the remaining 29.8% or 6,345.0MW.

Based on the effective contracted power generation capacity of the key players, RATCH was the largest player in the domestic private power generation sector with a market share of 22.0% or 4,674.6MW in 2016. Meanwhile, JPHT held the second position in terms of market share in domestic private power generation sector with a market share of 14.8% or 3,146.7MW in 2016.

This is followed by EGCO and GLOW who held the third and fourth largest market share in the domestic private power generation sector with a market share of 12.4% or 2,645.2MW and 9.2% or 1,950.4MW respectively in 2016. The Company, GPSC, Banpu Power Public Company Limited ("BANPU") and B. Grimm Power Public Company Limited ("B.Grimm"), each held respective market share of 7.2% or 1,523.0MW, 5.0% or 1,059.5MW, 3.2% or 673.3MW and 2.6% or 553.8MW in the same year. Other players constitute 23.8% or 5,067.5MW.

On the other hand, the Company held the largest market share in total in operation and future IPPs and SPPs power projects in Thailand with an effective contracted power generation capacity of 4,723.6MW and largest effective capacity of gas-fired power projects in the pipeline with 3,038.2MW based on the Company's equity stake in the GSRC and GPD power plants of 51.00% as of September 30, 2017. On November 13, 2017, the Company increased its equity stake in the GSRC and GPD power plants to 70.00%. Accordingly, as of that date, the Company has an effective contracted power generation capacity of 5,673.6MW and effective capacity of gas-fired power projects in the pipeline of 3,988.2MW by December, 31 2024.

1.4.1 Key Players Profiles

Thailand's top players mostly comprise local SET-Listed companies partially owned by EGAT. Key players selected for this section are based on private power producers with rankings based on aggregated effective contracted power generation capacity in the IPP and SPP sectors.

Table 1-13: Profile of Local SET-listed and Private Companies with Interests in IPPs and SPPs Based on Effective Contracted Power Generation Capacity (MW) with PPA secured ⁽¹⁾ in Thailand, as of September 30, 2017

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
The Company										
1	GNS	IPP	Natural Gas	JPHT (60.00%)	40.00%	1,600.0	640.0	25	2014	2039
2	GUT	IPP	Natural Gas	JPHT (60.00%)	40.00%	1,600.0	640.0	25	2015	2040
3	GKP1	SPP	Natural Gas	JPHT (60.00%)	40.00%	90.0	36.0	25	2013	2038
4	GKP2	SPP	Natural Gas	JPHT (60.00%)	40.00%	90.0	36.0	25	2013	2038
5	GCRN	SPP	Natural Gas	JPHT (60.00%)	40.00%	90.0	36.0	25	2013	2038
6	GTLC	SPP	Natural Gas	JPHT (60.00%)	40.00%	90.0	36.0	25	2013	2038
7	GNNK	SPP	Natural Gas	JPHT (60.00%)	40.00%	90.0	36.0	25	2013	2038
8	GNK2	SPP	Natural Gas	JPHT	40.00%	90.0	36.0	25	2013	2038

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
				(60.00%)						
9	GNLL	SPP	Natural Gas	JPHT (45.00%)	30.00%	90.0	27.0	25	2013	2038
10	GVTP	SPP	Natural Gas	-	52.49%	90.0	47.2	25	2017	2042
11	GTS1	SPP	Natural Gas	-	52.49%	90.0	47.2	25	2017	2042
12	GTS2	SPP	Natural Gas	-	52.49%	90.0	47.2	25	2017	2042
Total Contracted Power Generation Capacity in Operation						4,100.0	1,664.7			
Projects Under Construction										
1	GTS3 ⁽⁴⁾	SPP	Natural Gas	-	52.49%	90.0	47.2	25	2017	2042
2	GTS4	SPP	Natural Gas	-	52.49%	90.0	47.2	25	2018	2043
3	GBP	SPP	Natural Gas	-	52.50%	90.0	47.3	25	2018	2043
4	GBL	SPP	Natural Gas	-	52.50%	90.0	47.3	25	2018	2043
5	GNC	SPP	Natural Gas	-	70.00%	90.0	63.0	25	2018	2043
6	GNPM	SPP	Natural Gas	-	70.00%	90.0	63.0	25	2019	2044
7	GNRV1	SPP	Natural Gas	-	70.00%	90.0	63.0	25	2019	2044
8	GNRV2	SPP	Natural Gas	-	70.00%	90.0	63.0	25	2019	2044
9	GNLL2	SPP	Natural Gas	-	52.49%	90.0	47.2	25	2019	2044
10	GSRC ⁽⁵⁾	IPP	Natural Gas	-	51.00%	2,500.0	1,275.0	25	2021-22	2046 – 2047
11	GPD ⁽⁵⁾	IPP	Natural Gas	-	51.00%	2,500.0	1,275.0	25	2023-24	2048 – 2049
12	CGC ⁽⁶⁾	SPP	Biomass	-	100.00%	20.6	20.6	25	2019	Renewal Every

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
										5 Years
Total Contracted Power Generation Capacity Under Construction						5,830.6	3,058.8			
Total Contracted Power Generation Capacity						9,930.6	4,723.6			
RATCH										
1	RATCHGEN	IPP	Natural Gas	-	99.99%	3,481.0	3,480.7	25	2000 - 2002	2025 - 2027
2	Tri Energy Power Plant (TECO)	IPP	Natural Gas	-	99.99%	700.0	699.9	20	2000	2020
3	Ratchaburi Power Company's Power Plant (RPCL)	IPP	Natural Gas	GPSC (15.00%)	25.00%	1,400.0	350.0	25	2008	2033
4	Ratchaburi World Cogen Power Plant (RW Cogen)	SPP	Natural Gas	-	40.00%	180.0	72.0	25	2014	2039
5	Nava Nakhon Electricity Generating Co., Ltd (NNEG)	SPP	Natural Gas	GPSC (30.00%)	40.00%	90.0	36.0	25	2016	2041
6	Huay Bong 2 Wind-Turbine Power Plant	SPP	Wind	-	20.00%	90.0	18.0	5	2013	2018
7	Huay Bong 3 Wind-Turbine Power Plant	SPP	Wind	-	20.00%	90.0	18.0	5	2012	2017
Total Contracted Power Generation Capacity in Operation						6,031.0	4,674.6			
Projects Under Construction										
1	Bakprai Cogeneration	SPP	Natural Gas	-	35.00%	90.0	31.5	25	2019	2044

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
Total Contracted Power Generation Capacity Under Construction						90.0	31.5			
Total Contracted Power Generation Capacity						6,121.0	4,706.1			
JPHT										
1	Roi-Et Green Company Limited (Roi-Et Green)	SPP	Biomass	EGCO (70.30%)	24.70%	8.8	2.2	21	2003	2024
2	EGCO Cogeneration Company Limited (EGCO Cogen)	SPP	Natural Gas	EGCO (80.00%)	20.00%	60.0	12.0	21	2003	2024
3	Gulf Cogeneration Company Limited (GCC)	SPP	Natural Gas	EGGO (50.00%)	49.00%	90.0	44.1	21	1998	2019
4	Samutprakarn Cogeneration Company Limited (SCC)	SPP	Natural Gas	EGCO (50.00%)	49.00%	90.0	44.1	21	1999	2020
5	Nong Khae Cogeneration Company Limited (NKCC)	SPP	Natural Gas	EGCO (50.00%)	49.00%	90.0	44.1	21	2000	2021
6	Gulf Yala Green Co., Ltd.	SPP	Biomass	EGCO (50.00%)	49.00%	20.2	9.9	25	2006	2031
7	Gulf Power Generation Co., Ltd (GPG)	IPP	Natural Gas	EGCO (50.00%)	49.00%	1,468.0	719.3	16	2007	2033
8	GKP1	SPP	Natural Gas	The Company (40.00%)	60.00%	90.0	54.0	25	2013	2038
9	GKP2	SPP	Natural Gas	The Company (40.00%)	60.00%	90.0	54.0	25	2013	2038

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
10	GCRN	SPP	Natural Gas	The Company (40.00%)	60.00%	90.0	54.0	25	2013	2038
11	GTLC	SPP	Natural Gas	The Company (40.00%)	60.00%	90.0	54.0	25	2013	2038
12	GNNK	SPP	Natural Gas	The Company (40.00%)	45.00%	90.0	40.5	25	2013	2038
13	GNK2	SPP	Natural Gas	The Company (40.00%)	60.00%	90.0	54.0	25	2013	2038
14	GNLL	SPP	Natural Gas	The Company (30.00%)	45.00%	90.0	40.5	25	2013	2038
15	GNS	IPP	Natural Gas	The Company (40.00%)	60.00%	1,600.0	960.0	25	2014	2039
16	GUT	IPP	Natural Gas	The Company (40.00%)	60.00%	1,600.0	960.0	25	2015	2040
Total Contracted Power Generation Capacity in Operation						5,657.0	3,146.7			
Projects Under Construction										
N/A										
Total Contracted Power Generation Capacity						5,657.0	3,146.7			
GLOW ⁽⁷⁾										
1	Glow IPP Co., Ltd	IPP	Natural Gas	-	95.00%	713.0	677.4	25	1998	2023
2	Gheco-One Co., Ltd	IPP	Coal	-	65.00%	660.0	429.0	25	2012	2037
3	Glow Energy Co-Gen (Phase 2) - extension	SPP	Natural Gas	-	100.00%	120.0	120.0	333	2017	2020

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
4	Glow SPP 1	SPP	Natural Gas	-	100.00%	110.0	110.0	23	1998	2021
5	Glow SPP 2	SPP	Natural Gas	-	100.00%	120.0	120.0	25	1999	2024
6	Glow Energy Phase 4	SPP	Natural Gas	-	100.00%	74.0	74.0	32	2005	2037
7	Glow SPP 11 Phase 1 plant (formerly known as Glow SPP 11 plant)	SPP	Natural Gas	-	100.00%	90.0	90.0	25	2000	2025
8	Glow SPP 11 Phase 2 plant (formerly known as Glow SPP 12 plant)	SPP	Natural Gas	-	100.00%	90.0	90.0	25	2012	2037
9	Glow SPP 3	SPP	Bituminous Coal	-	100.00%	180.0	180.0	25	2000	2025
<i>Total Contracted Power Generation Capacity in Operation</i>						2,157.0	1,890.4			
Projects Under Construction										
1	SPP Replacement (Phase 1) – Replacing Glow Energy Phase 2 and SPP 1	SPP	Natural Gas	-	100.00%	120.0	120.0	25	2020-2021	2045-2046
<i>Total Contracted Power Generation Capacity Under Construction</i>						120.0	120.0			
Total Contracted Power Generation Capacity						2,277.0	2,010.4			
EGCO										
1	Khanom Electricity Generating Company Limited (KEGCO) 4 Project (KN4)	IPP	Natural Gas or Fuel Oil	-	100.00%	930.0	930.0	25	2016	2041

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
2	GPG	IPP	Natural Gas	JPHT (49.00%)	50.00%	1,468.0	734.0	25	Unit 1: 2007 Unit 2: 2008	Unit 1: 2032 Unit 2: 2033
3	BLCP Power Limited	IPP	Bituminous Coal	Banpu Power (50.00%)	50.00%	1,346.5	673.3	25	Unit 1: 2006 Unit 2: 2007	Unit 1: 2031 Unit 2: 2032
4	EGCO Cogen	SPP	Natural Gas	JPHT (20.00%)	80.00%	60.0	48.0	21	2003	2024
5	Roi-Et Green	SPP	Biomass	JPHT (24.70%)	70.30%	8.8	6.2	21	2003	2024
6	GCC	SPP	Natural Gas	JPHT (49.00%)	50.00%	90.0	45.0	21	1998	2019
7	SCC	SPP	Natural Gas	JPHT (49.00%)	50.00%	90.0	45.0	21	1999	2020
8	NKCC	SPP	Natural Gas	JPHT (49.00%)	50.00%	90.0	45.0	21	2000	2021
9	Gulf Yala Green Co., Ltd.	SPP	Biomass	JPHT (49.00%)	50.00%	20.0	10.0	25	2006	2031
10	Natural Energy Development Company Limited (NED)	SPP	Solar	CLP (33.33%)	66.67%	55.0	36.7	5	2011	2016
11	Chaiyaphum Wind Farm Co., Ltd.	SPP	Wind	PVI Group (10.00%)	90.00%	80.0	72.0	5	2016	2021
12	Klongluang Utilities Co., Ltd (TJ Cogen)	SPP	Natural Gas	-	100.0%	90.0	90.0	25	2017	2042

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
Total Contracted Power Generation Capacity in Operation						4,328.3	2,735.1			
Projects Under Construction										
1	Banpong Utilities Co., Ltd (TP & SK Cogen)	SPP	Natural Gas	-	100.0%	90.0	90.0	25	2017	2042
Total Contracted Power Generation Capacity Under Construction						90.0	90.0			
Total Contracted Power Generation Capacity						4,418.5	2,825.1			
GPSC ⁽⁸⁾										
1	GPSC Sriracha	IPP	Natural Gas	-	100.00%	700.0	700.0	25	2000	2025
2	RPCL	IPP	Natural Gas	RATCH (25.00%)	15.00%	1,400.0	210.0	25	2008	2033
3	Bangpa-in Cogeneration Company Limited (Project 1)	SPP	Natural Gas	-	25.00%	90.0	22.5	25	2013	2038
4	Central Utility Plant (CUP-1)	SPP	Natural Gas	-	100.00%	40.0	40.0	15	2006	2021++
5	Central Utility Plant (CUP-2)	SPP	Natural Gas	-	100.00%	60.0	60.0	15	2008	2022++
6	NNEG	SPP	Natural Gas	RATCH (40.00%)	30.00%	90.0	27.0	25	2016	2041
7	Bangpa-in Cogeneration Company Limited (Project-2)	SPP	Natural Gas	-	25.00%	90.0	22.5	25	2017	2042
Total Contracted Power Generation Capacity in Operation						2,470.0	1,082.0			

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
Projects Under Construction										
1	IRPC-CP (Phase 2)	SPP	Natural Gas, Coal, Bunker Oil	-	51.00%	180.0	91.8	25-27	2017	2044
Total Contracted Power Generation Capacity Under Construction						180.0	91.8			
Total Contracted Power Generation Capacity						2,650.0	1,173.8			
B.Grimm ⁽⁹⁾										
1	Amata B.Grimm Power 1 Limited	SPP	Natural Gas	-	15.30%	90.0	13.8	25	1998	2023
2	Amata B.Grimm Power 2 Limited	SPP	Natural Gas	-	15.30%	90.0	13.8	25	2001	2026
3	Amata B.Grimm Power 3 Limited	SPP	Natural Gas	-	60.70%	90.0	54.6	25	2012	2037
4	Amata B.Grimm Power 4 Limited	SPP	Natural Gas	-	55.50%	90.0	50.0	25	2015	2040
5	Amata B.Grimm Power 5 Limited	SPP	Natural Gas	-	55.50%	90.0	50.0	25	2015	2040
6	Amata B.Grimm Power (Rayong) 1 Limited	SPP	Natural Gas	-	61.70%	90.0	55.5	25	2013	2038
7	Amata B.Grimm Power (Rayong) 2 Limited	SPP	Natural Gas	-	61.70%	90.0	55.5	25	2013	2038
8	B.Grimm Power (Laem Chabang) 1 Limited	SPP	Natural Gas	-	100.00%	60.0	60.0	25	2001	2026

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
9	B.Grimm BIP Power 1 Limited	SPP	Natural Gas	-	74.00%	90.0	66.6	25	2015	2040
10	B.Grimm BIP Power 2 Limited	SPP	Natural Gas	-	74.00%	90.0	66.6	25	2015	2040
11	B.Grimm Power (WHA) 1 Limited	SPP	Natural Gas	-	75.00%	90.0	67.5	25	2016	2041
Total Contracted Power Generation Capacity in Operation						960.0	553.8			
Project Under Construction										
1	Amata B.Grimm Power (Rayong) 3 Limited	SPP	Natural Gas	-	55.50%	90.0	50.0	25	2018	2043
2	Amata B.Grimm Power (Rayong) 4 Limited	SPP	Natural Gas	-	55.50%	90.0	50.0	25	2018	2043
3	Amata B.Grimm Power (Rayong) 5 Limited	SPP	Natural Gas	-	55.50%	90.0	50.0	25	2018	2043
4	B.Grimm Power (Ratchaburi) 1 Limited	SPP	Natural Gas	-	100.00%	90.0	90.0	25	2021	2046
5	B.Grimm Power (Ratchaburi) 2 Limited	SPP	Natural Gas	-	100.00%	90.0	90.0	25	2021	2046
Total Contracted Power Generation Capacity Under Construction						450.0	329.9			
Total Contracted Power Generation Capacity						1,410.0	883.7			
BANPU										
1	BLCP Power	IPP	Bituminous Coal	EGCO (50.00%)	50.00%	1,346.5	673.3	25	Unit 1: 2006 Unit 2: 2007	Unit 1: 2031 Unit 2: 2032

No.	Power Plant	Type	Fuel Type	Power Producer JV Partner ⁽²⁾	Equity Stake (%)	September 30, 2017 ⁽³⁾		Power Purchase Agreement in Years	Commercial Operation Date (COD)	Commercial Operation End Date
						Contracted Power Generation Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)			
Total Contracted Power Generation Capacity in Operation						1,346.5	673.3			
Project Under Construction										
N/A										
Total Contracted Power Generation Capacity						1,346.5	673.3			

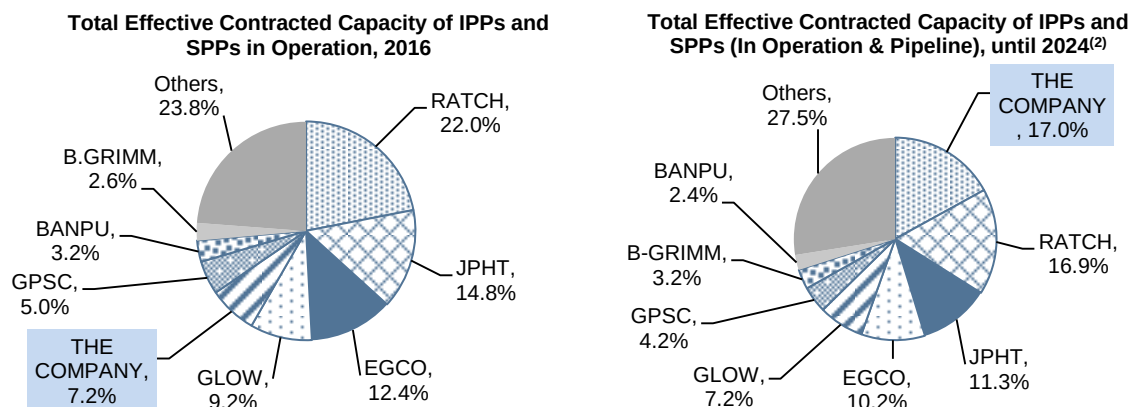
Note:

- (1) PPA Secured included Letter of Award from EGAT
- (2) Partnership (% owned) data provided for power generation players only
- (3) Contracted power generation capacity to EGAT as of September 30 2017 is as per confirmation by respective companies
- (4) GTS3 to commence in November 2017.
- (5) The Company's effective contracted power generation capacity reflected above for GSRC and GPD power plants is calculated based on the Company's equity stake in the GSRC and GPD plants of 51.00% as of September 30, 2017. On November 13, 2017, the Company increased its equity stake in these projects to 70.00%. Accordingly, as of that date, the Company's effective contracted power generation capacity for the GSRC and GPD power plants is 1,750.0MW and 1,750.0MW respectively.
- (6) The Company has received letter of award from EGAT for its Biomass SPP.
- (7) Four SPPs for GLOW namely Glow Energy Phase 5, Glow SPP 11 Phase 1 (formerly known as Glow SPP 11), Glow SPP 11 Phase 2 (formerly known as Glow SPP 12), Glow SPP 11 Phase 3 (formerly known as Glow SPP 13) and Glow SPP 11 Phase 3 expansion plant has no PPA secured with EGAT and only supply to Industrial Users.
- (8) For GPSC, IRPC Clean Power Co. Ltd (IRPC-CP) Phase 1 and Central Utility Plant (CUP-4) has no PPA secured with EGAT and only supply to Industrial User.
- (9) B.Grimm Power (Laem Chabang) 2 Limited has no PPA secured with EGAT and only supply to Industrial User.
- (10) The figures might not add up due to rounding.

Source: EGAT, Respective players' company profiles, Frost & Sullivan

1.4.2 Market Share and Ranking

Chart 1-26: Market Share⁽¹⁾ (%) of Key Private Power Generation Players with Interests in IPPs and SPPs Based on Effective Contracted Power Generation Capacity (MW) with PPA secured in Thailand



Note:

- (1) The numbers might not add up to 100.0% due to rounding.
- (2) Market share figures are calculated based on ownership interests and contracted capacities as of September 30, 2017. Accordingly, these calculations do not reflect the Company's increased equity stake in the GSRC and GPD power plants as of November 13, 2017.

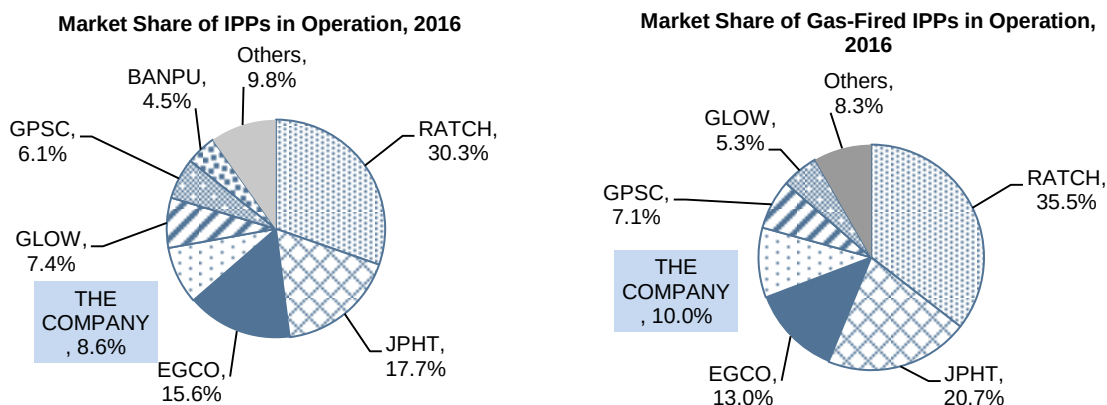
Source: EGAT, respective players' company profiles, Frost & Sullivan

The charts above showcase the total contracted power generation capacity of both IPPs and SPPs in operation and future pipeline of key players in Thailand. The contracted power generation capacity of IPPs and SPPs in operation is 21,294.0MW, while the total contracted generation capacity of IPPs and SPPs (both in operation and future pipeline) accounts for 27,789.0MW.

In terms of total effective contracted power generation power capacity of in operation IPPs and SPPs with PPA secured, RATCH leads with 22.0% (4,674.6MW), followed by JPHT with 14.8% (3,146.7MW) and EGCO with 12.4% (2,645.2MW) in 2016. Meanwhile, The Company is ranked fifth with 7.2% market share for IPPs and SPPs in operation. However, when taking into account the total capacity of IPPs and SPPs in operation and future pipeline with PPA secured, The Company ranked first with market share of 17.0% (4,723.6MW), with RATCH following in the second position with 16.9% (4,706.1MW) and JPHT in the third position with 11.3% (3,146.7MW).

On November 13, 2017, the Company increased its equity stake in the GSRC and GPD power plants to 70.00%. Accordingly, as of that date, the Company has an effective contracted power generation capacity of 5,673.6MW and effective capacity of gas-fired power projects in the pipeline of 3,998.2MW by December 31, 2024. Based on planned capacity pipeline and retirements of IPPs and SPPs from PDP 2015, Frost & Sullivan estimates Thailand's total IPP and SPP contracted power generation capacity to reach 27,789.0MW by December 31, 2024.

Chart 1-27: Market Share^{(1),(2)} (%) of Key Private Players with Interests in Gas-Fired⁽³⁾ IPPs Based on Effective Contracted Power Generation Capacity in Operation (MW) in Thailand, 2016



Note:

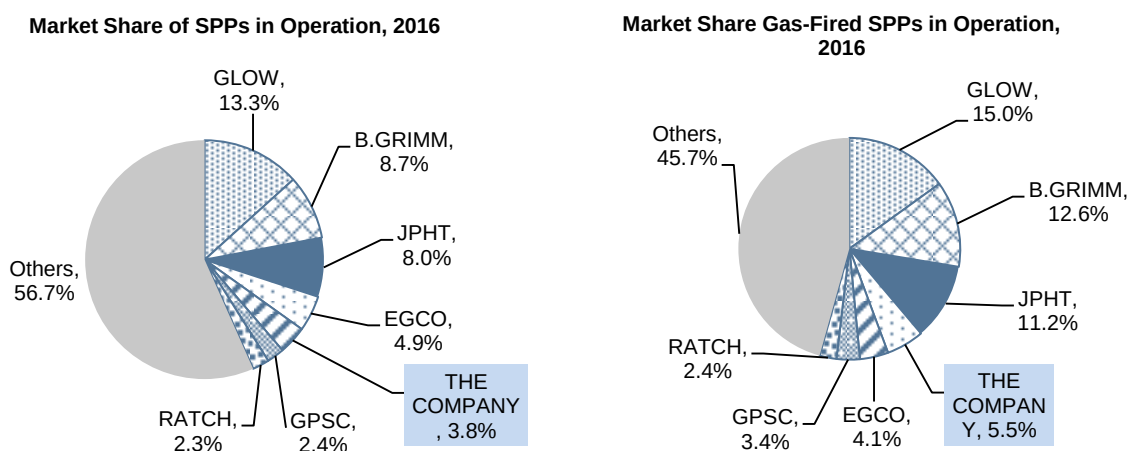
- (1) The numbers might not add up to 100.0% due to rounding.
- (2) Market share figures are calculated based on ownership interests and contracted capacities as of December 31, 2016. Accordingly, these calculations do not reflect the Company's increased equity stake in the GSRC and GPD power plants as of November 13, 2017.
- (3) Banpu and B.Grimm have no gas-fired IPPs available.

Source: EGAT, respective players' company profiles, Frost & Sullivan

According to EPPO, the total contracted power generation capacity of IPPs in operation with PPA secured of key industry players stood at 14,949.0MW in 2016. RATCH leads with 30.3% (4,530.6MW), followed by JPHT with 17.7% (2,639.3MW) and EGCO with 15.6% (2,337.3MW). Similarly, for the total effective capacity of gas-fired IPPs in operation, RATCH held the largest market share, followed by JPHT and EGCO.

The Company ranked fourth with 8.6% (1,280.0MW) market share in terms of effective contracted power generation capacity IPPs and has a 10.0% market share among gas-fired IPPs in operation.

Chart 1-28: Market Share^{(1),(2)} (%) of Key Private Players with Interests in Gas-Fired SPPs Based on Effective Contracted Power Generation Capacity in Operation (MW) in Thailand, 2016



Note:

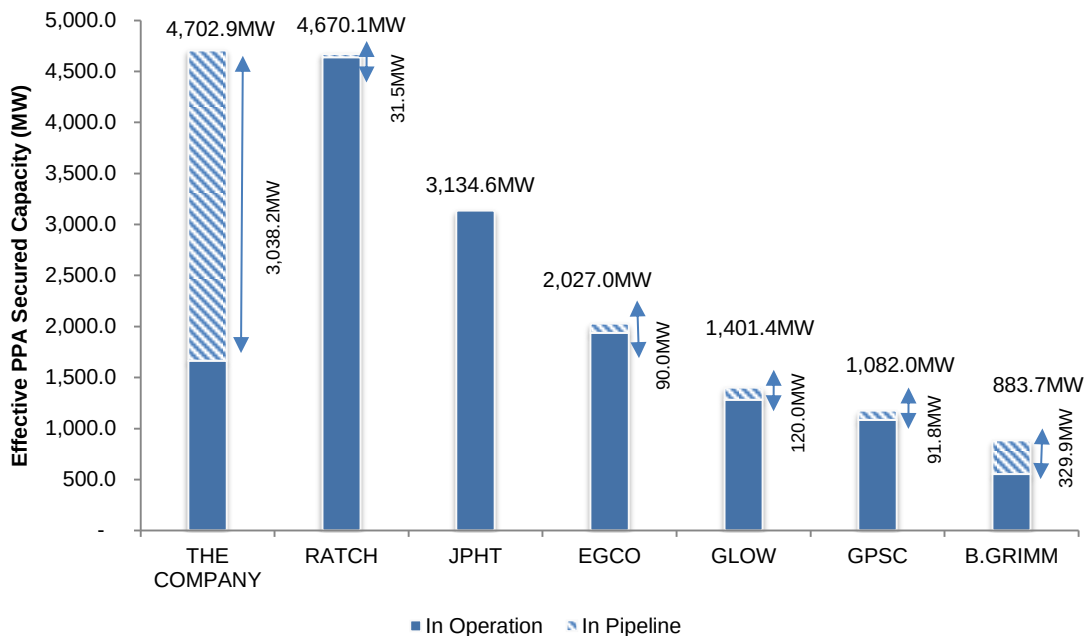
- (1) The numbers might not add up to 100.0% due to rounding.
- (2) Market share figures are calculated based on ownership interests and contracted capacities as of December 31, 2016.

Source: EGAT, respective players' company profiles, Frost & Sullivan

According to EPPO, total contracted power generation capacity of SPPs with PPA secured in operation was 6,345.0MW in 2016, while the total contracted power generation capacity of gas-fired SPPs in operation amounted to 4,412.0MW. In terms of effective capacity market share with PPA secured of key players in the SPPs industry, GLOW leads the market with 13.3% (SPPs in operation) and 15.0% (gas-fired SPPs in operation) of effective contracted power generation capacity market share, followed by B.Grimm with 8.7% (SPPs in operation) and 12.6% (gas-fired SPPs in operation) and JPHT with 8.0% (SPPs in operation) and 11.2% (gas-fired SPPs in operation).

The Company ranked sixth in terms of total SPPs in operation (3.8%) and fifth in terms of total gas-fired SPPs in operation (5.5%) in the same year.

Chart 1-29: Gas-Fired IPPs and SPPs Ranking (In Operation & Pipeline) Based on Effective Contracted Power Generation Capacity (MW) in Thailand, until 2024^{(1),(2)}



Notes:

- (1) On November 13, 2017, the Company increased its equity stake in the GSRC and GPD power plants to 70.00%. Accordingly, as of that date, the Company's effective contracted gas-fired power generation capacity is 5,653.0MW.
- (2) BANPU has no gas-fired power plant.

Source: EGAT, respective players' company profiles, Frost & Sullivan

The chart above illustrates the total effective contracted power generation capacity for in operation and future Gas-Fired IPPs and SPPs in Thailand until 2024. As of September 30, 2017, The Company has the largest effective PPA-secured contracted pipeline capacity for gas-fired plants of 3,038.2MW. This is followed by B.Grimm and Glow with 329.9MW and 120.0MW of pipeline capacity until 2024. Due to the strong pipeline with COD between 2017 and 2024 at a total effective contracted power generation capacity of 3,038.2MW in gas-fired power generation, Frost & Sullivan forecasts The Company to become the largest gas-fired power generation player

in Thailand based on a total effective contracted power generation capacity of 4,702.9MW by 2024. On November 13, 2017, the Company increased its equity stake in the GSRC and GPD power plants to 70.00%. Accordingly, as of that date, the Company remains the largest with 5,653.0MW of total effective contracted capacity in gas-fired power generation by 2024.

1.4.3 Competitive trends

Electricity generation in Thailand has been an appealing sector for investment with attractive investment incentives from the Thailand Board of Investment. Renewable projects approved for solar, wind, biomass and biogas are granted 8 years corporate income tax holiday⁵⁸. The finalization of PDP 2015 in April 2015 increased confidence for private companies in the power sector. A revised version of PDP 2015 is expected to be released to the public in mid-2017.

The total effective contracted power generation capacity of gas-fired power plants of major private players in the SEA regions totals at 47,923.7MW in 2016. Among the private players within the region, the Company ranked first with contracted power generation capacity of 4,702.9MW or effective market share of 10.3%. This is followed by RATCH with 10.2% or 4,670.1MW and China General Nuclear Power Corp with 9.8% or 4,459.5MW in the same year. Frost & Sullivan notes that the Company has the largest portfolio of power plants when compared to both operation and pipeline power plants within the SEA region.

Most key private players in Thailand are focusing on overseas operations in SEA countries. For example, RATCH has only an effective capacity of 35.0MW pipeline project in Thailand, compared to its effective capacity of 339.0MW of overseas pipeline projects. Similarly, EGCO and GPSC have higher project pipelines overseas with an effective capacity of 547.0MW and 347.0MW respectively as compared to their pipelines in Thailand. JPHT only has one coal-fired power plant in the pipeline with 680.0MW of effective capacity in Indonesia.

This indicates the Company remains positive in expanding their businesses in Thailand, and becoming the private power operator with the largest power project pipelines, in Thailand and the SEA region.

1.5 RELEVANT LAWS AND REGULATION

The Thailand power generation industry is mainly governed by three regulatory frameworks, namely the PDP 2015 – 2036, the AEDP 2012 – 2021 and EEDP 2011 – 2030.

PDP 2015 – 2036

The PDP 2015 was a revised version of PDP 2010, which outlines the future PDP in Thailand based on three principles:

- Security – To ensure the security of the power systems including power generation, T&D systems. A greater fuel diversification to be implemented to reduce the risk of heavy natural gas dependency.

⁵⁸ http://www.boi.go.th/index.php?page=pdf_page&menu_id=93

- Economy – To appropriately price electricity tariff to reflect the cost of energy. Slowdown of construction of new power plants and reduction of energy import to ensure efficient energy consumption.
- Ecology – To reduce and minimize environmental impact by reducing carbon dioxide emissions and promoting electricity production from renewable energy.

AEDP 2015 – 2036

The AEDP sets the framework to increase the renewable and alternative energy share by promoting the use of renewable energy such as solar, wind and biomass for power and heat generation. The AEDP 2015 is currently being updated from the AEDP 2012; however, the target of AEDP 2015 has been mentioned during the public hearing of the PDP 2015. The AEDP has an alternative energy generation target of 19,634.4MW in 2036, from approximately 7,490.4MW in 2014.

The focus of the AEDP will be revised to emphasize power generation from waste, biomass and biogas. The allocation of renewable energy generation capacity will depend on the energy demand in the region / province, as well as the energy potential of renewable energy sources that can be generated. Solar and wind power will be promoted at a later stage during the AEDP once the cost of generation is competitive when compared the gas-fired generation from LNG. The renewable energy consumption will be set as 20.0% target of final energy consumption in 2036.

EEDP 2011 – 2030

The EEDP was launched in 2011 to set short-term (2011 – 2015) and long-term (2011 – 2030) energy conservation target for specific energy consuming sectors such as industry, transportation, commercial and residential sector. Energy efficiency is important for raising energy security and lowering fuel imports.

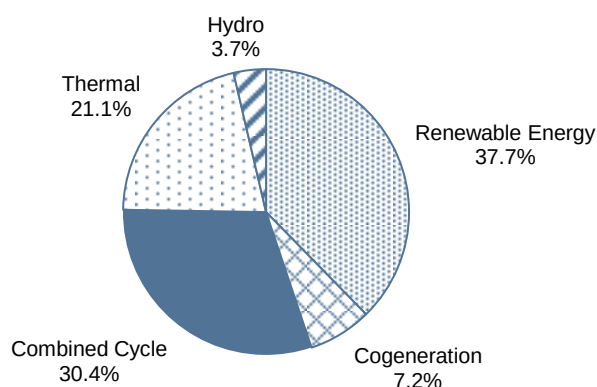
The EEDP outlined targets to reduce overall energy consumption by 20.0%, from 151 million tons of oil equivalent (“**mtoe**”), in the projected BAU case energy consumption in 2030, to 121 mtoe in the energy efficiency plan case.

1.6 OUTLOOK AND PROSPECTS

According to PDP 2015, electricity generation is forecasted to be 234,654.0GWh in 2021 with a CAGR of 3.3% from 199,566.9GWh in 2016 as reported by EPPO Energy Statistics. The growth in power generation is supported by additional contracted power generation capacity of 10,467.0MW from 2016 to 2021.

The development of AEDP 2015 – 2036 shows a clear direction set by the Thai government in encouraging the production of electricity from renewable energy sources. Besides, combined cycle power plant utilizing natural gas is expected to remain the most prominent fossil fuel based power generation plant with an additional contracted power generation capacity of 17,478.0MW or 30.4% of total additional contracted power generation capacity in Thailand. Thermal power generation represented 21.1% or 12,113.0MW of the new contracted power generation capacity respectively. Coal and lignite are expected to contribute 61.0% or 7,390.0MW as fuel sources for new thermal power plants.

Chart 1-30: Additional Contracted Power Generation Capacity by Type of Power Plant, Thailand, 2015 - 2036



Total Additional Contracted Power Generation Capacity 57,459.0MW

Note: Renewable energy consists of power purchase from neighboring country (9,543.0MW, 16.6%), solar power (4,400.0MW, 7.6%), biomass (3,487.0MW, 6.1%), wind power (2,554.0MW, 4.4%), energy crops (680.0MW, 1.2%), municipal solid waste (429.0MW, 0.8%), biogas (307.0MW, 0.5%), and hydroelectricity (278.0MW, 0.5%)

Source: PDP 2015

Although the contribution of natural gas in the overall contracted power generation capacity is likely to decline in the long run due to the increasing governmental emphasis on renewable energy and clean coal-fired technologies, it is likely to remain the dominant source of fuel for the power generation industry in Thailand. According to the PDP 2015, out of 326,119.0GWh of projected energy generation in Thailand in 2036, natural gas and LNG will remain the dominant source of power generation with share of 36.8% or 120,152.0GWh, which is 63.0% higher than lignite and imported coal with share of 22.6% or 73,706.0GWh, 105.4% higher than renewable sources with share of 17.9% or 58,499.0GWh, and 109.0% higher than hydro with share of 17.6% or 57,496.0GWh.

1.6.1 Country Attractiveness

Fuel Cost Pass-Through

Between 2015 and 2025, as outlined by the PDP 2015, it is estimated that EGAT will sign PPAs with 5 IPP projects amounting to a total contracted power generation capacity of 8,070.0MW⁵⁹. During the same period, 97 SPP projects are expected to be commissioned with a total contracted power generation capacity of 5,922.0MW, of which 41 projects will be new co-generation plant with total contracted power generation capacity of 3,660.0MW; 25 projects of renewal contracts for co-generation plant with total contracted power generation capacity of 424.0MW and 31 renewable energy projects with total contracted power generation capacity of 1,838.0MW.

⁵⁹ Includes replacement of Khanom Combined Cycle Unit 1 of 930.0MW contracted capacity in 2016

With these planned projects, Thailand remains an attractive country for private power producers. However, for projects that rely on imported natural gas and imported coal as fuel sources, there has been some concern regarding fuel cost fluctuation. Since 1991, the Automatic Adjustment Mechanism, that incorporates Automatic Fuel Adjustment (or F_A) was introduced to reflect actual costs of the tariffs and to reduce the impact of fuel price volatility on the power utilities' financial status. For private power producers, the risk of fluctuation of fuel prices is treated as pass-through from the private power producer to EGAT, MEA and PEA depending on the type of PPAs signed.

ASEAN Interconnectivity Projects⁶⁰

Thailand is strategically located to leverage electricity imports as well as the currently established or future development of transmission infrastructure in the neighboring countries, such as Lao PDR, Myanmar, Cambodia, and Malaysia.

Lao PDR has the most extensive transmission network with 2,111.0MW existing and 6,062.0MW on-going capacity on the Roi Et 2 – Nam Theun 2 and Sakon Nakhon 2 – Thakhek – Then Hinboun. It is estimated that the future expansion of the interconnected transmission network with a capacity of 2,465.0MW will be added between 2015 and 2023.

Between Thailand and Myanmar, there is a provision to connect the electricity transmission networks. The interconnection is estimated to have a capacity of between 11,709.0MW and 14,860.0MW and to be commissioned between 2018 and 2026.

Thailand and Cambodia have an existing interconnection of 100.0MW capacity for electricity export from Thailand to Cambodia. An estimated of 2,200.0MW interconnected transmission network will be added beyond 2020.

Between Thailand and Malaysia, there have been existing transmission lines, which connect Sadao – Bukit Keteri and Khlong Ngae – Gurun. There are plans for further connection expansion for the interconnection of Khlong Ngae – Gurun, which has a capacity of 300.0MW and has been commissioned in 2016.

With this planned interconnection of transmission networks in Thailand with its neighboring countries in the Association of Southeast Asian Nations (“**ASEAN**”), Thailand remains attractive for potential investment and expansion in the regional power sector.

⁶⁰ ASEAN Power Grids Interconnection Projects for Energy Efficiency and Security of Supply, retrieved from http://www.carecprogram.org/uploads/events/2014/Regional-Energy-Trade-Workshop/Presentation-Materials/009_104_209_Session3-3.pdf

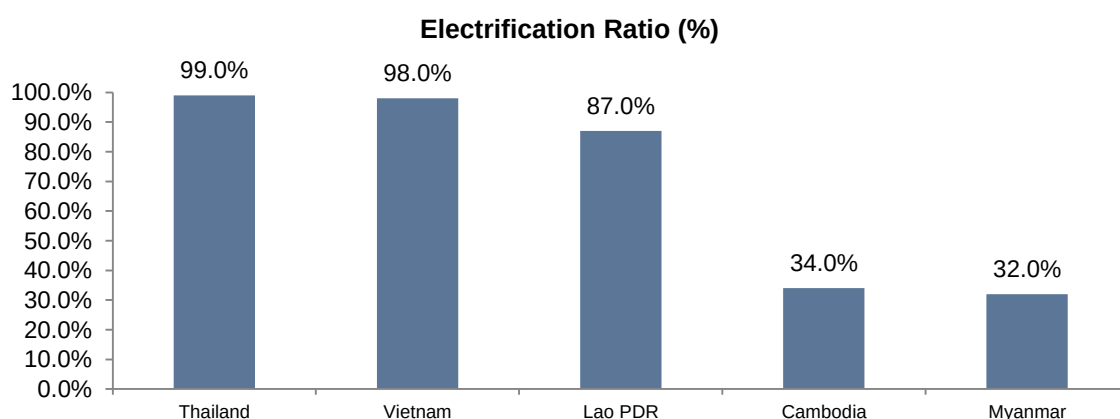
2 OVERVIEW OF THE POWER GENERATION INDUSTRY IN CAMBODIA, LAO PDR, MYANMAR, VIETNAM (“CLMV”) REGION

2.1 BACKGROUND OF THE POWER GENERATION INDUSTRY

Robust economic development has accelerated the demand for electricity in the CLMV region. Moreover, access to continuous and reliable electricity supply has become an indispensable factor for households and businesses. As the region continues to grow in urbanization rate, population and electrification ratio, the power sectors in these countries are expected to continue expanding. Huge reserves of gas in Myanmar and Vietnam (cumulatively amount to 1.8 trillion cubic meters as of 2016) have increased the dominance of gas-fired power plants in these countries. In addition to gas-fired power plants, Cambodia and Vietnam also generate the bulk of their power (about 47.4% and 32.5% respectively as of 2015) through coal-fired power plants. Furthermore, Myanmar and Vietnam alongside Cambodia and Lao People's Democratic Republic (“**Lao PDR**”) also generate power through hydroelectricity using abundant water resource from the Mekong River (Cambodia, Lao PDR and Vietnam) and Salween River (Myanmar). Both utility companies and IPPs in the CLMV region have invested heavily in combined cycle gas turbine power plants, coal-fired power plants, and hydroelectricity dams and this trend is expected to continue towards 2020.

As of 2016, countries such as Thailand, Vietnam and Lao PDR enjoy relatively higher electrification ratio of 99.0%, 98.0% and 87.0% respectively, compared to Cambodia and Myanmar at only 34.0% and 32.0% respectively. The lower electrification ratio in Cambodia and Myanmar is largely due to topographical issues⁶¹. These countries face power blackouts and brownouts and rely on other power generation technologies especially diesel generator sets to meet their electricity needs.

Chart 2-1: Electricity Access in Thailand and the CLMV Region, 2016



Source: International Energy Agency (“**IEA**”), *World Energy Outlook 2016*

⁶¹ Topography of land determines the cost of expanding national grids in a country. To build grids in mountainous areas is more expensive. For example, Myanmar has the lowest electrification ratio among CLMV countries as certain areas in the country are not suited for grid electricity.

Table 2-1: Long-term Load / Power Demand Forecast, Thailand & CLMV, 2012 –2021

Country	Power demand (peak load) forecast	CAGR (2012 - 2021)
Thailand	From 26,418M.3W in 2012 to 35,775.0MW in 2021	3.4%
Cambodia	From 574.0MW in 2012 to 1,538.0MW in 2021	11.6%
Lao PDR	From 614.0MW in 2012 to 2,996.6MW in 2021	19.3%
Myanmar	From 1,730.0MW in 2012 to 4,180.0MW in 2021	10.3%
Vietnam	From 18,603.0MW in 2012 to 45,685.2MW in 2021	10.5%

Source: Ministry of Mines and Energy of Cambodia, Vietnam's Revised Power Master Plan VII 2011 - 2020 with vision to 2030 and Vietnam Electricity ("EVN"), Thailand's PDP 2015, Electricity Demand Forecast and Supply 2016-2030 by Ministry of Energy and Mines of Lao PDR, Myanmar Energy Master Plan 2015

Thailand and the CLMV countries are also part of the ASEAN community taking part in the ASEAN Plan of Action for Energy Cooperation ("APAEC") 2016-2025. The AEC that was formed in 2007 acknowledged the critical role played by energy and wanted to expedite the development of the APG⁶². The APG aims to initiate multilateral electricity trade in at least one sub-region⁶³ by 2018, and eventually to a total integrated Southeast Asia power grid system post-2020. It is projected that power exchange and purchase in the region will greatly increase from 3,489.0MW in 2014 to 10,800.0MW in 2020⁶⁴, and further increase to 16,000.0MW post-2020 through these interconnection projects. Another initiative of APAEC is Trans-SEA Gas Pipeline ("TAGP") that aims at enhancing connectivity for energy security and accessibility via pipelines and regasification terminals. Fueled by demand from the growing regional economy, demand for natural gas in the region is projected to grow from 14.5 billion standard cubic feet per day ("scfd") in 2013 to 23 billion scfd by 2035. These two major initiatives would optimize the region's energy resources for greater security and provide suitable opportunities for private sector investments in the areas of financing and technology transfer.

Besides these two initiatives, the AEC encourages coordination and participation from member countries in several other areas of energy including coal and clean coal technology, renewable energy, energy efficiency and conservation measures, regional energy policy and planning as well as the feasibility of adopting civilian nuclear energy.

⁶² An initiative to construct a regional power interconnection to connect the ASEAN region to enhance electricity trade across borders to meet the rising electricity demand and improve access to energy services in the region

⁶³ Refers to Northern Sub system (Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam), Southern Sub System (Indonesia, Malaysia, and Singapore) and eastern Sub System (Brunei Darussalam, Indonesia, Malaysia, and Philippines)

⁶⁴ APAEC 2016 – 2025

2.2 DEMOGRAPHIC AND SOCIO-ECONOMIC TRENDS

2.2.1 Macroeconomic Overview of CLMV

The regional economic cooperation between Cambodia, Myanmar, Lao PDR and Vietnam was conceptualized by the Asian Development Bank (“ADB”) in 1992 after decades of instability within the region. It was a momentous event that marked the beginning of geo-political stability which was expected to enhance prospects of foreign direct investment in the region. CLMV are high growth emerging markets within ASEAN. According to ADB, CLMV is gradually shifting from agricultural to more diversified economies, and to more open, market-based systems. The process of modernization and industrialization in these countries has led to the strengthening regional and trade relationships in terms of investment, cross-border trade and labor mobility.

Cambodia

Cambodia is moving towards becoming one of the new growth economies in Asia after decades of internal conflict and poverty⁶⁵. Its nominal GDP grew at a CAGR of 8.2% from USD14.1 billion in 2012 to USD17.8 billion in 2015. The supply of inexpensive, low-skilled labor in Cambodia has attracted foreign direct investment into the country, particularly for the production of garments and footwear for export, which in addition to the construction and services sectors are the main drivers of the economy. Growth is expected to remain strong in 2016 with recovering domestic demand and dynamic garment exports offsetting slower growth in tourism and stagnation in agriculture. Cambodia’s nominal GDP is forecasted to grow from USD19.4 billion in 2016 to USD29.1 billion in 2021 at a CAGR of 8.5%.

Lao PDR

The nominal GDP of Lao PDR has grown from USD9.4 billion in 2012 to USD12.6 billion in 2015 at a CAGR of 10.1%. The country’s real GDP growth averaged 7.0% over the past decade with increasing use of the country’s natural resources, such as water, minerals and forestry. Construction and services also expanded in line with growing regional integration attracting foreign investment and tourists. Expansions in the services, construction, electricity generation and manufacturing sectors have sustained solid recent economic growth in Lao PDR. Moving forward, Lao’s nominal GDP is expected to grow at a CAGR of 9.0% from 2016 to 2021 with electricity exports, construction and services sectors as the main pillars of growth. In addition, according to ADB, Lao PDR is on track to upgrade from the least-developed country to developing country status by 2020.

Myanmar

Myanmar is an emerging economy with its nominal GDP fluctuating between USD59.7 billion in 2012 and USD59.5 billion in 2015 with a decreasing CAGR trend of 0.1%. In 2011, the Burmese government embarked on fundamental policy reforms including anti-corruption, liberalizing its foreign exchange rules to adopt managed float exchange rate system, introducing new foreign investment laws and undergoing tax reformation policies to encourage investments to accelerate economic growth. With the reforms, investors’ confidence in Myanmar has increased, as evident

⁶⁵ ADB

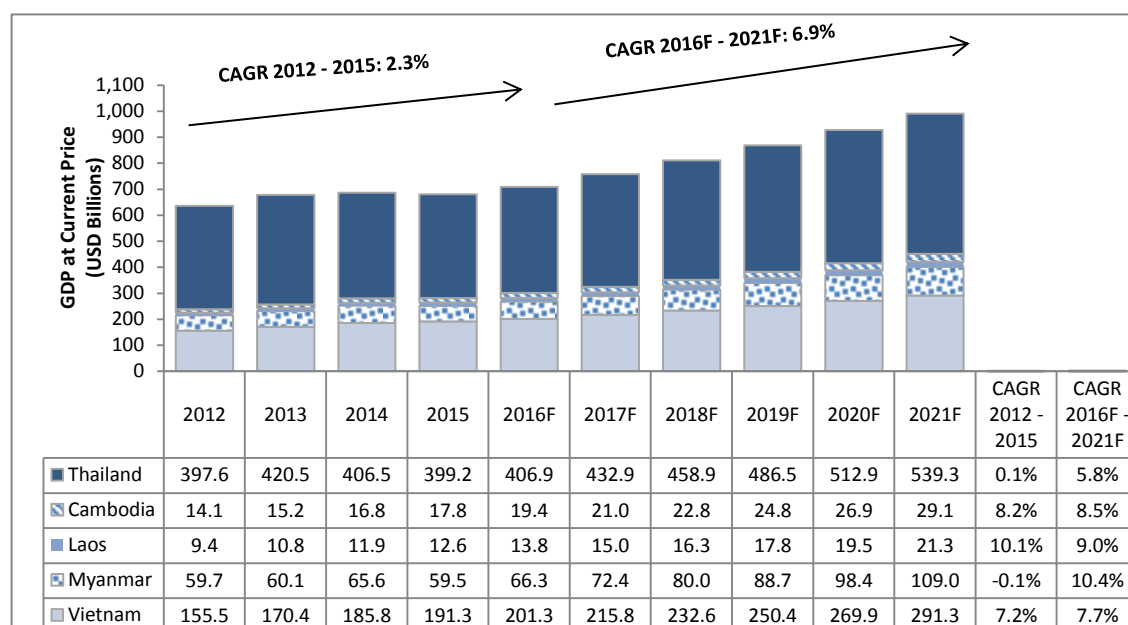
from foreign direct investments increasing from USD901 million in 2010 to USD1.4 billion in 2014 at a CAGR of 11.7%⁶⁶.

Despite severe flooding in 2015 resulting in an estimated economic cost of USD1.5 billion, Myanmar's economy performed well in the year with economic reforms supporting improved consumer and investor confidence. The service sector was the main driver of growth in line with expansion in telecommunications and transportation. The nominal GDP of Myanmar is expected to reach USD109.0 billion in 2021 from USD66.3 billion in 2016 at a CAGR of 10.4%.

Vietnam

Vietnam's nominal GDP has grown at a robust pace, from USD155.5 billion in 2012 to USD191.3 billion in 2015 at a CAGR of 7.2%. Since the political and economic reforms in 1986, Vietnam has transformed from one of the lowest income countries in the world to a country of lower middle-income status with income per capita of USD2,088 by the end of 2015. The services sector is estimated to contribute 43.7% of the GDP in 2015, while industrial activities, such as food processing, garment and shoes manufacturing and mining contributed to 38.8% of GDP during the same year. The remaining 17.4% of the GDP was contributed by the agriculture industry including products such as rice, coffee, rubber and tea. Expansion in manufacturing and construction sectors, as well as strong foreign direct investments, are expected to support the growth of Vietnam's nominal GDP from USD201.3 billion in 2016 to USD291.3 billion in 2021 at a CAGR of 7.7%.

Chart 2-2: Nominal GDP in Thailand and CLMV (USD billion), 2012 – 2021F

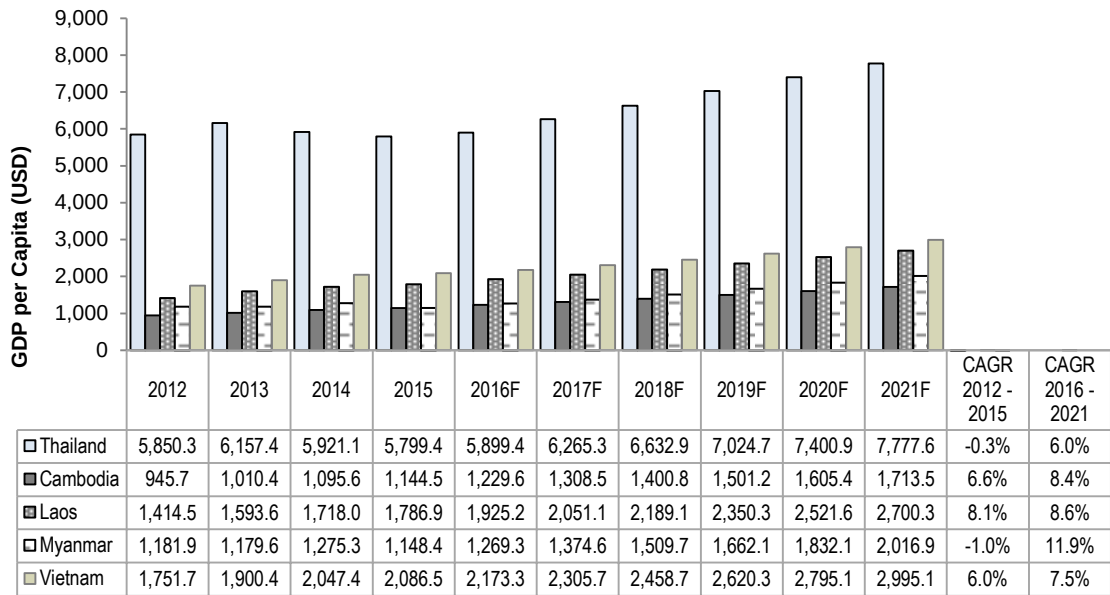


Note: Figures for Thailand, Lao PDR, Myanmar and Vietnam are estimated after 2016; Figures for Cambodia are estimated after 2013.

Source: IMF; Frost & Sullivan

⁶⁶ Independent UK

Chart 2-3: GDP per Capita at Current Prices in Thailand and CLMV (USD), 2010 – 2021F



Note: Figures for Lao PDR are estimated after 2016; Figures for Thailand and Myanmar are estimated after 2015; Figures for Vietnam are estimated after 2014; Figures for Cambodia are estimated after 2012.

Source: IMF; Frost & Sullivan

2.2.2 Population Overview of CLMV

CLMV have maintained a stable population growth in the past five years, with its total population growing from 160.8 million in 2012 to 166.1 million in 2015 at a CAGR of 1.1% while the total population in CLMV is expected to grow to 176.3 million at a CAGR of 1.0% by 2021.

Table 2-2: Population Growth Trends in Thailand and CLMV (million), 2012 – 2021F

Year	Thailand	Cambodia	Lao PDR	Myanmar	Vietnam
2012	68.0	14.9	6.6	50.5	88.8
2013	68.3	15.1	6.8	51.0	89.7
2014	68.7	15.3	6.9	51.4	90.7
2015	68.8	15.5	7.0	51.8	91.7
2016F	69.0	15.8	7.2	52.3	92.6
2017F	69.1	16.0	7.3	52.6	93.6
2018F	69.2	16.3	7.4	53.0	94.6
2019F	69.3	16.5	7.6	53.4	95.6
2020F	69.3	16.7	7.7	53.7	96.6
2021F	69.3	17.0	7.9	54.1	97.3
CAGR (2012 – 2015)	0.4%	1.5%	1.9%	0.9%	1.1%
CAGR (2016 – 2021)	0.1%	1.5%	1.9%	0.7%	1.0%

Note: Figures for Lao PDR are estimated after 2016; Figures for Thailand and Myanmar are estimated after 2015; Figures for Vietnam are estimated after 2014; Figures for Cambodia are estimated after 2012.

Source: IMF; Frost & Sullivan

2.3 ELECTRICITY CONSUMPTION TRENDS

Table 1-2-3: Selected Asian Economies: Real Gross Domestic Product (“GDP”) Growth, in National Currency (Annual percent change)

	Real GDP Growth (%)						
	2015	2016	2017	2018	2019	2020	2021
Advanced Asia							
Japan	1.2	1.0	1.2	0.6	0.8	0.2	0.7
Korea	2.8	2.8	2.7	2.8	3.0	3.0	3.1
Australia	2.4	2.5	3.1	3.0	2.9	2.8	2.8
Taiwan Province of China ⁽¹⁾	0.7	1.4	1.7	1.9	2.0	2.3	2.5
Hong Kong SAR	2.4	1.9	2.4	2.5	2.7	2.9	3.1
Singapore	1.9	2.0	2.2	2.6	2.6	2.6	2.6
New Zealand	3.1	4.0	3.1	2.9	2.6	2.6	2.6
Emerging and Developing Asia							
China	6.9	6.7	6.6	6.2	6.0	5.9	5.8
India ⁽²⁾	7.9	6.8	7.2	7.7	7.8	7.9	8.1
ASEAN							
Indonesia	4.9	5.0	5.1	5.3	5.4	5.5	5.5
Thailand	2.9	3.2	3.0	3.3	3.2	3.1	3.0
Malaysia	5.0	4.2	4.5	4.7	4.9	4.9	4.8
Philippines	5.9	6.8	6.8	6.9	7.0	7.0	7.0
CLMV							
Cambodia ⁽³⁾	7.0	7.0	6.9	6.8	6.8	6.5	6.3
Lao PDR	7.5	6.9	6.8	6.7	7.0	6.9	7.0
Myanmar	7.3	6.3	7.5	7.6	7.5	7.5	7.5
Vietnam	6.7	6.2	6.5	6.3	6.2	6.2	6.2
Emerging & Developing Asia	6.7	6.4	6.4	6.4	6.3	6.3	6.3

Note:

(1) Figures for Taiwan Province of China are estimated after 2015.

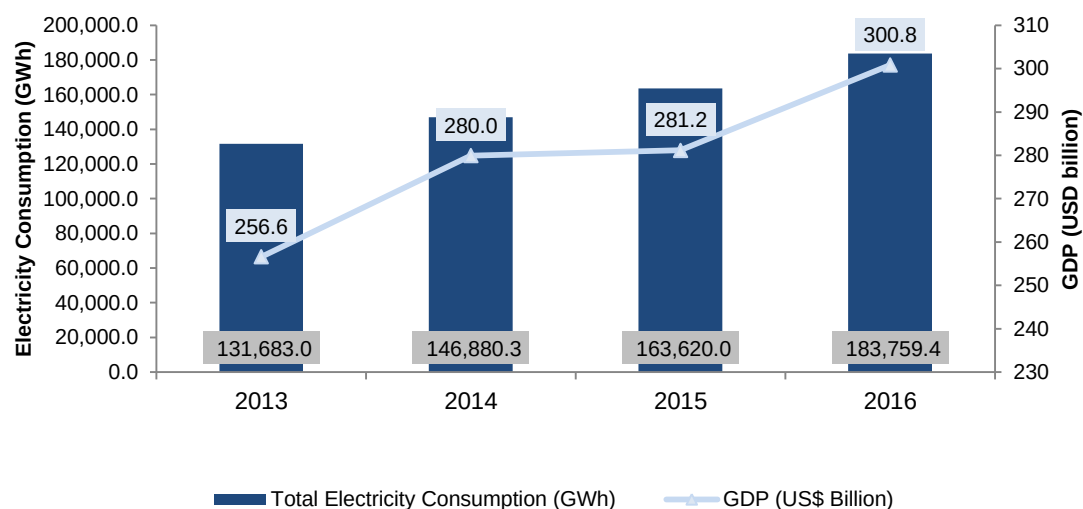
(2) Figures for India are estimated after 2017.

(3) Figures for Cambodia are estimated after 2013.

(4) The remaining country figures are estimated after 2016.

Source: Extracted from the World Economic Outlook April 2017: Subdued Demand Symptoms and Remedies, IMF

Chart 2-4: Historical GDP (in US\$ Billion) and Total Electricity Consumption (in GWh), CLMV, 2013-2016F



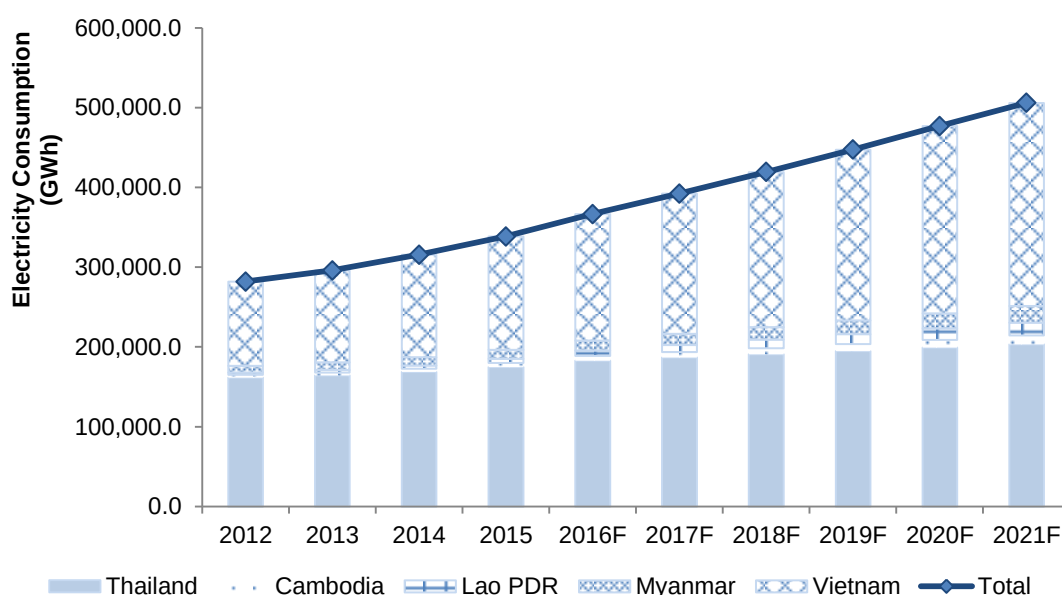
Note: GDP is at current prices.

Source: GDP data extracted from IMF and Electricity Consumption data from Ministry of Mines and Energy of Cambodia, Vietnam's Revised Power Master Plan VII 2011 - 2020 with vision to 2030, Energy Policy and Planning Office, Ministry of Energy Thailand, Electricity Demand Forecast and Supply 2016-2030 by Ministry of Energy and Mines of Lao PDR, Ministry of Electric Power ("MOEP"), Myanmar, Myanmar Energy Master Plan 2015, Frost & Sullivan Analysis

The economic development of the CLMV countries is the biggest driver for rising electricity consumption in the region. In addition, expected power market reforms and investments in extending the power grid (in Vietnam, Cambodia and Myanmar to increase national electrification ratios) are likely to fuel the growth of electricity consumption in the CLMV region. Electricity consumption, power infrastructure expansion and modernization are crucial components of a country's economic development. Apart from domestic private investment, the expected continuous inflow of foreign direct investment ("FDI") into the region and the establishment of business operations by foreign companies, are likely to spur industrial and commercial development. The provision of reliable and stable power is expected to attract new enterprises to expand into the region.

Frost & Sullivan estimates that electricity consumption in the CLMV countries is expected to grow at a CAGR of 10.5% from an estimated 183,759.4GWh in 2016 to 302,521.1GWh in 2021. The CLMV countries are among the fastest growing countries for electricity consumption within the South East Asian region during the period driven by accelerating urbanization and economic development.

Chart 2-5: Historical and Projected Total Electricity Consumption (GWh), Thailand and CLMV, 2012–2021F



Note:

(1) 2014 actual data for Cambodia, Lao PDR, Vietnam, and Thailand; estimates for Myanmar

(2) 2015 actual data for Thailand and Cambodia; forecasts for Lao PDR, Vietnam, and Myanmar

Source: For Thailand: Historical numbers 2012-2016 taken from Energy Policy and Planning Office, Ministry of Energy Thailand. For Cambodia: Historical numbers 2012-2015 taken from Electricity Authority of Cambodia. For Lao PDR: Historical numbers 2012-2014 taken from Department of Energy Policy and Planning, Ministry of Energy and Mines. For Myanmar: Historical numbers 2012-2013 taken from National Energy Management Committee of Myanmar. For Vietnam: Historical numbers 2012-2014 taken from Ministry of Industry and Trade, General Directorate of Energy, Frost & Sullivan Analysis

Table 2-4: Historical and Projected Total Electricity Consumption (GWh), Thailand and CLMV, 2012–2021F

Year	Electricity Consumption (GWh)					
	Lao PDR	Vietnam	Myanmar	Cambodia	Total CLMV	Thailand
2012	3,074.9	105,474.0	8,207.0	3,314.0	120,069.9	161,779.0
2013	3,381.0	115,069.0	9,613.0	3,620.0	131,683.0	164,341.1
2014 ⁽¹⁾	3,791.3	128,434.0	10,411.0	4,244.0	146,880.3	168,685.4
2015 ⁽²⁾	5,213.0	141,800.0	11,209.0	5,398.0	163,620.0	174,833.1
2016F	6,789.0	158,394.0	12,475.5	6,100.9	183,759.4	182,847.4
2017F	8,445.0	175,901.0	13,885.1	6,895.4	205,526.5	186,798.5
2018F	10,857.0	194,393.0	15,454.0	7,793.3	228,497.3	190,833.4
2019F	12,531.0	213,966.0	17,088.9	8,808.1	252,394.0	194,955.4
2020F	14,378.0	234,558.0	18,896.8	9,955.1	277,787.9	199,166.4

Year	Electricity Consumption (GWh)					
	Lao PDR	Vietnam	Myanmar	Cambodia	Total CLMV	Thailand
2021F	15,937.0	254,436.7	20,896.0	11,251.4	302,521.1	203,468.4
CAGR 2012-2015E	19.2%	10.4%	1.0%	17.7%	10.9%	2.6%
CAGR 2016F-2021F	18.6%	9.9%	10.9%	13.0%	10.5%	2.2%

Note:

(3) 2014 actual data for Cambodia, Lao PDR, Vietnam, and Thailand; estimates for Myanmar

(4) 2015 actual data for Thailand and Cambodia; forecasts for Lao PDR, Vietnam, and Myanmar

Source: For Cambodia: Historical numbers 2012-2015 taken from Electricity Authority of Cambodia. For Lao PDR: Historical numbers 2012-2014 taken from Department of Energy Policy and Planning, Ministry of Energy and Mines. For Myanmar: Historical numbers 2012-2013 taken from National Energy Management Committee of Myanmar. For Vietnam: Historical numbers 2012-2014 taken from Ministry of Industry and Trade, General Directorate of Energy, Frost & Sullivan Analysis

Cambodia

Electricite du Cambodge (“**EDC**”) is a state-owned limited liability company under the Ministry of Mines and Energy responsible for generation, transmission and distribution of electricity throughout the country.

Cambodia electricity consumption grew at a CAGR of 16.5% from 3,314.0GWh in 2012 to 6,100.9GWh in 2016. Frost & Sullivan forecast that it will continue to increase from 6,895.4GWh in 2017 to 11,251.4GWh in 2021 at a CAGR of 13.0% with more commercial and industrial buildings are being constructed.

The country continues to import electricity from neighboring countries such as Vietnam, Thailand and Lao PDR during drought seasons when hydroelectricity generation declines due to lack of water supply. Nonetheless, the Cambodian government is planning for energy independence in the next two years⁶⁷ by increasing coal-fired power generation capacity. 28.0% of the electricity consumption in 2016 was imported, whilst the Cambodian government forecasted the 2017 import level to reduce to 25.0%. Hydroelectricity and coal-fired power generation are forecasted to be the dominant fuel sources by 2026⁶⁸. Similarly, domestic gas-fired generation is forecasted to be the third most important fuel source for power generation. By 2030, coal-fired power generation and hydroelectricity are cumulatively expected to account for 72.0%, followed by gas-fired power generation with 18.0% and others with 10.0%⁶⁹.

Lao PDR

Electricite du Lao PDR (“**EDL**”) is a state-owned corporation under the Ministry of Energy and Mines (“**MEM**”) which owns and operates the country’s main generation, T&D assets, and also manages electricity imports into its grids and exports from its stations. EDL also has a project

⁶⁷ The Council for the Development of Cambodia

⁶⁸ Mekong Strategic Partners

⁶⁹ Ministry of Industry and Trade

development role and has been the implementing agency for government-owned hydroelectricity projects. EDL usually takes over from the MEM the responsibility for a project once a shareholders' agreement is executed and the project loans for the development of the power plant are secured.⁷⁰

Based on EDL electricity consumption data, Lao PDR electricity consumption is expected to increase at a CAGR of 18.6% from 6,789.0GWh in 2016 to 15,937.0GWh in 2021 supported by the country's initiative to improve accessibility to reliable and stable electric power. Lao PDR's installed capacity is dominated by hydroelectricity plants as the country's hydroelectricity potential is estimated to be 26,000.0MW. However, as of 2014, only 2,994.0MW hydroelectricity generation capacity has been installed, of which 23.4% is used for the domestic market. The country is planning to increase its installed capacity by developing hydroelectricity projects by 2020. Upon completion, the majority of the capacity generated from these hydroelectricity plants is likely to be exported to neighboring countries, such as China (Yunnan province), Vietnam, Myanmar, Thailand and Cambodia. Lao PDR has agreed to export 7,000.0MW to Thailand and 5,000.0MW to Vietnam by 2020⁷¹. The hydroelectricity projects under construction are mostly developed by EDL in collaboration with foreign IPPs.

Hydroelectricity export revenues have played a key role in financing the projects under the national electrification program and the projects undertaken as a part of national power grid expansion initiative. Nevertheless, the country is keen to accelerate installed capacity additions for the domestic market, improve the electrification ratio and to meet the growing power demand.

Lao PDR has no reserve margin and is a net exporter of electricity to neighboring countries, such as Thailand, Vietnam, and China. Lao PDR has imported more electricity for its domestic consumption than exports since 2007.

Unlike its neighboring countries in ASEAN, Lao's power plants run almost entirely on hydroelectricity. As a result, the reserve margin in Lao PDR is volatile and dependent on seasonal factors. For example, Lao PDR's reserve margin can reach almost 30.0%⁷² during the rainy season from July to September. During the non-rainy season, Lao PDR mainly relies on imports of electricity for domestic consumption. Lao PDR intends to build up reserve margin capacity, but it largely depends on the planned number of projects getting completed. Upon completion of the Hongsa Power Plant, Lao PDR's dependence on power imports during the non-rainy season is likely to decline.

Myanmar

The electricity market in Myanmar is centralized, controlled and managed by MOEP which is responsible for developing, implementing, operating, and maintaining all large hydroelectricity and coal-fired thermal power plants. The Electricity Regulatory Commission authorized MOEP, region and state governments as well as leading bodies of self-administrated zones and divisions the power to grant permits to entities in the engagement of electricity works such as generation, transmission and distribution. This liberal policy encourages the growth of foreign and domestic investments in power projects.

⁷⁰ EDL

⁷¹ Lao PDR Country Report, Economic Research Institute for ASEAN and East Asia 2012-2019

⁷² Based on primary interviews conducted with EDL by Frost & Sullivan

Myanmar had a low per capita electricity consumption of 229.5kWh in 2016 due to low electrification ratio, moderate industrial development and lack of investments. Major cities such as Yangon which are relatively well electrified are also affected by frequent power blackouts and brownouts. Based on Myanmar Energy Master Plan released in 2015, Myanmar's electricity consumption is expected to increase from 12,475.5GWh in 2016 to 20,896.0GWh in 2021 at a CAGR of 10.9%. This is supported by the growing urbanization and industrialization efforts across the country such as the development of industrial complexes, mega city projects and housing projects.

The installed capacity in Myanmar has been on an increasing trend from 3,322.0MW in 2012 to 4,421.0MW in 2014. Myanmar Energy Master Plan released in 2015 highlights installed capacity to reach 15,281.0MW by 2030⁷³. The MOEP is undertaking a five-year project to supply electricity to rural and non-electrified areas mainly through power grid expansion. As Myanmar faces power shortages during the summer months due to the drying up of its dams, the MOEP is interested in inviting IPPs to develop thermal power projects which will provide additional power generation in the country. Private sector participation has been permitted in electricity generation in the form of IPPs for local investors and as Build-Operate-Transfer ("**BOT**") arrangements or joint ventures ("**JVs**") for foreign investors. Due to the liberalization of Myanmar electricity market, several regional players have expressed interest in building gas-fired power plants. In early 2017, Sembcorp Industries signed a BOT agreement with Ministry of Electricity and Energy of Myanmar to build and operate a gas-fired power plant for 22 years, before transferring ownership to the Lao government. Other than that, approximately 4 companies signed a PPA for two solar powered plants and two gas-fired plants to be built in Myanmar. In 2016, Myanmar unofficially adopted the PPA model, which was a game-changer to the local power generation market as it helps to provide a higher degree of uniformity in Myanmar's power purchase structure.

Vietnam

EVN is a state-owned power utility company under the Ministry of Energy responsible for the country's electrical power generation, transmission, and distribution business. It is also the sole off-taker of electricity produced by IPPs. The power generation market is currently dominated by the Vietnamese government through its SOE EVN, oil and gas company Petro Vietnam, and the mining company Vinacomin. The state accounts for 77.3% Vietnam's total installed capacity as of 2015.

Frost & Sullivan forecast Vietnam to register a high electricity consumption growth with CAGR of 9.9% from 158,394.0MW in 2016 to 254,436.7MW in 2021. The country has made remarkable progress in expanding electricity access to households and communities since 2001. Industry and construction sector is the largest consumer of electricity accounting for 53.7% of total consumption, followed by the administration and residential sector with a share of 35.1% in 2015. Demand for electricity is expected to be met with significant investment in coal-fired power plants.

Due to the uncertain environmental conditions such as droughts that are associated with hydroelectricity generation, the country has decided to reduce its reliance on hydroelectricity and pursue thermal power plants to meet its growing electricity demand.

⁷³ Based on planned power generation through hydroelectricity and coal at medium growth scenario

In October 2011, the Directorate General of Energy replaced Department of Energy in Vietnam, tasked with the responsibility of policy development, while the Electricity Regulatory Authority of Vietnam (“**ERAV**”) that functions under the supervision of the Ministry of Industry and Trade (“**MOIT**”) regulates electricity tariff, grants licenses and resolves disputes. ERAV manages the regulation of electricity-related activities to ensure stability, quality, and efficiency in the delivery of electricity. The clearer definition of roles and responsibility of the regulatory bodies are likely to boost investors’ confidence in the power generation sector. Electricity regulations in Vietnam are being revised by the ERAV to increase private sector participation.

In August 2016, the Vietnamese government approved a detailed design of a competitive power wholesale market. Between 2017 and 2018, Vietnam will undergo pilot phases of the wholesale competitive power market where sellers (power plants) and buyers (distributors and large consumers) will competitively transact in a power pool, unlike the current scenario where EVN is the sole buyer.⁷⁴ The competitive power wholesale market is scheduled to be implemented by 2019. Meanwhile, a competitive retail power market is likely to be implemented by 2021.

In 2016, EVN announced its plans to reduce natural gas supplies to power plants, which generate about 22.0% of Vietnam’s electricity. During the dry season, coal-fired plants took over hydroelectricity plants making it the largest source of electricity in Vietnam. Coal-fired plants are expected to generate 41.0% of total output, while natural gas is expected to be 28.0% of domestic power output in 2016.

2.3.1 Industry Drivers

Increasing Rate of Urbanization

Table 2-5: Urbanization Rate, countries in Thailand, CLMV and SEA, 2015, 2020 and 2050

Country	2015	2020	2050
Thailand	50.4%	56.0%	72.0%
Cambodia	20.7%	22.0%	36.0%
Lao PDR	38.6%	44.0%	61.0%
Myanmar	34.1%	37.0%	55.0%
Vietnam	33.6%	37.0%	54.0%

Source: Central Intelligence Agency (“CIA”), United Nations (“UN”), Department of Economic and Social Affairs, Population Division (2014). *World Urbanization Prospects: The 2014 Revision Database*

As the urbanization rate⁷⁵ in the CLMV countries increases, there is a growing need to satisfy the urban population’s energy demand. Demand for additional power generation capacity is acutely evident in emerging economies, such as Myanmar, Vietnam and Cambodia.

⁷⁴ Vietnam Breaking News, retrieved from <https://www.vietnambreakingnews.com/2017/02/ban-in-government-to-issue-power-market-rules/>

⁷⁵ Urbanization is calculated using the World Bank’s population estimates and urban ratios from the UN World Urbanization Prospects. Urbanization refers to the increase in the proportion of people living in towns and cities when a country is still developing. Increase in urbanization rates creates more demand for goods and services.

In Cambodia, the growth of electrification increased with the introduction of large-scale imports from Vietnam and building-out the rural sub-transmission grid. The Royal Government of Cambodia (“**RGC**”) targets 70.0% of rural households to have access to electricity by 2030 by scaling up the Solar Home System program throughout the country⁷⁶.

In Myanmar, the government is ramping up initiatives to provide electricity connections by using pre-electrification methods such as temporary mini-grids or off-grid solar home systems. The Burmese government envisages achieving approximately 47.0% electrification rate by 2020 and 100.00% electrification rate by 2030⁷⁷.

In Vietnam, the government introduced a renewable energy program that aims to electrify approximately 501,000 households across 48 provinces both on-grid and off-grid by 2020. The country achieved 98.0% electrification rate in 2016. Moreover, the program aims to improve existing households which have access to electricity but suffer from poor quality of electricity supply.

Similarly, in Lao PDR, the government implemented the Power to the Poor (“**P2P**”) program in 2008 to provide electricity to the poor and disadvantaged households. The pilot program has benefitted 537 households in the Champasak province. Eligible households⁷⁸ were provided with free meter and free interest credit amount of USD80 which can be repaid within three years. The outcome of the pilot project showed the electrification rate of the households increased rapidly from an average of 78.0% to 95.0%⁷⁹. The Lao government aims to achieve 98.0% electrification rate by 2030.

Liberalization of the Power Generation Market

Power shortages, tight reserve margins and power utility companies’ lack of cash reserves are driving the liberalization of power markets. As such, in encouraging private power producers to invest in the competitive power generation market, the majority of the CLMV countries are moving towards adopting a single off-taker model mainly to protect financiers of power generation projects from market risk and retail-level regulatory risk, whilst enabling investments to be commercially profitable. Nonetheless, the degree of competitiveness varies from country to country. In addition, governments are now more open to regional power integration and private sector participation in projects. The increasing pace of power sector liberalization presents a business expansion opportunity for power producers in the CLMV countries.

Abundant Availability of Natural Gas Reserves

The abundant availability of natural gas reserves in the CLMV countries, particularly Myanmar and Vietnam has enabled power plant operators to obtain fuel resources domestically and within the region.

Myanmar’s vast natural gas reserve is the key factor for the gas-fired power plants to become the major conventional fuel power generation technology in the country. Myanmar is also one of the

⁷⁶ The World Bank

⁷⁷ Myanmar National Electrification Project

⁷⁸ Non-eligible households consists of newly constructed homes which are located too far from the post or too poor to repay the micro-credit.

⁷⁹ World Bank, “Power to the Poor in Lao PDR brings electricity to (almost) all”

top five major energy exporters in the region, to supply natural gas in the region⁸⁰. Increasing production of natural gas in Myanmar and Central Asia is met by import demand from China. The completion of the Myanmar-China pipeline in 2013 enabled Myanmar to export approximately 12 billion cubic meters of natural gas annually to China⁸¹.

Similarly, Vietnam emerged as an important natural gas producer within the Southeast Asia region. As of 2015, the country proven natural gas reserves stand at 21.2 trillion cubic feet. An increased foreign investment has led to greater exploration activities which significantly increased the proven natural gas reserves in the country. However, although Vietnam is self-sufficient in natural gas, PetroVietnam predicts that there will be a natural gas supply gap of 1.3 billion cubic feet/day by 2025. To overcome this, the Vietnamese government has considered importing LNG in the future to provide for the growing demand of natural gas in the country.

Table 2-6: Proven Natural Gas Reserves, Thailand and CLMV, 2016

Country	Proven Gas Resource(billion cubic meter)	Production (billion cubic meter)
Thailand	200.0	38.6
Cambodia	50.0	NA
Lao PDR	10.0	NA
Myanmar	1,200.0	18.9
Vietnam	600.0	10.7
Total	2,060.0	68.2

Note: Cambodia and Lao PDR publicly available data is as of 2015.

Source: BP Statistical Review of World Energy, June 2017; BGR 2016 Energy Study – Reserves, Resources and Availability of Energy Resources

2.3.2 Industry Constraints

Obstacles and Transparency of Project Agreements

IPPs usually enter into PPAs with state-owned utility companies which have an effective monopoly over their respective countries' electrical transmission and distribution ("T&D") services. In the CLMV countries, IPPs face difficulties in negotiating tariffs that are commercially acceptable for both new and extended PPAs. Furthermore, terms of the PPAs are often not tailored to the IPPs' specific operating circumstances and may contain ambiguous provisions. This challenge is more prominent in Vietnam. The lack of transparency and clarity in project agreements and the inability to agree on mutually favorable PPAs have led to project delays in the recent years. Recently, Myanmar unofficially adopted the PPA system in the power generation market. However, at an early stage, there may be areas to be improved especially on the uniformity and efficiency of the system which typically requires time for continuous improvement in the longer term.

⁸⁰ Asian Development Bank

⁸¹ International Energy Outlook, U.S. Energy Information Administration

Meanwhile in Lao PDR, its government often solicits foreign investors into the IPP segment by being accommodative and flexible to their needs⁸². This led to the ADB findings that the Lao government lacked transparency on the guidelines regarding the award of IPP contracts as well as the negotiation outcome on the terms of the agreement⁸³.

Access to Capital

Power plant development is highly capital intensive and requires significant capital investment by project developers. Usually, power projects also involve extensive debt financing. Hence, the ability to execute a successful project on time largely depends on the ability of the utility companies or IPPs to obtain financing. In countries like Myanmar and Vietnam, where PPAs are characterized by lengthy negotiations and bureaucratic processes, prolonged negotiations can result in a longer project completion cycle. For example, there are uncertainties surrounding the combined 4,000.0MW multi-billion dollar nuclear power plant in Vietnam. The project plans were approved by the Vietnamese government in 2009. However, Vietnam's National Assembly voted to abandon plans to construct the two power plants in November 2016 due to rising costs and safety concerns. In Myanmar, several projects are facing delays due to lack of funds from the Burmese government to finance the project⁸⁴. IPPs need to have a strong relationship with their lenders in order to be able to negotiate for flexible timing of loan disbursement until the conclusion of negotiations with all other parties involved.

Fuel Costs and Supply Constraints

Generally, the responsibility to arrange fuel for power plants is borne by the IPPs, where each of the IPPs enters into a fuel supply agreement with a fuel provider in the host country or one from neighboring countries. In some markets and for certain types of projects, the IPPs may either enter into a long-term fuel supply agreement or opt to purchase fuel in the spot market. Securing a reliable fuel supply is highly critical for coal-fired and gas-fired power plants as any shortages in fuel supply will disrupt the IPPs' ability to generate electricity continuously, thus causing IPPs to adopt more costly alternatives.

In Thailand's PPA price structure, the USD exchange is included in the calculation of CP for both coal-fired and gas-fired power plants, while USD exchange rate is included for EP of only coal-fired plants. The fluctuations of foreign exchange rate may have an effect on decision making in power plants business and securing fuel supply, but it is most likely to affect coal-fired plants since foreign exchanges are included in both CP and EP calculation in the pricing structure. PTT sells natural gas in THB. In CLMV countries, all countries except Cambodia have foreign exchange rate incorporated into the PPAs. In Cambodia, EDC tariffs are not indexed to movement of foreign exchange or inflation⁸⁵.

Natural Disasters

The CLMV countries under the Greater Mekong Regions are vulnerable to natural disasters such as floods, droughts, typhoons and tropical storms. ADB reported Cambodia is highly susceptible to natural disasters given the massive Tonle Sap and Mekong River system in the country. In

⁸² Technical Notes on Fiscal Regime in the Hydro Power Sector published by the Ministry of Energy and Mines

⁸³ "Sector Assistance Program Evaluation for the Energy Sector in Lao PDR" published by the ADB in 2010

⁸⁴ "Hungry for power, Myanmar bets on hydro in new energy plan", Reuters, retrieved from <http://www.reuters.com/article/us-myanmar-energy-hydroelectricity-idUSKCN11H0SD>

⁸⁵ World Bank

September 2011, these water system recorded highest levels, displacing approximately 8.0% of the population and ruining many infrastructures within the country. In the same year, Thailand was affected by massive flooding disaster affecting close to 3.0 million populations from 64 provinces in the country. Hundreds of factories within the major economic zones such as Industrial Estate located in Ayutthaya, Pathum Thani and Nonthaburi were submerged. During the event, Thailand recorded an economic loss ranging from USD7.0 billion to USD10.0 billion⁸⁶. This event was one of the greatest setbacks on Thailand's economy, but the country managed to gradually recover as it did following previous natural disasters. In Vietnam, negative reaction from the local community stems from a flood incident caused by water discharged from hydroelectricity dams during heavy rains in Ha Tinh Province in 2016, destroying thousands of homes. Similar cases were reported in 2009 and 2013 where hydroelectricity plants were accused of floods in Vietnam. In late 2016, before the country was hit by Typhoon Sarika, Vietnam was tested by another flooding incident which caused significant damage to power lines and other associated infrastructure.

2.4 INDUSTRY OUTLOOK AND PROSPECTS

Cambodia

Since 2010, the consumption of electricity in Cambodia is growing rapidly at approximately 20.0% annually. The growth continues to increase as national grids are being developed and average household income rises. The demand for electricity is projected to reach 3,478.0GWh by 2020 supported by the growth that will occur in Phnom Penh.

Under the National Strategic Development Plan 2014 – 2018 and The Rectangular Strategy Phase 111 (2013), the RGC have initiated strategies such as encouraging private sector investment, providing 100.0% electricity to villages by 2020 and achieving 70.0% households equipped with access to reliable and affordable grid quality electricity by 2030. This aims to ensure there is sufficient supply of electricity to meet the ever-growing demand. Cambodia is aiming towards 100.0% renewable electricity by 2050 as they aim to heavily rely on renewable energy sources such as solar, wind, water and biomass energy. There is a large amount of potential untapped, such as biomass potential of 700.0MW and abundant solar energy available for rural areas. This outlook is deemed favorable for Cambodia as the country is moving towards higher contribution of power generation from renewable sources, in addition to conventional power generation from large hydroelectricity plants and fossil fuel plants. .

Lao PDR

Lao PDR has leveraged its hydroelectricity potential both for meeting the domestic power market's requirements and for earning export revenues. The power and mining sector in the country contributes to 17.0% of Lao PDR's GDP and approximately 70.0% of overall exports. Thailand is known to be the largest buyer of electricity, which has agreements to supply to Vietnam and Cambodia. With a significant potential still largely untapped, the country has put forth plans under its Power System Development Plan in 2015⁸⁷ to increase its hydroelectricity

⁸⁶ ADB, "Greater Mekong Sub region – Atlas of the Environment", 2012

⁸⁷ Lao PDR Ministry of Energy & Mines, Department of Energy Business: "Lao PDR Power System Development Plan", April 2015

capacity from 2017 until 2020 as the country's hydroelectricity potential is estimated to be 26,000.0MW. Many large hydroelectricity projects are under construction, with some of them solely developed to meet the country's growing domestic power demand, including 7 hydroelectricity plants under construction for domestic market consumption with total installed capacity of 1,465.5MW by 2020⁸⁸. As of 2014, Lao PDR has 2,994.0MW capacity installed, with approximately 76.0% capacity exported and the remaining used for domestic consumption.

Currently, Lao PDR does not have a comprehensive regulatory framework for promoting renewable energy development in the country. Many of the existing projects are either research oriented or pilot projects with no commercial viability. Though financial incentives exist for developing renewable energy projects, the uptake of renewable energy is likely to be slow between 2015 and 2020, since the power transmission grid needs to be strengthened, central & local authorities need to be educated, and adequate local infrastructures need to be set up.

Lao PDR is an attractive market for investments in the hydroelectricity segment of the power sector. Large untapped hydroelectricity potential, conducive business climate with a stable political setup, special economic zones, low risk from natural disasters and low labor costs make it an attractive destination in SEA. Being a landlocked country, Lao PDR is strategically located to provide electricity export access to neighboring countries like China, Vietnam, Thailand, and Cambodia.

Incentives from the Lao government, such as exemption from import duties and taxes on capital equipment, exemption from export duty on export products, tax holidays of up to 10 years, and reduced tax rates for large projects with special concessions available upon negotiation, continue to attract foreign investors' interest in the Laotian power generation sector.

Myanmar

In 2014, Myanmar launched a 15-year plan to bridge the huge gap between power demand and supply through capacity building efforts and upgrade of the current distribution system to reduce power loss. The country intends to increase from 4,714.0MW to approximately 29,000.0MW installed capacity by 2031 through the development of both hydroelectric power plants and coal-fired power plants.

Hydroelectric power plants would continue to dominate the country's electricity mix until 2031 due to its vastly untapped potential. As of 2015, hydroelectric constitutes 68.0% of total generation in the country⁸⁹. As per the 15-year plan, around 20 hydroelectric power plants with a combined capacity of 6,270.0MW are likely to be built, mainly in the Mandalay region and three states of Kachin, Kayin, and Shan. However, high reliance on hydroelectricity projects causes unstable electricity supply, as the reservoirs dry up during the summer months. Hence, the country intends to develop other types of power plants using fossil fuels and renewable energy sources.

Fourteen coal-fired power projects have been planned for commissioning between 2017 and 2031 with a combined capacity of 10,895.0MW. Five of these projects with a combined capacity of 6,100.0MW would be located in Yangon and Tanintharyi regions due to the concentration of special economic zones and industrial estates in these locations. Eight other projects

⁸⁸ 7 power plants consists of Nam Lik 1, Nam Phav, Nam Tha 1, Nam Pha, Don Sahong, Nam Phak and Nam Ou-1,2,4 and 7 (Source: MEM, Department of Energy Business)

⁸⁹ ADB, "Power Sector Development in Myanmar", 2015

(4,395.0MW) are located in the Arakan (1), Mon (2), and Shan (2) states, as well as the Ayeyarwady (2) and Sagaing (1) regions. The location of the remaining 400MW coal-fired project is yet to be announced⁹⁰. However, due to public concerns over environmental impact as well as limitation in transportation and logistics infrastructure, the outlook for coal-fired power projects remains uncertain along with several previously announced postponement and cancellation of coal-fired projects in Yangon and Tavoy Special Economic Zone.

In 2011, Myanmar owned 10 gas-fired power plants with a total installed capacity of 715.0MW connected to the national grid and increased it to 2,403.0MW as of 2016. Sempcorp Industries signed an agreement to develop the largest gas-fired power plant in the country with an installed capacity of 225.0MW. In addition, the Burmese government has also signed a Memorandum of Understanding with Marubeni Corporation to build a 400.0MW gas-fired power plant in Yangon. At the end of 2015, the Burmese government announced an IPP tender to invite local and international firms to develop gas-fired plants with a total capacity of 270.0MW in Yangon and Myingyan. To date, the tender bid is still in progress.

Though Myanmar has been receptive to foreign investments in several industries, the stakeholders are still skeptical of investing in the power market until clear directions in terms of establishing policies, stabilizing the financial and banking sector, and tackling other political issues are articulated. Investment by foreign companies is encouraged through BOT JVs in the power sector and they are mandated to submit their proposals to the MOEP with the required details of the project to get in-principle approval from the Union Cabinet.

Vietnam

According to the Vietnam's 'National Master Plan for Power Development for 2011 - 2020 period with the vision to 2030', planned total capacity of power plants will be around 75,000.0MW by 2020. The country was about 50,000.0MW short of its 2020 target as of 2012. According to this plan, the cumulative installed capacity of coal-fired power plants in 2020 is estimated to be 36,000.0MW or 48.0% of total capacity whereas gas-fired power plants are likely to have a combined capacity of 10,400.0MW. Vietnamese government continues to enforce BOT contracts, guarantees tariff payments, and grants tax exemptions. As a result, Vietnam is likely to attract foreign and private investments in the power sector. However, any slowdown in economic growth is likely to cause a slippage in achieving the ambitious domestic installed capacity target. Vietnam would also need to address fuel availability challenges by importing coal from either Australia or Indonesia. In addition, sufficient capital should be arranged to open new mines to produce coal within the country.

Based on the track record of installations in Vietnam and the progress of current projects, Frost & Sullivan forecasts that Vietnam is likely to achieve at least 70.0% of its capacity target by 2020. Engineering, procurement, and construction services companies and original equipment manufacturers have already taken steps to strengthen their foothold in the attractive power market.

In 2016, ABB signed a contract with Central Power Corporation to supply a software solution that could improve power supplies to 250,000 inhabitants. This software enables monitoring and control of grid condition to improve grid reliability in Vietnam. This aims to achieve the 10-year

⁹⁰ Project Maje: March 2016

roadmap for smart grid development in optimizing power network and improving power reliability within the country. Overall, Vietnam can be considered one of the best locations in ASEAN to invest in the power sector, with the country's high electricity demand growth, easing regulations and no foreign ownership restriction for private investment in the power market, as well as long PPA duration of 20 to 25 years.

3 PROSPECTS AND OUTLOOK FOR THE COMPANY

Thailand

According to EPPO Energy Statistics, Thailand's electricity consumption was reported at 182,847.4GWh in 2016 and is projected to reach 301,327.6GWh in 2036 under PDP 2015 at a CAGR of 2.5%, driven by growth in economic and industrial activities as well as rising population within the country. In order to attract foreign investment and strengthen its industrial sector, Thailand has developed a two-pronged approach via the Super Cluster development for advanced technology and future industries as well as the Eastern Economic Corridor for the development of its Eastern Seaboard. The initiatives are likely to spur the development of energy-intensive industrial activities within the designated regions, which will, in turn, drive the demand for electricity consumption. For instance, the Super Clusters are expected to require a total generation capacity demand of approximately 37,000.0MW, which significantly benefits SPPs and Co-generation power producers that are able to provide a direct supply of electricity.

In order to meet the anticipated electricity demand, Thailand recognizes the need for supportive policies in the power generation industry to attract domestic and foreign companies to invest into the power generation business. According to PDP 2015, it is estimated that contracted power generation capacity in Thailand (including VSPPs⁹¹) will increase from 46,947.0MW in 2016 to 70,335.0MW in 2036 at a CAGR of 2.0%. Natural gas is still expected to be the dominant fossil fuel source for power generation with a share of 36.8% or 120,152.0GWh for electricity generated in 2036, despite a planned decrease in the share of natural gas power generation to diversify electricity generation fuel mix. Meanwhile, with the clear direction from the Thai government in encouraging the production of electricity from renewable energy sources, the share of renewable energy (excluding the large hydroelectricity plant) as a fuel source is expected to grow significantly from 8.1% in 2016 to 17.9% by 2036.

CLMV

Frost & Sullivan estimates that electricity consumption in the CLMV countries is expected to grow at a CAGR of 10.5% from an estimated 183,759.4GWh in 2016 to 302,521.1GWh in 2021. The CLMV countries are among the fastest growing countries for electricity consumption within the South East Asian region during the period which is driven by expanding population, accelerating urbanization as well as economic development. The CLMV region is expected to have a population growth of 10.1 million between 2015 and 2021, while its real GDP growth of between

⁹¹ Data collection of power plants linked outside of EGAT system such as VSPPs are not viable due to their large numbers of sites. The installed capacity of VSPPs, which would be used in the calculation on energy requirement of EGAT system and the country was estimated from the AEDP

6.2% and 7.8% represents one of the highest amongst South East Asian countries. The Group's focus on the regional expansion includes Lao PDR and Myanmar.

In terms of generation capacity, Cambodia is aiming towards 100.0% renewable electricity by 2050 as they aim to heavily rely on renewable energy sources such as solar, wind, water and biomass energy. There is large potential untapped, such as biomass potential of 700.0MW and abundant solar energy available in rural areas.

Lao PDR has leveraged its hydroelectricity potential both for meeting the domestic power market's requirements as well as for earning export revenues. As of 2014, Lao PDR has 2,994.0MW capacity installed, with approximately 76.0% capacity exported and the remaining capacity used for domestic consumption. With the country's hydroelectricity potential being estimated to be 26,000.0MW, which is largely untapped as of 2016, the country has put forth plans to augment its hydroelectricity capacity from 2017 until 2020. Many large hydroelectricity projects are under construction, with some of them solely being developed to meet the country's growing domestic power demand, including 7 hydroelectricity plants under construction for domestic market consumption with total installed capacity of 1,465.5MW by 2020⁹².

In 2014, Myanmar launched a 15-year plan to bridge the huge gap between power demand and supply by achieving 29,000.0MW installed capacity by 2031 through the development of both hydroelectric power plants and coal-fired power plants. Around 20 hydroelectric power plants with a combined capacity of 6,270.0MW are likely to be built mainly in the Mandalay region and three states of Kachin, Kayin, and Shan. Fourteen coal-fired power projects have been planned for commissioning between 2017 and 2031 with a combined capacity of 10,895.0MW.

In 2011, Myanmar owned 10 gas-fired power plants with a total installed capacity of 715.0MW connected to the national grid and increased capacity to 2,403.0MW as of 2016. Sempcorp Industries signed an agreement to develop the largest gas-fired power plant in the country with an installed capacity of 225.0MW. In addition, the government has also signed a Memorandum of Understanding with Marubeni Corp to build a 400.0MW gas-fired power plant in Yangon. At the end of 2015, the local government announced an IPP tender to invite local and international firms to develop gas-fired plants with total capacity of 270.0MW in Yangon and Myingyan. To date, the tender bid is still in progress.

According to Vietnam's 'National Master Plan for Power Development for 2011 - 2020 period with the vision to 2030', planned total capacity of power plants will be around 75,000.0MW by 2020. The country is about 50,000.0MW short of its 2020 target as of 2012. According to this plan, the cumulative installed capacity of coal-fired power plants in 2020 is estimated to be 36,000.0MW or 48.0% of total capacity whereas gas-fired power plants are likely to have a combined capacity of 10,400.0MW.

Each respective government in CLMV has developed its initiatives for the development of its power supply industry such as Cambodia's target of providing 100.0% electricity to villages by 2020, Lao PDR capitalizing on its geographical advantage of high annual precipitation and hilly terrain to meet the domestic and export power demand, Myanmar's 15 year power development plan and Vietnam's 'National Master Plan for Power Development for 2011 - 2020 period with the vision to 2030'. Through the development plans, new power projects are expected to be

⁹² 7 power plants consists of Nam Lik 1, Nam Phav, Nam Tha 1, Nam Pha, Don Sahong, Nam Phak and Nam Ou-1,2,4 and 7 (Source: MEM, Department of Energy Business)

constructed with strong government support by encouraging private investment into the sector. This market trend provides favorable market opportunity for the Company to in the CLMV region.

The Company's Operation

As of September 30, 2017, within the IPP and SPP segments, the Group owned a total contracted power generation capacity in operation of 4,100.0MW, of which the Company owned an effective contracted power generation capacity of 1,664.7MW. The Company is the fifth largest private power producer in Thailand based on its effective contracted power generation capacity in operation as of September 30, 2017. Meanwhile, the Company has the strong growth in terms of confirmed pipeline projects within the private power generation segment in Thailand, with ten SPP and two IPP projects between October 1, 2017 and December 31, 2024 totalling to a contracted power generation capacity of 5,830.6MW and effective contracted power generation capacity of 3,058.8MW. As a result, the Company's effective contracted power generation capacity is expected to grow at a CAGR of 15.5% from 1,664.7MW as of September 30, 2017 to 4,723.6MW as of December 31, 2024. In total, the Company's portfolio of power plants until 2024 has a gross contracted power generation capacity of 9,930.6MW and an effective contracted power generation capacity of 4,723.6MW, propelling the company to be the leading private power producer in Thailand based on its portfolio of power plants. Frost & Sullivan notes that the portfolio of gas-fired power plants of the Company totalled up to 4,702.9MW in terms of effective contracted power generation capacity, making the Company have the largest gas-fired power portfolio among all private power producers in SEA (based on contracted power generation capacity or capacity secured via PPA), followed by RATCH (4,670.1MW), China General Power Nuclear Corp (4,459.5MW), JPHT (3,134.6MW) and First Gen Corporation (3,037.0MW). The discussion above does not reflect the Company's increased equity stake in the GSRC and GPD power plants. On November 13, 2017, the Company increased its equity stake in the GSRC and GPD power plants to 70.00%. Accordingly, as of that date, the effective contracted capacity is 5,673.6MW. Frost & Sullivan forecast The Company to remain the largest gas-fired power generation player in Thailand by 2024.

Meanwhile, the Company with all of its power plants in operation being gas-fired power plants achieved an average heat rate of 6,952.6BTU/kWh from 2014 to 2016 for its IPP plants and 7,809.8BTU/kWh for its SPP plants from 2013 to 2016. This performance compares favorably to the industry average among peers of 8,062.4BTU/kWh⁹³ and 8,230.9BTU/kWh⁹⁴ for gas fired power generation IPP and SPP plants, respectively, during the same periods. The average EAF from 2014 to 2016 for the Company's IPP plants of 97.5% and average EAF of the Company's SPP plants of 96.5% from 2013 to 2016 are also superior compared to the industry average among peers in the IPP and SPP segments which stood at 92.8%⁹⁵ and 93.9%⁹⁶, respectively, during the same periods.

Frost & Sullivan notes that the Company has a strong pipeline of power plants expected to be commissioned between 2017 and 2024, which bodes well with the rising demand of electricity in Thailand. Furthermore, the strategic location of the Company's SPP power plants, where all ten of its existing SPP power plants, as well as nine future SPP power plants, are located within or

⁹³ Derived based on the averaging of 2014 to 2016 heat rate for the Gas-fired IPPs outlined in Table 1-11.

⁹⁴ Derived based on the averaging of 2013 to 2016 heat rate for the Gas-fired SPPs outlined in Table 1-11.

⁹⁵ Derived based on the averaging of 2014 to 2016 EAF for the IPPs outlined in Table 1-12.

⁹⁶ Derived based on the averaging of 2013 to 2016 EAF for the SPPs outlined in Table 1-12.

proximately to the Supercluster catchment areas, is likely to provide a competitive advantage for the Company in the industrial power supply segment.

Despite the concerns about depletion of domestic natural gas reserves, gas-fired power generation remains as one of the most attractive options due to its cleanliness and operational efficiency. The risk of insufficient natural gas supply is also mitigated as Thailand plans to expand the natural gas transmission system and infrastructure, with PTT to invest THB210 billion from 2016 to 2020 to expand their gas business via expansion of its natural gas pipeline, LNG receiving terminal, a floating storage regasification unit, and setting up a new energy service company. Thailand also began to source for LNG beyond the SEA region, by importing LNG from Qatar from 2015 as well as tapping into new LNG production in Mozambique with the agreement to purchase 3.5 billion bcm of LNG per year from the planned Mozambique LNG project. Lastly, the Company's foray into renewable energy power generation, as indicated by the Chana Green biomass power project, is also in line with the general direction of Thailand to increase its power generation dependency on renewable energy.