เอกสารแนบ 5

รายงานการวิจัยทางการตลาดแบบอิสระเกี่ยวกับอุตสาหกรรม การผลิตไฟฟ้าในประเทศไทย ประเทศลาว และประเทศจีน

Independent Market Research on the Power Generation Industry in Thailand, Laos and China (Hebei, Shandong & Shanxi); Power Generation Industry in Indonesia focusing on Coal-Fired Power Plants; Overview of the Solar Power Generation Industry in Japan, China, Thailand and India

August 2016

FROST & SULLIVAN

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 August 2016.

This report is prepared for inclusion in the Circular/Explanatory Statement of Banpu Power Public Company Limited for submission to the Securities and Exchange Commission of Thailand and other relevant parties.

Frost & Sullivan has prepared this report in an independent and objective manner and has taken adequate care to ensure the accuracy and completeness of the report. We believe that this report presents a true and fair view of the industry within the limitations of, among others, secondary statistics and primary research, and does not purport to be exhaustive. Our research has been conducted with an "overall industry" perspective and may not necessarily reflect the performance of individual companies in the industry. Frost & Sullivan shall not be held responsible for the decisions and/or actions of the readers of this report. This report should also not be considered as a recommendation to buy or not to buy the shares of any company or companies as mentioned in this report or otherwise.

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Abbreviations

General Definitions

AP	Availability Payment
APG	ASEAN Power Grid
AUSC	Advanced Ultra-Supercritical
AUSC	Advanced Ultra-Supercritical operation of Steam cycles
BOT	Build-Operate-Transfer
CA	Concession Agreement
CCMP	Climate Change Master Plan, Thailand
CP	Capacity Payment
CAGR	Compound Annual Growth Rate
CSG	Coal Seam Gas
CSP	Concentrated Solar Power
CHP Plant	Combined Heat and Power Plant
EGS	Enhanced Geothermal Systems
EP	Energy Payment
EPC	Engineering, Procurement and Construction
EPIRA	Electric Power Reform Act 2001, the Philippines
ESB	Enhanced Single Buyer
ESS	energy storage system
FBC	Fluidised Bed combustion
FDI	Foreign Direct Investment
FiT	Feed-In-Tariff
FTP	Fast Track Program
GBI	Generation-Based Incentive
GDP	Gross Domestic Product
GW	Gigawatt
GWh	Gigawatt Hour
GSP	Gas separation plants
Hongsa Power Plant	Hongsa mine-mouth Power Plant

HVDC	High-voltage direct current
IGCC	Integrated Gasification Combined Cycle
IPP	Independent Power Producer
IPPD	IPP Domestic
IPPX	IPP Export
IUP	Mining Business Permit
JNNSM	Jawaharlal Nehru National Solar Mission
JV	Joint Venture
kW	Kilowatt
LNG	Liquefied Natural Gas
LPG	Liquified Petroleum Gas
mmscfd	Million Standard Cubic Feet per Day
MoF	Ministry of Finance
MOEP	Ministry of Electric Power, Myanmar
MOU	Memorandum of Understanding
MP3EI	The Masterplan for the Acceleration and Expansion of Economic Development of Indonesia
MSW	Municipal Solid Waste
Mtoe	Million Tonnes of Oil Equivalent
MW	Megawatt
NAPCC	National Action Plan on Climate Change
NAPES	National Action Plan for Energy Strategy, China
NEP	National Electricity Policy
NGV	Natural Gas Vehicle
NNES	New National Energy Strategy, Japan
NOx	Nitrogen Oxides
NTP	National Tariff Policy
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacture
PDP	Power Development Plan

PEA	Provincial Energy Agency
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PPS	Power Producer and Supplier
PPU	private power utilities
PV	Photovoltaic
REC	Rural Electrification Corporation
REDS	Renewable Energy Development Strategy, Laos
RPO	Renewable Purchase Obligation
RUKN	General Plan of Electricity, Indonesia
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik
SCPS	coal-fired power station
SEA	South East Asia
SEZ	Special and Specific Economic Zone
SOE	State-owned Enterprise
SOx	Sulphur Oxide
SPP	Small Power Producer
T&D	Transmission and Distribution
TAGP	Trans-SEA Gas Pipeline
tcf	Trillion Cubic Feet
TES	Thermal Energy Storage
TW	Terawatt
VSPP	Very Small Power Producer

Companies, Authorities and Organisations

ADB	Asian Development Bank
AEC	ASEAN Economic Community
AEDP	Alternative Energy Development Plan, Thailand
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations

Banpu PCL	Banpu Public Company Limited
Banpu Power	Banpu Power Public Company Limited
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe
CEA	Central Electricity Authority
CEA	China Electric Association
CEP	PT Cirebon Electric Power
CERC	Central Electricity Regulatory Commission
CIPC	China Investment Power Corporation
CK	CK Power Public Company Limited
DEDE	Department of Alternative Energy Development and Efficiency
DIW	Department of Industrial Works, Thailand
DMF	Department of Mineral Fuels, Thailand
EC	Energy Commission, Malaysia
EDL	Electricite du Laos
EEDP	Energy Efficiency Development Plan, Thailand
EGAT	Electricity Generating Authority of Thailand
EGCO	Electricity Generating Public Company Limited
EGCO Cogen	EGCO Cogeneration Company Limited
EIA	Energy Information Administration
EMA	Energy Market Authority
EPPO	Energy Policy and Planning Office, Thailand
ERAV	Electricity Regulatory Authority of Vietnam
ERC	Energy Regulatory Commission
EVN	VietNam Electricity
FEPC	Federation of Electric Power Companies of Japan
GCC	Gulf Cogeneration Company Limited
GK	Godo Kaisha
GLOW	Glow Energy Public Company Limited
GPG	Gulf Power Generation Company Limited
GYG	Gulf Yala Green Company Limited

JEPX	Japan Electric Power Exchange
JREF	Japan Renewable Energy Foundation
JWPA	Japan Wind Power Association
IEE	Institute of Energy Economics
IMF	International Monetary Fund
IREDA	Indian Renewable Energy Development Agency Ltd
KEGCO	Khanom Electricity Generating Company Limited
Lao PDR	Lao People's Democratic Republic
LHSE	Lao Holding State Enterprise
MAFF	Ministry of Agriculture, Forestry and Fisheries
MEA	Metropolitan Electricity Authority, Thailand
MEM	Ministry of Energy and Mines of Laos
METI	Ministry of Trade, Economy and Industry, Japan
MEXT	Ministry of Education, Culture, Sports, Science and Technology
Mibugawa	Mibugawa Power Company
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MNRE	Ministry of New and Renewable Energy
MOIT	Ministry of Industry and Trade, Vietnam
MOP	Ministry of Power
NCEA	National Commission for Environmental Affairs
NDRC	National Development and Reform Commission, China
NEA	National Energy Agency
NEPC	National Energy Policy Council, Thailand
NN2	Nam Ngum 2 Power Co., Ltd.
NPC	National Power Corporation, the Philippines
NTPC	Nam Theun 2 Power Company
NVVN	National Thermal Power Corporation Vidyut Vyapar Nigam
OSS	One Stop Service
PDRC	Provincial Development and Reform Committee, China

PEA	Provincial Electricity Authority, Thailand
PLN	Perusahaan Listrik Negara
PT PJB	PT Pembangkitan Java-Bali
PTT	PTT Public Company Limited
RATCH	Ratchaburi Electricity Generating Holding Company Limited
REDP	Renewable Energy Development Plan
Roi-Et Green	Roi-Et Green Company Limited
SCC	Samutprakarn Cogneration Company Limited
SEAN	Southeast Asia Energy Limited
SECI	Solar Energy Corporation of India
SERC	State Electricity Regulatory Commission
SERC	State Electricity Regulatory Commission, China
SNA	State Renewable Development Agencies
TEPCO	Tokyo Electric Power Company
TK	Tokumei Kumiai
UN	United Nations
UNFCC	United Nations Framework Convention on Climate Change
US	United States of America
WEC	World Energy Council

GLOSSARY OF TECHNICAL TERMS

Anaerobic Digestion Process	The process of breaking down biodegradable material in the absence of oxygen by micro-organism.
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 resides 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.
Carbon Capture and Storage (CCS)	A technology that allow capturing and storing the CO2 emitted by large fossil fuel power plants.
Clean Coal Technology	A near-zero emission coal-based power generation that is embedded carbon capture and storage (CCS) technology.
Clean Development Mechanism	One of the flexibility mechanisms defined in the Kyoto Protocol that provides for emissions reduction projects which generate Certified Emission Reduction units which may be traded in emissions trading schemes
Climate Change	Change in the state of climate that can be identified by changes in the mean and/or the variability of its properties.
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.
Competitive Bidding	Transparent procurement method in which bids from competing contractors, suppliers, or vendors are invited by openly advertising the scope, specifications and terms and conditions of the proposed contract as well as the criteria by which the bids will be evaluated
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 Generation Capacity	Installed capacity that is reserved to meet the requirements of the negotiated power supply contracts such as the power purchasing agreement.
Cubic metre	(m3) A volume measurement equal to 1,000 litres or 264. 2 US gallons. One cubic metre of water weighs one tonne

Distribution Network	The final stage in delivery of electric power from transmission system to individual consumers.
Effective Generation Capacity	The effective generation capacity factors the equity stake of the project developers. Example if in a 100 MW power plant a company has 70% equity stake, then the effective generation capacity of the company is 70 MW
Electricity Consumption Per Capita	Total electricity consumption divided by the total population
Electrification Ratio	Percentage of households with access to electricity
Energy Diversification	A policy adopted by many countries to mitigate dependence on any one source of energy, to bolster economic and physical security.
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 Equity	Equal and fair access to electricity for all.
Energy Management Contract	A business-to-business turnkey contract to reduce electricity consumption of a facility through efficient operation and installation of energy efficient machineries.
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.
Energy Storage System	The system compensates many renewables' variability, allowing electrical energy stored in the system to be delivered to the grid on or demand
Environmental Impact Assessment (EIA)	A process of evaluating the consequences of a proposed project or development, taking into account inter-related socioeconomic, cultural and human-health impacts, both beneficial and adverse.
Engineering, Procurement, and Construction (EPC)	A form of contracting arrangement with the construction industry, which the contractor designs the installation, procures the necessary materials and equipment and proceed to finalise the project.
Equivalent Availability	A measure of power plant availability calculated as the

Factor (EAF)	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
Evaporation	The process in which water is converted to a vapour that can be condensed
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 synthesise 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.
Geothermal	Energy stored in the form of heat below the earth's surface that is used for electricity generation.
Grid-connection Agreement	Bilateral agreements to facilitate transfer of electricity powers across national borders, often with stipulated rights and obligations.
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
Levelised Tariff	Levelised tariff in the power sector essentially refers to the average fixed and variable tariff over the entire term of the PPA or Power Purchase Agreement adjusted for inflation
Licensed Capacity	The maximum capacity in MW permitted or licensed by the regulator. The power plant developer cannot install a power plant with a higher capacity than the licensed capacity. The project developer may implement the project in phases, but the total capacity installed need to be less than the licensed capacity

Lignite	Also known as brown coal, it is composed mainly of volatile matter and moisture continent 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.
Marine Energy	A renewable energy by harnessing marine ecosystem in generating electricity.
Mega cities	A cluster of cities with minimum 8 million population
Mega corridors	A cluster of regions with a minimum 25 million population
Mega region	A region with a minimum 15 million population
Micro-grid	Localised 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.
Mine-mouth Power Plants	A power plant is classified as 'mine-mouth' if it is located in close proximity to the coal mine that which it has guaranteed supply over a period of time to make it economical for transportation and consumption for generation.
Mini-hydroelectric	Hydroelectric power plants smaller than 50 MW
Original equipment manufacturer (OEM)	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	The term peak demand refers to the highest amount of electricity being consumed at any one point in time across the entire network system. The peak demand is used to calculate the reserve margin
Peak Production	Peak production denotes the maximum level of electricity generation given its installed capacity.
Peak Shaving	Refers to the process of reducing peak demand for electricity by relying on off-grid electricity supply during peak period.

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 Development Agreement (PDA)	Approval in Principle by the pertinent Government agency to pursue construction of a power plant.
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)
Rankine Cycle	A model used to predict the performance of steam turbine system. It idealised thermodynamic cycle of a heat engine that converts heat into mechanical work
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 Reserve Margin = (Installed Capacity – Peak Demand) / Peak Demand
Small Power Producer	On-grid power producers which installed capacity do not exceed a certain threshold, e.g. 90MW in Thailand.
Solar Photovoltaics (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 Not-Firm	It is the opposite of SPP Firm, renewed usually over 5-year period.
Super High Voltage (HV) Direct Transmission Lines	Referring to transmitting electricity power through direct current line that is over ±500 KVA instead of the more common alternating current systems. The key advantage of high voltage direct current transmission is the reduction of energy loss during transmission, which is paramount over long distance electricity power transmission.

Supercritical	At pressure levels of more than 3206.2 psi (221.2 bar) and corresponding saturation temperature 705.4°F (374.15°C), the vapour and liquid are indistinguishable. This level is called the Critical Point.
Thermodynamic Cycle	A series of thermodynamic processes transferring heat and work, to convert some heat input into a mechanical output.
Thermodynamic Efficiency	Performance in Conversion of Energy from Fuel to Power Output.
Tidal Energy	Vertical movement of large bodies of water due to gravitational forces of the sun and moon creates horizontal movement hence kinetic energy that can be converted into electricity.
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 centres.
Urbanisation Rate	Calculated using the World Bank's population estimates and urban ratios from the UN World Urbanisation Prospects. Urbanisation refers to the increase in the proportion of people living in towns and cities when a country is still developing. Increase in urbanisation rates creates more demand for goods and services.
Waste-to-Energy	Refers to the process of generating electrical energy through direct and indirect combustion due to the primary treatment of waste.

TABLE OF CONTENTS

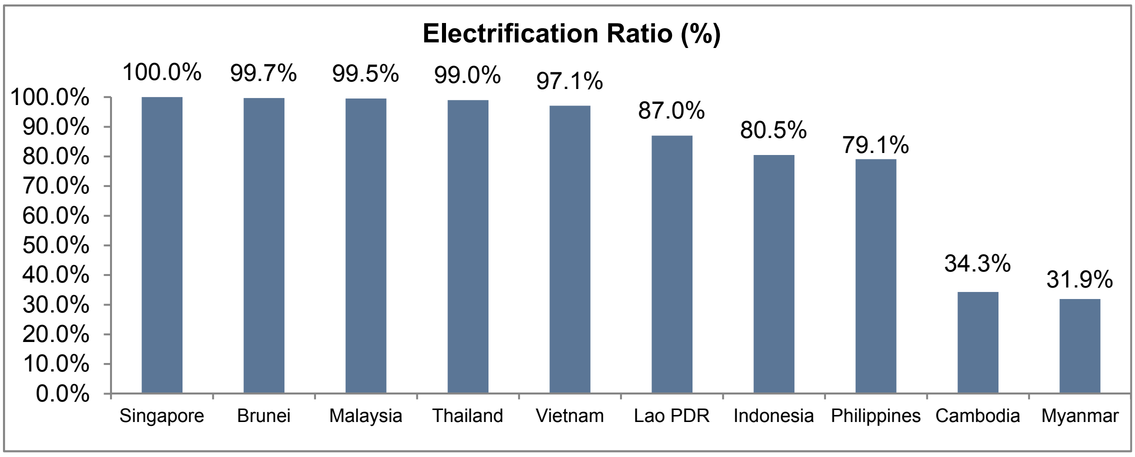
1 OVERVIEW OF THE POWER GENERATION INDUSTRY IN SOUTH EAST ASIA ("SEA")

1.1 INTRODUCTION

Robust economic development has accelerated the demand for power especially in developing countries in SEA, such as Indonesia, Philippines and Vietnam. Moreover, access to continuous and reliable power has become an indispensable factor for businesses. Power sector expansion continues in the region due to growing urbanisation, growth of the middle class population and higher electrification ratio. Huge reserves of coal (21.0 billion tonnes) and gas (6.6 trillion cubic meters) as of 2014 in SEA have increased the dominance of coal-fired and gas-fired power plants in the region's electricity mix. The role of coal and gas-fired technologies in power generation is likely to remain significant despite the growing importance of nuclear and renewable energy technologies. Both utility companies and independent power producers (**"IPPs"**) in SEA have invested heavily in combined cycle gas turbine power plants and coal-fired power plants since 2011 and this trend is expected to continue towards 2020.

During the five year period from 2013 to 2017, Vietnam is expected to see a peak load capacity addition of 14.5 gigawatt (**"GW"**), which is likely to be the highest in the region followed by Indonesia at 14.0 GW. While in 2013, countries like Singapore, Brunei and Thailand enjoy electrification of 100.0%, 99.7% and 99.0% respectively, several other countries in SEA, such as Myanmar, Cambodia, Vietnam, Indonesia, Philippines, Lao People's Democratic Republic (**"Lao PDR"**) and eastern parts of Malaysia are yet to be completely covered by the power grid due to topographical issues. These countries face power blackouts and brownouts and rely on other power generation technologies especially diesel generator sets to meet their electricity needs.

Chart 1-1: Electricity Access in SEA, 2013



Note: Based on latest available 2013 data.

Source: World Energy Outlook 2015 Electricity Access Database, International Energy Agency

Table 1-1: Long-term Load / Power Demand Forecast, Selected SEA Countries, 2012 – 2020

Country	Power demand (peak load) forecast	CAGR (2012 - 2020)
Vietnam	From 18,649 MW in 2012 to 52,040 MW in 2020	13.7%
Indonesia	From 23,000 MW in 2012 to 43,000 MW in 2020	8.1%
Thailand	From 25,913 MW in 2012 to 36,336 MW in 2020	4.3%
Philippines	From 10,944 MW in 2012 to 14,998 MW in 2020	4.0%
Malaysia	From 15,826 MW in 2012 to 20,847 MW in 2020	3.5%
Laos	From 614 MW in 2012 to 1,960 MW in 2020	15.6%

*Source: Indonesia's Draft General Plan of Electricity 2012 - 2031, Vietnam's National Power Development Plan (**"PDP"**) 2011 - 2020 and VietNam Electricity (**"EVN")**, Thailand's PDP 2010 (Rev. 3), Energy Commission **("EC")**, Malaysia, Department of Energy, Philippines, Lao PDR Country Report 2013 from Hapuasecretariat*

Many SEA countries continue to rely significantly on fossil fuels and hydropower plants above 25.0 megawatt (**"MW"**) capacity to generate electricity. However, to improve electrification ratio as well as to address power demand forecast, the SEA region places emphasis on energy diversification in its energy policies. Many countries in the region have recently introduced policies that set forth specific targets for renewable energy utilisation and have evaluated options of introducing nuclear power. As such, the contribution of renewable energy sources in electricity generation in SEA countries is expected to grow from 4.8% in 2015 to 8.0% in 2025[1].

The ASEAN Economic Community ("**AEC**") that was formed in 2007 acknowledged the critical role played by energy and wanted to expedite the development of the ASEAN Power Grid ("**APG**") and Trans-SEA Gas Pipeline ("**TAGP**"). These two major initiatives would optimise 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.

[1] SEA Energy Outlook published by the IEA

1.2 ELECTRICITY CONSUMPTION TRENDS

Table 1-2: Selected Asian Economies: Real Gross Domestic Product ("GDP") Growth (Annual percent change)

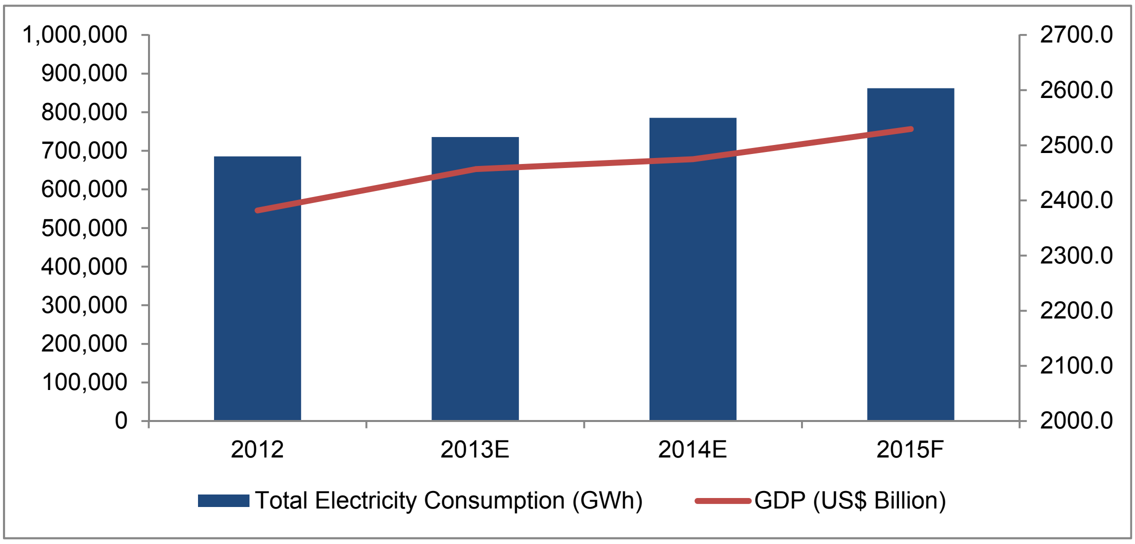
	Real GDP Growth (%)			
	2013	**2014**	**2015**	**2016E**
Asia Pacific	**5.2**	**5.4**	**5.6**	**5.3**
Advanced Asia	**2.1**	**2.3**	**2.2**	**N/A**
Japan	1.5	1.4	0.5	0.5
Korea	2.8	3.7	2.6	2.7
Australia	2.4	2.6	2.5	2.5
Taiwan Province of China	2.1	3.1	0.7	1.5
Hong Kong SAR	2.9	3.7	2.4	2.2
Singapore	4.1	3.6	2.0	1.8
New Zealand	2.4	3.3	3.4	2.0
Emerging and Developing Asia	**6.5**	**6.7**	**6.6**	**6.4**
China	7.7	7.5	6.9	6.5
India	4.4	5.4	7.3	7.5
ASEAN-5	**5.2**	**4.9**	**4.8**	**4.8**
Indonesia	5.8	5.4	4.8	4.9
Thailand	2.9	2.5	2.8	3.0
Malaysia	4.7	5.2	5.0	4.4
Philippines	7.2	6.5	5.8	6.0
Vietnam	5.4	5.6	6.7	6.3
Laos	8.2	7.5	7.8	7.4
Emerging Asia	**6.5**	**6.7**	**6.6**	**6.4**

Notes: 1. Emerging Asia comprises the ASEAN-5 economies, China, and India.

*2. GDP growth data in 2015 for Korea, Singapore, Indonesia, Malaysia, Laos and Thailand are estimations from International Monetary Fund ("**IMF**")*

Source: Extracted from the World Economic Outlook 2016: "Too Slow for Too Long", IMF

Chart 1-2: Historical GDP (in US$ Billion) and Total Electricity Consumption (in GWh), SEA, 2012 - 2015F



Note: GDP is in current prices.
*Source: GDP data extracted from IMF and Electricity Consumption data from Energy Market Authority (**"EMA"**) of Singapore, Perusahaan Listrik Negara (**"PLN"**) Statistik, Department of Alternative Energy Development and Efficiency, Ministry of Energy Thailand. Department of Energy Philippines' Power Statistics 2012, Ministry of Electric Power (**"MOEP"**), Myanmar, Energy Information Administration **("EIA")**, Frost & Sullivan Analysis*

The economic development of countries in SEA is the biggest driver for rising electricity consumption in the SEA region. In addition, expected power market reforms and investments in extending the power grid in the Philippines, Indonesia and Vietnam are likely to fuel the growth of electricity consumption in the SEA region. Electricity consumption, power infrastructure expansion and modernisation 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 SEA's electricity consumption is expected to grow at a compound annual growth rate (**"CAGR"**) of 7.9% from an estimated 862,058 gigawatt hour (**"GWh"**) in 2015 to 1,263,530 GWh in 2020. Vietnam, Laos, Malaysia, Indonesia and Myanmar are the top five fastest growing markets based on CAGR from 2015 to 2020.

Chart 1-3: Historical and Projected Total Electricity Consumption (GWh), SEA, 2012 – 2020F

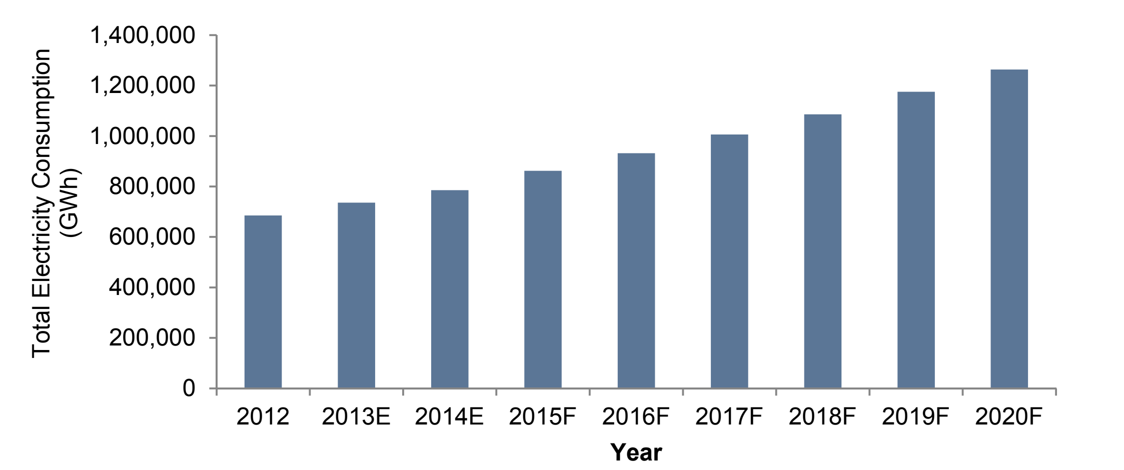
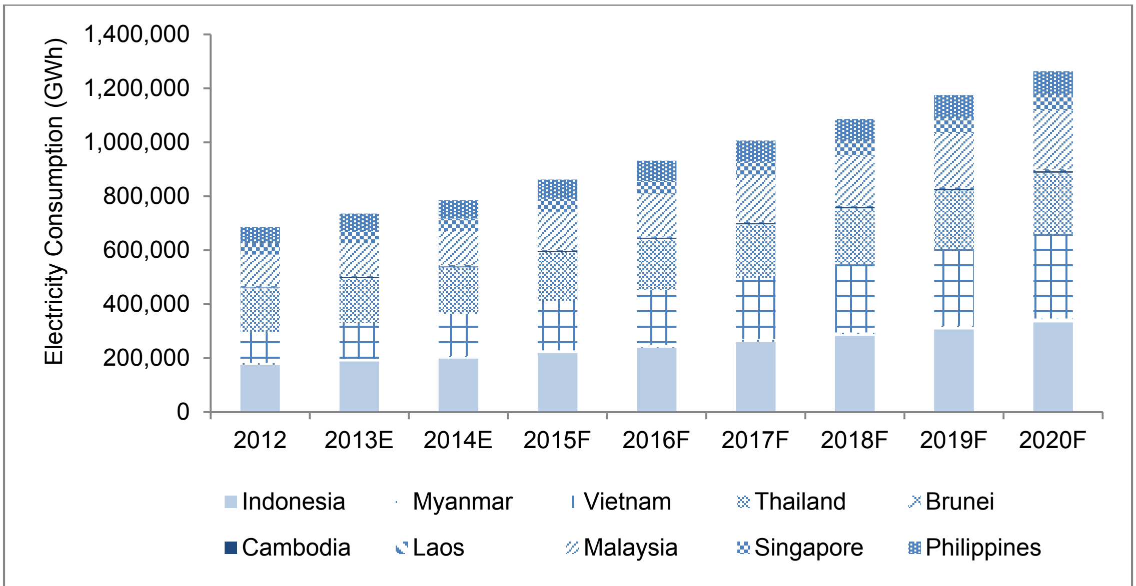


Chart 1-4: Historical and Projected Total Electricity Consumption (GWh), SEA, 2012 – 2020F



Note: SEA includes countries, such as Brunei, Cambodia, Laos, Myanmar, Malaysia, Indonesia, Philippines, Singapore, Thailand, and Vietnam.

Source: For Singapore: Historical numbers 2012 and 2013 taken from the Singapore Energy Statistics 2014 by the EMA of Singapore. For Indonesia: Historical numbers 2012-2014 taken from PLN Statistik, For Thailand: Historical numbers 2012-2015 taken from Department of Alternative Energy Development and Efficiency, Ministry of Energy Thailand. For the Philippines: Historical number 2012 taken from Department of Energy's Power Statistics 2012. For Myanmar: Historical numbers 2012-2014 taken from MOEP. For Vietnam, Brunei, Cambodia, Laos and Malaysia: Historical numbers taken from EIA publication, Frost & Sullivan Analysis

Table 1-3: Historical and Projected Total Electricity Consumption (GWh), SEA, 2012 – 2020F

Year	Electricity Consumption (GWh)										
	Vietnam	Laos	Malaysia	Indonesia	Myanmar	Cambodia	Thailand(4)	Philippines	Singapore	Brunei	Total
2012	114,444	2,874	116,354	173,990	7,888	3,004	161,779	59,211	42,569	3,451	685,564
2013(1)	133,897	3,381	121,613	187,800	8,450	3,191	164,323	65,164	44,441	3,530	735,790
2014(2)	156,678	3,791	127,345	198,602	9,040	3,501	168,685	68,201	46,175	3,550	785,568
2015(3)	183,335	4,073	141,456	219,100	9,722	3,803	177,598	71,379	47,987	3,605	862,058
2016F	203,882	4,379	156,292	238,800	10,442	4,098	185,689	74,705	49,854	3,671	931,812
2017F	226,741	4,775	170,726	259,900	11,244	4,446	194,507	78,187	51,992	3,734	1,006,252
2018F	252,390	5,245	185,564	282,900	12,156	4,836	204,090	81,368	53,888	3,840	1,086,277
2019F	284,104	5,788	201,995	306,700	13,210	5,268	213,980	84,933	55,225	3,957	1,175,160
2020F	312,088	6,421	218,695	332,300	14,557	5,668	224,492	87,844	57,377	4,088	1,263,530
CAGR 2012-2014E	**17.0%**	**14.8%**	**4.6%**	**6.8%**	**7.1%**	**8.0%**	**2.1%**	**7.3%**	**4.1%**	**1.4%**	**7.0%**
CAGR 2015F-2020F	**11.2%**	**9.5%**	**9.1%**	**8.7%**	**8.4%**	**8.3%**	**4.8%**	**4.2%**	**3.6%**	**2.5%**	**7.9%**

Note:

(1) 2013 actual data for Indonesia, Laos, Myanmar and Singapore; estimates for Brunei, Cambodia, the Philippines, Vietnam and Malaysia

(2) 2014 actual data for Indonesia, Laos and Myanmar; forecasts for Brunei, Cambodia, the Philippines, Singapore, Vietnam and Malaysia

(3) 2015 estimates for Indonesia and Myanmar; forecasts for Brunei, Cambodia, Laos, the Philippines, Singapore, Vietnam and Malaysia

(4) 2012 to 2015 actual data for Thailand

Source: For Singapore: Historical numbers 2012 and 2013 taken from the Singapore Energy Statistics 2014 by the EMA of Singapore. For Indonesia: Historical numbers 2012-2014 taken from PLN Statistik, For Thailand: Historical numbers 2012-2015 taken from Department of Alternative Energy Development and Efficiency, Ministry of Energy Thailand. For the Philippines: Historical number 2012 taken from Department of Energy's Power Statistics 2012. For Myanmar: Historical numbers 2012-2014 taken from MOEP. For Vietnam, Brunei, Cambodia, Laos and Malaysia: Historical numbers taken from EIA publication, Frost & Sullivan Analysis

Indonesia

In Indonesia, PLN is a state-owned enterprise (**"SOE"**) that builds and owns most of the electricity infrastructure in the country. PLN owns coal-fired, oil-fired steam, gas turbine, geothermal, hydropower and diesel power plants. Most of these generation facilities are under the management of two PLN's subsidiaries, PT Indonesia Power and Java-Bali Electric Company. PLN also acts as the single buyer that purchases electricity from IPPs. The electricity is also generated by large industries and mines that own private power utilities mainly for their own use.

Electricity consumption in Indonesia is mainly driven by demand from the residential sector followed by the commercial sector. Frost & Sullivan expects Indonesia's electricity consumption to increase from 219,100 GWh in 2015 to 332,300 GWh in 2020 at a CAGR of 8.7%. This higher forecast growth rate in Indonesia is attributed to the growing middle income population and rapid urbanisation in the country. As the spending power of the population increases and enables improvement in living standards, the uptake of electrical appliances is expected to similarly increase.

The installed capacity in Indonesia has been on an increasing trend between 2011 and 2014, increasing from 43,972.2 MW to 51,620.6 MW at a CAGR of 8.3%[2]. The Government of Indonesia has been encouraging investments in the electricity supply industry, particularly for generation and transmission activities. According to Indonesia 10 Year PDP in 2010, the Government of Indonesia aims to enhance the country's power generation capacity by 55,345.0 MW by 2020.

The Government's effort to meet growing electricity demand is reflected in the "Pengelolaan Energi Nasional 2005–2025" Plan that was released in 2005. The Government of Indonesia targets to achieve electrification ratio of 95.0% by 2025. To achieve this target, the Government plans to increase the availability of the electricity supply infrastructure which includes the APG Plan. The proposed APG Plan would link the transmission between Java, Kalimantan and Sulawesi.

The Government of Indonesia has released the latest draft General Plan of Electricity, coined as Rencana Umum Ketenagalistrikan Nasional ("**RUKN**") 2015 - 2034. Under the RUKN, Indonesia's reserve margin is to be capped at 35.0% for all the provinces for the duration from 2015 to 2034. In 2014, Indonesia's power reserve margin was critically low at 10.0% of its total electricity generation capacity.

Myanmar

The electricity market in Myanmar is centralized, controlled and managed by the MOEP, which is responsible for developing, implementing, operating, and maintaining all large hydropower and coal-fired thermal power plants.

Frost & Sullivan expects Myanmar's electricity consumption to increase from 9,722 GWh in 2015 to 14,557 GWh in 2020 at a CAGR of 8.4%, supported by the growing urbanisation and industrialisation efforts across the country. Industrial complexes, megacity projects and housing projects drive power demand growth. Myanmar had a low per capita electricity consumption of 176 kWh in 2014 due to low electrification ratio, moderate industrial development and lack of investments. Although major cities such as Yangon are relatively well electrified, they are also affected by frequent power blackouts and brownouts.

The installed capacity in Myanmar has been on an increasing trend from 3,322 MW in 2012 to 4,421 MW in 2014 as new power stations were built MOEP's PDP released in 2014 highlights installed capacity to rise to 24,981.0 MW by 2030. The MOEP is undertaking a five-year project to supply power to rural and non-electrified areas mainly through power grid expansion.

[2] PLN Annual Reports

Myanmar faces power shortages during the summer months due to the drying up of its dams, hence drastically affecting hydropower generation. This challenge has resulted in the MOEP's interest in inviting IPPs to develop thermal power projects that will support additional generation. 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.

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 Government through its SOEs EVN, oil and gas company Petro Vietnam, and the mining company Vinacomin. The state accounts for more than 80.0% Vietnam's total installed capacity.

Vietnam is forecasted to register a high electricity consumption growth with CAGR of 11.2% from 2015 to 2020. The country has made remarkable progress in expanding electricity access to households and communities since 2001. Industrial sector is the largest consumer of electricity accounting for nearly 54.0% of total consumption followed by the residential sector. Demand for electricity is expected to be met with significant coal-fired power plants. Due to the uncertain conditions associated with hydropower generation, the country has decided to reduce its reliance on hydropower and pursue thermal power plants to meet its growing electricity demand.

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 instil investors' confidence in the power generation sector. Electricity regulations in Vietnam are being revised by the ERAV to increase private sector participation.

By 2016, Vietnam will have an initial pilot operation 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.[3] A competitive retail power market is likely to be implemented by 2024.[4]

Philippines

The Philippines is one of the most liberalised power generation markets in SEA. IPPs share in the country's installed capacity is likely to increase, as the National Power Corporation ("**NPC**") continues to privatise its generating assets and its IPP contracts in pursuant of the Electric Power Reform Act 2001 ("**EPIRA**"). In 2006, the EPIRA also established a wholesale electricity spot market to enable wholesale competition through merit-order dispatch of generators and

[3] VietnamPlus, Vietnam News Agency
[4] News from VietNamNet Bridge

market-based pricing. On the retail side, distribution to customers traditionally was mainly through investor-owned utilities, such as the Manila Electric Company. In 2013, the Energy Regulatory Commission (**"ERC"**) implemented the retail competition and open access system that allowed qualified customers to choose alternate electricity suppliers. Despite these restructuring efforts, the country continues to face power supply challenges[5].

The Philippine Energy Plan 2012-2030, which the Department of Energy launched in December 2012, provides the roadmap for future demand and capacity addition. As per the plan, installed capacity is expected to increase to 25,800MW by 2030 from 17,944 MW in 2014. Additional capacity is likely to be achieved by adopting coal-fired power plants and geothermal power plants.Philippines is forecasted to register a moderate electricity consumption growth with CAGR of 4.2% from 2015 to 2020. Electricity demand from the commercial sector continues to remain high due a robust services sector.

1.2.1 Industry Drivers

Increasing Rate of Urbanisation

Table 1-4: Urbanisation Rate, countries in SEA, 2015, 2020E and 2050E

Country	2015	2020E	2050E
Brunei	77%	79%	84%
Malaysia	75%	78%	86%
Indonesia	54%	57%	71%
Thailand	50%	56%	72%
Philippines	44%	44%	56%
Lao PDR	39%	44%	61%
Myanmar	34%	37%	55%
Vietnam	34%	37%	54%
Cambodia	21%	22%	36%
SEA	**48%**	**51%**	**65%**

Note: As of 2015, Singapore has already achieved 100.0% urbanisation
*Source: United Nations (**"UN"**), Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision Database*

[5] EIA insight

As the urbanisation rate[6] in the SEA region 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 Thailand, Vietnam and Indonesia.

In Indonesia, the gap between capacity growth and the pace of electricity demand growth has led to frequent power outages. Such power outages have caused the Government of Indonesia to introduce programmes, such as the 'Fast Track Program' (**"FTP"**), to expand the country's power generation capacity. Based on Indonesia's 10-year PDP and Long Term Power System Security announced in 2010, the Government of Indonesia plans to add 55,345.0 MW of installed capacity from 2011 to 2020[7].

Liberalisation of the Power Generation Market

Power shortages, tight reserve margins and power utility companies' lack of cash reserves are driving the liberalisation of power markets. As such, in encouraging private power producers to invest in the competitive power generation market, a majority of the SEA 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, 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 liberalisation presents a business expansion opportunity for power producers in the SEA region.

Abundant Availability of Fuel

The abundant availability of coal and natural gas reserves in SEA has enabled power plant operators to obtain fuel resources domestically or within the region. Coal is one of the fossil fuels easily sourced in SEA, with Indonesia being the largest producer within the region[8]. According to Bundesanstalt für Geowissenschaften und Rohstoffe ("**BGR**"), Indonesia was ranked fifth (5th) largest coal producer in the world in 2014 with 410.8 million tonnes of coal production. Easy access to low-cost fuel spurs the high adoption rate of proven technologies, such as coal-fired power plants in the SEA region, especially in Indonesia that predominantly uses gas-fired power plants with steam turbines and boilers.

Indonesia has ample natural gas reserves that facilitate the installation of gas-fired power plants. Indonesia has the largest proven natural gas reserves in the Asia Pacific region, with approximately 1.5% of the world's total estimated proven natural gas reserves in 2014. In addition, Malaysia and Indonesia are the world's ninth (9th) and tenth (10th) largest exporter of liquefied natural gas (**"LNG"**) respectively.

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

7 Indonesia 10-year PDP and Long-term Power System Security, PLN

8 According to BGR, top five coal producers in 2013 were China, the US, India, Indonesia and Australia. Indonesia is the only country located in the SEA region.

Table 1-5: Proven Coal Reserves and Production, selected SEA Countries, 2014

Country	Reserves (Billion MT)	Production (million MT)
Indonesia	17.4	410.8
Vietnam	3.1	41.7
Rest of SEA	0.5	10.8
Total SEA	**21.0**	**463.3**
Share of World	***3.0%***	***6.5%***

Source: BGR 2015 Energy Study – Reserves, Resources and Availability of Energy Resources

Table 1-6: Proven Natural Gas Reserves, selected SEA Countries, 2014

Country	Proven Gas Resource (billion cubic metre)	Production (billion cubic metre)
Brunei	270.0	11.9
Indonesia	2,908.0	71.8
Malaysia	2,351.0	66.4
Philippines	80.0	3.7
Thailand	238.0	42.1
Vietnam	617.0	10.2
Rest of SEA	283	14.6
Total SEA	**6,747.0**	**220.7**
Share of World	***3.4%***	***6.3%***

Source: BGR 2015 Energy Study – Reserves, Resources and Availability of Energy Resources

1.2.2 Industry Constraints

Obstacles and Transparency of Project Agreements

IPPs usually enter into power purchase agreements (**"PPAs"**) with state-owned utility companies which have an effective monopoly over their respective countries' electrical transmission and distribution (**"T&D"**) services. In the SEA region, IPPs face difficulties in negotiating tariffs that are commercially acceptable for both new and extension of existing 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 Indonesia, the Philippines and Vietnam. The lack of transparency and clarity in project agreements and the inability to agree on mutually favourable PPAs have led to project delays in the recent years.

In Thailand, while the process of electricity sales to the grid is generally more transparent, as the Thailand PDP predetermined the required allocation of power generation from IPPs, the off-taker for IPPs is usually the Electricity Generating Authority of Thailand (**"EGAT"**), which is an effective monopoly in the industry. Hence, similar to the other SEA countries, IPPs in Thailand have little or no power to negotiate tariffs with state-owned utility and could be subjected to changes in Government policies on specific fuel source of power generation. Meanwhile in Laos, the Government often solicit foreign investors into the IPP segment by being accommodative and varying according to the needs of these foreign investors[9]. This led to the Asian Development Bank's (**"ADB"**) findings that the Government of Laos lacked transparency on the guidelines regarding the award of IPP contracts as well as the negotiation outcome on the terms of agreement[10].

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 Indonesia, the Philippines, Myanmar and Vietnam, where PPAs are characterised by lengthy negotiations and bureaucratic processes, prolonged negotiations can result in a longer project completion cycle. For example, there are uncertainties surrounding the 2,000.0 MW Batang power plant in Indonesia due to delays in land acquisition which in turn resulted in delays in the commencement of construction. The project was originally scheduled to commence construction in 2012. IPPs need to have a strong relationship with their lenders in order to be able to negotiate for flexibility in 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 neighbouring 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 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.

1.3 INDUSTRY OUTLOOK AND PROSPECTS

Coal-fired market is estimated to be the largest contributor in terms of MW additions to the overall power generation market in SEA due to the abundant availability of coal reserves, whereby its member nation, Indonesia, is ranked the fifth largest coal producer globally as of 2014. SEA accounted for 35.4 GW (2.2%) of the world's coal-fired capacity of 1,605.0 GW during 2010 and is likely to increase substantially to 114.9 GW (5.2%) of the world's estimated coal-fired capacity of 2,211.0 GW by 2030. Indonesia and Vietnam are the two major markets

[9] Technical Notes on Fiscal Regime in the Hydropower Sector published by the Ministry of Energy and Mines
[10] "Sector Assistance Program Evaluation for the Energy Sector in Lao PDR" published by the ADB in 2010

within the SEA region to have set forth ambitious plans to pursue coal-fired power plants for future base load power generation. Vietnam alone is likely to contribute 27.6% of the total coal-fired capacity in SEA. Thailand, increasingly dependent on gas imports, is also building more coal-fired plants including export-oriented plants in neighbouring Laos. Thailand's fairly high share of gas-fired power and its relatively limited gas resources make coal the ideal fuel for future base load power generation. Despite concerns raised by the environmental groups, coal-fired power plants are expected to dominate the installed capacity additions during the forecast period mainly because of high availability and more competitive pricing of coal. More coal from the United States of America **("US")** is likely to find its way to Asian markets, thus suppressing prices.

SEA accounted for 69.5 GW (5.3%) of the world's gas-fired capacity of 1,311.5 GW in 2010 and is expected to increase to 157.0 GW (7.8%) of the world's estimated gas-fired capacity of 2,008.0 GW by 2030. SEA is promoting the development of a TAGP by 2020, aimed at improved cross-national links. Upon completion, the scheme will consist of 7,000 km of transmission pipelines. This scheme will facilitate better availability of gas for power plants. Following earlier connections established between Malaysia (the country with the most extensive network currently) and Singapore and Thailand, an important link under construction is the 500 km Sabah-Sarawak pipeline in Eastern Malaysia. Overall, despite increasing penetration of gas-fired installed capacity in SEA, coal-fired capacity is expected to dominate the region throughout the forecast period for base load demand. Nuclear power projects are likely to come online only from 2020 onwards mainly from Vietnam.

In Indonesia and Vietnam, there has been active implementation of new policies and regulations to improve the regulatory framework overseeing the IPP sector and to create a more favourable investment climate for IPP investment.

Indonesia

In May 2015, the Government of Indonesia has released a program to develop an additional 35.0 GW of power capacity by 2019 to mitigate the impact of acute electricity shortages affecting country's economic growth. According to this program, 10.0 GW of capacity would be developed by PLN and the remaining 25.0 GW capacity would be developed through private sector participation in the power sector. Also, out of the 35.0 GW capacity being planned, coal-fired power plants will represent 20.0 GW, and gas-fired power plants as well as renewable energy projects will contribute the remaining capacity. This plan presents huge opportunity for IPPs to not only bid for power projects, but eventually strengthen their foothold in one of the largest power generation markets in SEA. Private companies may create consortiums to operate as IPPs in the market.

Based on the track record of installations under the FTP in Indonesia and the progress of current on-going projects, Frost & Sullivan forecasts that Indonesia is unlikely to achieve the proposed capacity target by 2019 unless there is a strong push for PLN to simplify the PPAs with IPPs.

Myanmar

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

Hydropower plants would continue to dominate the country's electricity mix till 2031 due to its vast untapped potential. As per the 15-year plan, around 20 hydropower plants with a combined capacity of 6,270.0 MW are likely to be built mainly in the Mandalay region and three states of Kachin, Kayin, and Shan. However, high reliance on hydropower 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.

Twelve coal-fired power plants have been planned for commissioning between 2015 and 2031. Eight of these with a combined capacity of 12,780.0 MW would be located in Yangon and Tanintharyi regions due to the concentration of special economic zones and industrial estates in these locations. But there are several environmental concerns associated with them. Until the external project development risks are minimized, development of coal-fired power plants would be slow.

Though Myanmar has been receptive to foreign investments in several industries, the stakeholders are still sceptical of investing in the power market until clear directions in terms of establishing policies, stabilising 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 75,000.0 MW by 2020. The country is about 50,000.0 MW 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 36,000.0 MW or 48.0% of total capacity whereas gas-fired power plants are likely to have a combined capacity of 10,400.0 MW. The 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 the 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 targets by 2020. Engineering, procurement and construction **("EPC")** services companies and original equipment manufacturers **("OEM")** have already taken steps to strengthen their foothold in the attractive power market.

Vietnam can be considered one of the best locations in SEA 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.

The Philippines

The Philippines Energy Plan 2012-2030, which the Department of Energy launched in December 2012, provides the roadmap for future demand and capacity addition. As per the plan, installed capacity is expected to increase to 25,800.0 MW by 2030 from 17,944.0 MW in 2014. Additional capacity is likely to be achieved by adopting coal-fired power plants and geothermal power plants. The Philippines is forecasted to register a moderate electricity consumption growth with CAGR of 4.2% from 2015 to 2020. Electricity demand from the commercial sector continues to remain high due a robust services sector.

As one of the most liberalised electricity market in SEA, transparent of electricity purchase structure and the Government of the Philippines' continuing effort in further privatising the power generation sector makes the Philippines an attractive consideration for foreign investors.

2 ANALYSIS OF THAILAND POWER GENERATION INDUSTRY

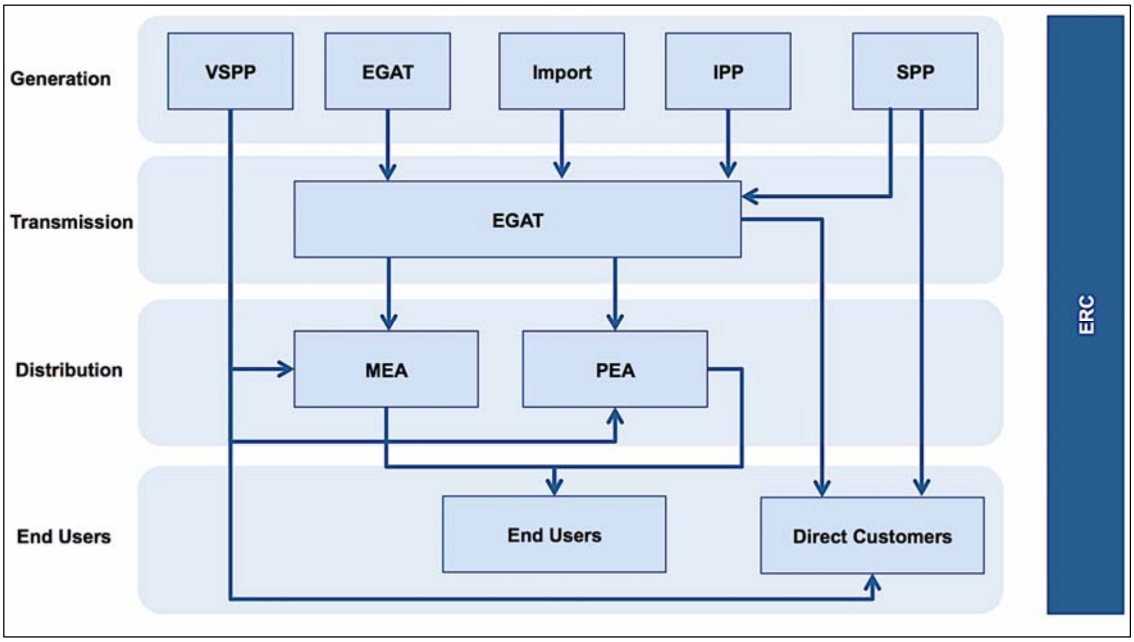
2.1 BACKGROUND OF THE POWER GENERATION INDUSTRY IN THAILAND

Thailand's power industry is largely owned by SOEs. Electricity is generated by both EGAT and private utilities and transmitted by EGAT's owned transmission infrastructure. The electricity is further distributed through two SOEs, namely Metropolitan Electricity Authority ("**MEA**") for the Bangkok metropolitan area and Provincial Electricity Authority ("**PEA**") for other provinces in Thailand.

Private utilities consist of IPPs, Small Power Producers ("**SPPs**"), and Very Small Power Producers ("**VSPPs**"). IPPs are private utilities that operate power plants with capacities of more than 90.0 MW and sell electricity directly to EGAT through the transmission grid. SPPs operate small power plants with capacities between 10.0 to 90.0 MW and sell most of the electricity generated through transmission grid to EGAT. However, SPPs can supply both power and heat directly to industrial customers. On the other hand, VSPPs are mostly renewable power plants with less than 10.0 MW capacity, connected directly to the distribution grid owned by MEA and PEA. Imported electricity is connected through the EGAT's transmission grid from Laos and Malaysia.

The entire value chain of the power sector in Thailand is governed by a regulatory body called the ERC. ERC is responsible to oversee the regulations encompass power generation, T&D, electricity tariffs, licensing and approval of PPA.

Figure 2-1: Power Sector Structure in Thailand



Source: Frost & Sullivan

2.1.1 Pricing Structure

IPP contracts

In Thailand, EGAT awards IPP contracts, known as PPAs, to utility-scale power producers and this arrangement has been in operation since 1994. Private entities are open to participate in the bidding of PPA which states the maximum amount of power generated that EGAT will purchase. The award of PPA is dependent on the approval of the cabinet and largely follows the Thailand's PDP. During the bidding process, participants can propose fuel selection and location, with conditions, such as the environmental standards to be met. A PPA gives EGAT the authority to commence 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 with the possibility of renewal for both short term (5 years) and long term (10 - 15 years), depending on power plants' condition, maintenance and upgrades.

Power producers engaged in PPAs receive Availability Payment ("**AP**")[11] and Energy Payment ("**EP**")[12] in accordance with a dual tariff structure.

SPP contract

A SPP contract is a type of PPA that EGAT awards to power producers for installed capacity not exceeding 90 MW. Similar to the IPPs, the contract is open for private entities to participate in but usually has a maximum amount of power generated that EGAT will purchase. The award of SPP contracts is also dependent on the approval of the cabinet and largely follows the Thailand PDP. The development of the SPP industry in Thailand is 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 on the operation of the power plant. The power plant will also be penalised 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**")[13] 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.

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 it is unable to deliver power according to committed quantity. This arrangement attracts the participation of co-generation and renewable energy power generation

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[11] AP is a 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 capital expenditures, interests, fixed cost in operation and maintenance, insurance premium, and dividends for shareholders.
[12] EP is 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.
[13] CP is based on actual kilowatts produced multiplied by a capacity charge covering investment costs plus foreign exchange fluctuations.

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 5 years on a renewable basis.

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 10.0 MW. 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. In particular, VSPP is used to promote the renewable energy power generation industry since the implementation of Feed-In-Tariff ("**FiT**") scheme. VSPP contracts are usually valid for 5 years on a renewal basis.

The current Thailand electricity tariff is as follows:

Table 2-1: Electricity Tariffs in Thailand by Customer Group (as of August 2015)

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)		1.8632	Baht/ kWh
Next 10 kWh (16th – 25th)		2.5026	Baht/ kWh
Next10 kWh (26th – 35th)		2.7549	Baht/ kWh
Next 65 kWh (36th – 100th)		3.1381	Baht/ kWh
Next 50 kWh (101st – 150th)		3.2315	Baht/ kWh
Next 250 kWh (151st – 400th)		3.7362	Baht/ kWh
Over 400 kWh (up from 401st)		3.9361	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)		2.7628	Baht/ kWh
Next 250 kWh (151st – 400th)		3.7362	Baht/ kWh
Over 400 kWh (up from 401st)		3.9361	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.	4.5827	2.1495	312.24
1.3.2 : Below 12 kV.	5.2674	2.1827	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 Normal tariff		
2.1.1 : 12 - 24 kV	3.423	312.24
2.1.2 : Below 12 kV		46.16
First 150 kWh (1st – 150th)	2.7628	
Next 250 kWh (151st – 400th)	3.7362	
Over 400 kWh (up from 401st)	3.9361	

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	4.5827	2.1495	312.24
2.2.2 : Below 12 kV	5.2674	2.1827	46.16

Schedule 3: Medium General Service

3.1 Normal tariff			
Monthly Tariff			
Voltage level	**Demand Charge (Baht/kW)**	**Energy Charge (Baht/kWh)**	**Service Charge (Baht/month)**
3.1.1 : 69 kV and over	175.7	2.6506	312.24
3.1.2 : 12-24 kV	196.26	2.688	312.24
3.1.3 : Below 12 kV	221.5	2.716	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	3.5982	2.1572	312.24
3.2.2 : 12-24 kV	132.93	0	3.6796	2.176	312.24
3.2.3 : Below 12 kV	210	0	3.8254	2.2092	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	224.3	29.91	0	2.6506	312.24
4.1.2 : 12 - 24 kV	285.05	58.88	0	2.688	312.24
4.1.3 : Below 12 kV	332.71	68.22	0	2.716	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	3.5982	2.1572	312.24
4.2.2 : 12-24 kV	132.93	0	3.6796	2.176	312.24
4.2.3 : Below 12 kV	210	0	3.8254	2.2092	312.24

Schedule 5: Specific Business Service

5.1 Normal tariff
Monthly Tariff

5.1 Normal tariff			
Voltage level	**Demand Charge** (Baht/kW)	**Energy Charge** (Baht/kWh)	**Service Charge** (Baht/Month)
5.1.1 : 69 kV and over	220.56	2.6506	312.24
5.1.2 : 12 – 24 kV	256.07	2.688	312.24
5.1.3 : Below 12 kV	276.64	2.716	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	3.5982	2.1572	312.24
5.2.2 : 12-24 kV	132.93	0	3.6796	2.176	312.24
5.2.3 : Below 12 kV	210	0	3.8254	2.2092	312.24

Schedule 6: Non-Profit Organisation

6.1 Normal tariff		
Monthly Tariff		
Voltage level	**Energy Charge (Baht/kWh)**	**Service Charge (Baht/Month)**
6.1.1 : 69 kV and over	2.9558	312.24
6.1.2 : 12 – 24 kV 3.2193	3.1258	312.24
6.1.3 : Below 12 kV		20
First 10 kWh (1st-10th)	2.3422	
Over 10 kWh (up from 11st)	3.4328	

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	3.5982	2.1572	312.24
6.2.2 : 12-24 kV	132.93	0	3.6796	2.176	312.24
6.2.3 : Below 12 kV	210	0	3.8254	2.2092	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)	1.6033
Over 100 kWh (up from 101st)	2.7549
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	3.6531	2.1495	228.17

7.2.2 : Below 12 kV	210	0	3.7989	2.1827	228.17

Schedule 8: Temporary Tariff

8.1 Monthly Tariff			
Energy charge (All voltage level)	Baht	6.3434	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 Labour Day and normal public holiday

(excluding substitution holiday and Royal Ploughing Day) from 00.00 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% 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.

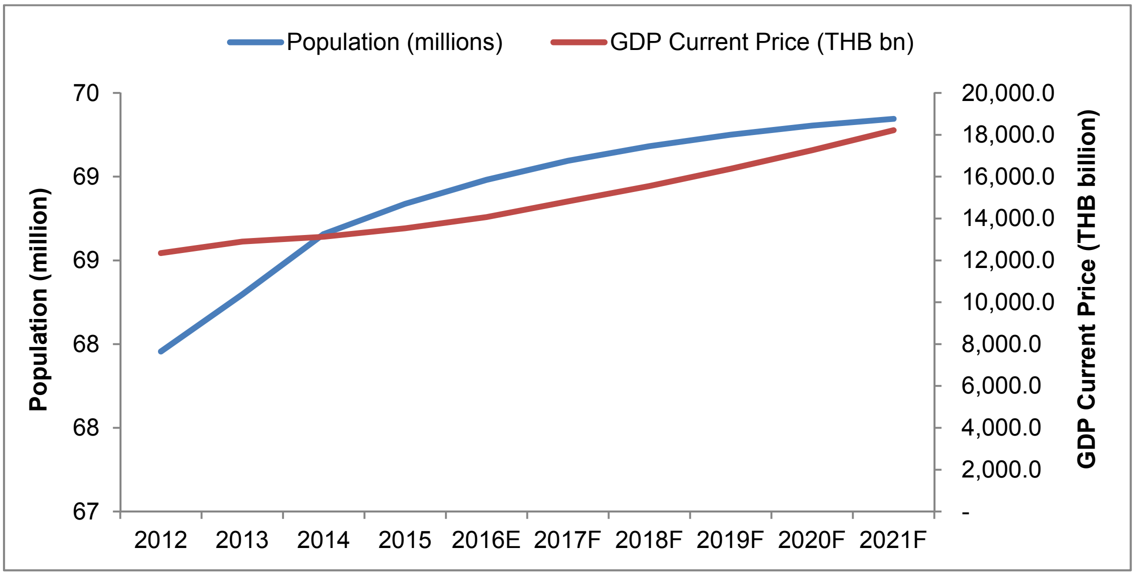
Source: MEA, PEA

2.2 DEMAND CONDITIONS

Electricity demand in Thailand is expected to grow in tandem with the increasing population and rising GDP. Thailand's population is expected to grow from 68.8 million in 2015 to 69.3 million by 2021 at a CAGR of 0.1%. GDP is expected to achieve a CAGR of 5.1% from 13,537.5 billion Thai Baht in 2015 to 18,219.9 Thai Baht in 2021[14].

[14] IMF, World Economic Outlook Database, 2016

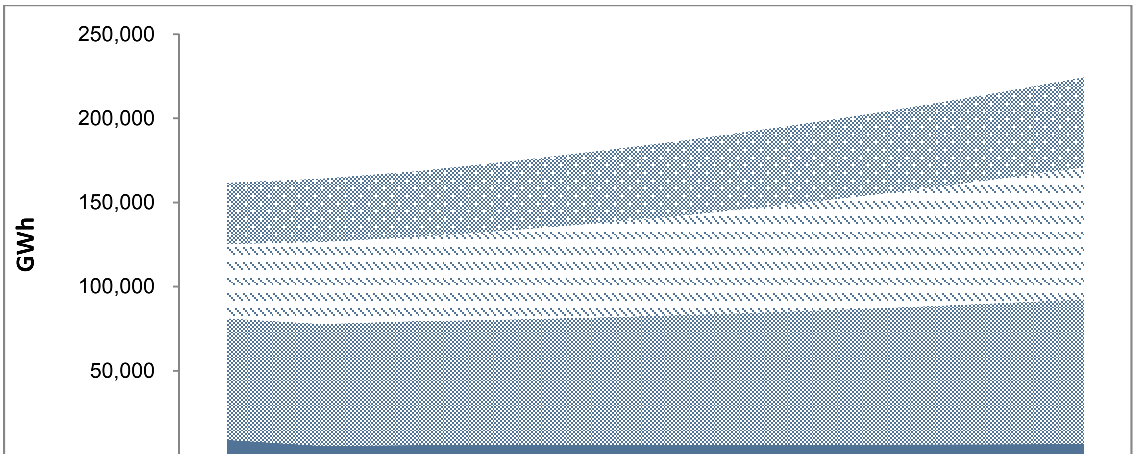
Chart 2-1: Population and GDP Growth Trend in Thailand, 2012 - 2021F



Source: IMF

Electricity consumption in Thailand increased at a CAGR of 2.6% from 161,799 GWh in 2012 to 174,833 GWh in 2015. Frost & Sullivan estimates that electricity consumption will register a higher growth at a CAGR of 4.3% between 2016 and 2021 from 181,473 GWh in 2016 to 224,443 GWh in 2021.

Chart 2-2: Total Electricity Consumption by Consumer Group in Thailand, 2012 - 2021F



	2012	2013	2014	2015	2016F	2017F	2018F	2019F	2020F	2021F
Residential	36447	37657	38993	41286	43061	44913	46889	48952	51204	53559
Commercial	44,102	48,787	50,169	52,987	56,431	60,099	64,186	68,551	73,349	78,484
Industrial	72,336	72,536	73,782	74,773	76,119	77,489	79,427	81,412	83,692	86,035
Others	8,894	5,261	5,741	5,787	5,862	5,938	6,028	6,118	6,240	6,365
Total	161,779	164,241	168,685	174,833	181,473	188,439	196,530	205,033	214,485	224,443

*Source: Energy Policy and Planning Office ("**EPPO**"), Ministry of Energy Thailand, Frost & Sullivan*

From 2012 to 2015, electricity consumption in Thailand is the highest in the industrial sector followed by the commercial sector and the residential sector. In the period between 2012 and 2015, electricity consumption by the commercial sector grew the fastest from 44,102 GWh to 52,987 GWh at a CAGR of 6.3%, closely followed by the residential sector from 36,447 GWh to 41,286 GWh at a CAGR of 4.2%. On the contrary, growth of electricity consumption in the industrial sector remained stagnant at a CAGR of 1.1% from 72,336 GWh in 2012 to 74,773 GWh in 2015 due to prolonged political uncertainties and the aftermath of the great flood in 2011. Despite setbacks in the industrial sector, projections through 2021 indicated that the industrial sector will remain as the largest consumer among three major consumer sectors with the upcoming industrial estates within the Special Economic Zones comprising 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 2.7% from 2,380.6 kWh in 2012 to 2,579.9 kWh in 2015. Moving forward, Frost & Sullivan estimated that the electricity consumption per capita in Thailand to grow from 2,653.4 kWh in 2016 to 3,237.3 kWh in 2021 at a CAGR of 4.1%.

2.2.1 Key Growth Drivers & Constraints

2.2.1.1 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, the National Energy Policy Council ("**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**"). Upon the completion of the public hearing process in 2015, PDP 2015 is expected to give confidence to investors, as it will enhance the main energy regulatory framework for the country. PDP 2015 is also likely to spur the growth of the power generation industry in Thailand, as more companies may be attracted to enter into the power generation business.

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 cooperation 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 1.0 MW in installed capacity are not required to obtain factory permit (Ror Ngor 4) from the Department of Industrial Works. On the other hand, Government initiatives to support the use of Electric Vehicle technology is also an example of supportive Government policy, as switching from conventional automobile fuel to electricity could increase the electricity consumption in Thailand.

AEC EXPANDS REGIONAL SUPPLY AND DEMAND POTENTIALS

According to the AEC Blueprint, SEA countries will be transformed into an economic region, known as the AEC by 2015. The AEC is envisaged to carry the characteristics of a single market and production base, a highly competitive economic region, a region of equitable economic development as well as a region fully integrated with the global economy. Free flow of goods, services, investment, and capital 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 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.

2.2.1.2 Growth Constraints

PUBLIC OPINION AGAINST THE CONSTRUCTION OF NEW POWER PLANTS

Unlike most developing SEA countries, construction of new power plants has faced negative public opinion in Thailand, 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 criticised for harmful dust and sulfur dioxide emissions. There was also protest against a new 800.0 MW coal-fired power plant project in Krabi province and also against Nakorn Sri Thammart's new city plan, which include the development of coal-fired power plants and chemical plants within the province.

ECONOMIC UNCERTAINTIES AND ECOLOGICAL FACTORS IMPACTING ELECTRICITY DEMAND

Electricity consumption in the industrial sector in Thailand is correlated to global economic conditions. For example, China is Thailand's largest trading partner in 2014[15], accounting for US$25.0 billion of trade values. In 2014, the top 5 exports from Thailand to China involved energy intensive manufacturing and process industries and accounted for 63.2% of total trade value. The Chinese economy is forecast to slowdown in 2015, growing at a slower rate of 7.4% in 2015[16], which is likely to slow down demand for Thailand exports. Hence, this is expected to affect the growth in electricity consumption by the industrial sector in Thailand due to reduced industrial activities. However, the devaluation of the Chinese Yuan in August 2015 is expected to boost Chinese industrial activity, which will mitigate the downside risk in electricity demand posed by the Chinese economic slowdown.

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[15] Ministry of Commerce, Thailand

[16] National Bureau of Statistics, China

Table 2-2: Top 5 Thailand exports to China, 2014

No.	Product	Trade Value (US$ billion)	Percentage of total trade value
1	Rubber and articles thereof	4.6	18.5%
2	Plastics and articles thereof	3.2	13.0%
3	Machinery, boilers, engines, pumps etc.	3.0	11.8%
4	Electrical and Electronic equipment	2.6	10.5%
5	Organic chemicals	2.4	9.4%

Source: Trademap, UN Comtrade, Frost & Sullivan

Thailand is also in the midst of a severe drought[17], which resulted to the delay in agricultural output and subsequently impacting the supplies of raw materials for the food processing industry. As a result, the shortage of supplies is expected to reduce manufacturing activities in the food processing industry and hence reduces the electricity consumption.

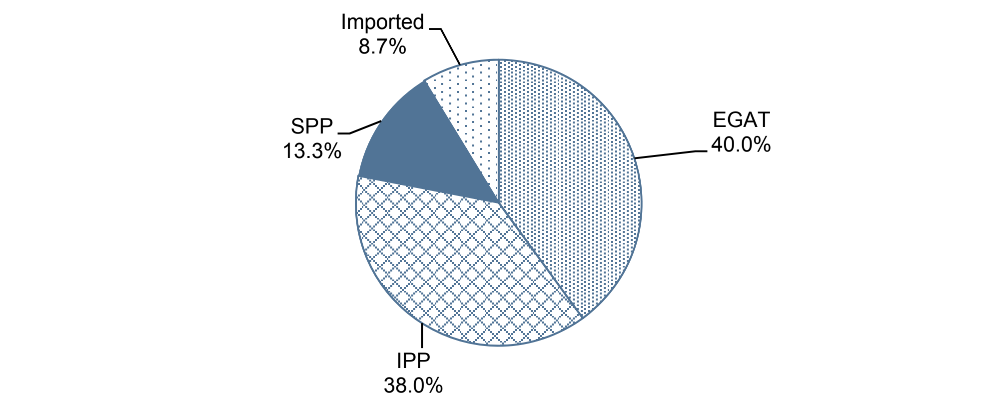
2.3 SUPPLY CONDITIONS

2.3.1 Installed Capacity

According to EPPO Energy Statistics, in 2015, total installed capacity in Thailand was recorded at 38,814.7 MW, of which 40.0% or 15,518.1 MW was owned by EGAT. In Thailand, IPPs and SPPs held 38.0% or 14,767.0 MW and 13.3% or 5,143.5 MW of the total installed capacity respectively. Thailand also imported 8.7% or 3,386.0 MW of its total installed capacity from Laos and Malaysia. The three largest domestic private power generation companies in Thailand based on effective capacity in 2014 were Ratchaburi Electricity Generating Holding Company Limited ("RATCH") with 4,566.6 MW, Electricity Generating Public Company Limited ("EGCO") with 2,354.8 MW and Glow Energy Public Company Limited ("GLOW") with 1,876.4 MW.

[17] Time: "Thailand is Suffering from the Worst Draught in Decades, July 2015

Figure 2-2: Installed Capacity (MW) by Power Generation Players in Thailand, 2015



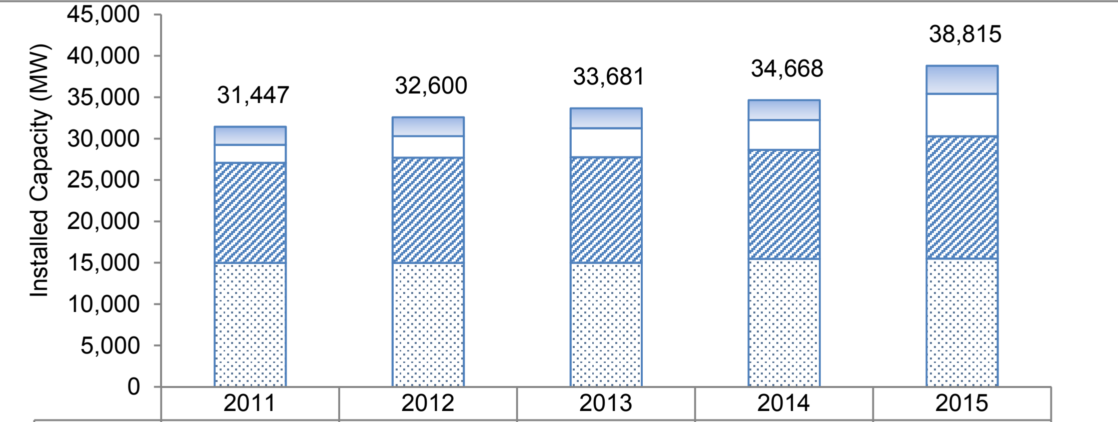
Note: Installed capacity includes only contracted capacity on EGAT transmission system and excludes capacity from VSPP.
Source: EPPO Energy Statistics

Installed capacity in Thailand from 2011 to 2015 had been dominated by EGAT and IPPs. EGAT maintained its largest share of installed capacity from 47.7% or 14,998.0 MW in 2011to 40.0% or 15,518.1 MW in 2015 with the lowest CAGR of 0.9% among all the power generation players. Similarly, IPPs maintained its second largest share of installed capacity from 38.4% or 12,082.0 MW in 2011 to 38.0% or 14,767.0 MW in 2015 with a CAGR of 5.1%.

The installed capacity share of SPPs and imported sources had been on the rise from 2011 to 2015. The installed capacity of SPPs recorded the highest CAGR of 23.9%, having increased from 2,182.0 MW in 2011 to 5,143.5 MW in 2015. The high growth of SPPs is mainly supported by the PDP that promotes co-generation from SPPs and the Government's initiative for fuel diversification to reduce dependency on natural gas in power generation.

The installed capacity from imported sources (Laos and Malaysia) achieved a CAGR of 11.64% over the same period from 2,185.0 MW to 3,386.0 MW, mainly attributed to capacity added from Nam Ngum 2 hydropower plant in Laos with capacity of 596.6 MW.

Figure 2-3: Historical Installed Capacity (in MW) in Thailand, 2011 - 2015



	2011	2012	2013	2014	2015
Imported	2,185	2,282	2,405	2,404	3,386
SPP	2,182	2,608	3,525	3,615	5,144
IPP	12,082	12,714	12,742	13,167	14,767
EGAT	14,998	14,996	15,010	15,482	15,518
Total	31,447	32,600	33,681	34,668	38,815

Source: EPPO Energy Statistics

The top 10 largest power plants by contracted capacity are largely dominated by natural gas as fuel source, with Bang Pakong gas-fired power plant owned by EGAT being the largest power plant with contracted capacity of 4,384.6 MW. On the other hand, the Ratchaburi power plant, which mainly operates on natural gas, is the largest power plant owned by an IPP by contracted capacity with 3,481.0 MW. Meanwhile, BLCP Power Plant, jointly owned by Banpu Power Public Company Limited ("**Banpu Power**") and EGCO, is the largest power plant in the country which utilise coal as fuel source, with a contracted capacity of 1,346.5 MW.

Table 2-3: List of Top 10 Largest Power Plants in Thailand, 2014

Name	Type	Ownership	Fuel Source	Contracted Capacity (MW)
Bang Pakong Power Plant	EGAT	EGAT (100%)	Natural Gas, Fuel Oil, Diesel	4,384.6
Ratchaburi Power Plant	IPP	RATCH (99.99%)	Natural Gas or Fuel Oil	3,481.0
Mae Moh Power Plant	EGAT	EGAT (100%)	Lignite	2,400.0
Wang Noi Power Plant	EGAT	EGAT (100%)	Natural Gas or Diesel	2,027.1
South Bangkok Power Plant	EGAT	EGAT (100%)	Natural Gas	1,690.6
Gulf JP Nong Saeng	IPP	J-Power Holdings Thailand (90%)	Natural Gas	1,600.0
GPG Saraburi (Kaeng Khoi 2)	IPP	EGCO (50%), J-Power Holding Thailand (49%)	Natural Gas	1,468.0

Name	Type	Ownership	Fuel Source	Contracted Capacity (MW)
Ratchaburi Power's Power Plant	IPP	RATCH (25%), Global Power Synergy (15%)	Natural Gas	1,400.0
BLCP Power Plant @ Rayong	IPP	Banpu Power (50%), EGCO (50%)	Bituminous (Coal)	1,346.5
Lam Ta Khong Hydropower Plant	EGAT	EGAT (100%)	Hydro	1,000.0

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

Source: EGAT, Frost & Sullivan Analysis

EGAT ranks the power plant merit order by fuel costs. Hydropower plants have the highest priority in the order of merit in EGAT's system. All the large hydropower plants are owned by EGAT. The Mae Moh Power Plant, the only large lignite power plant in Thailand, owned by EGAT, has a second order of merit in the power system. Imported coal-fired power plants have the third order of merit in the power system in Thailand. 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 2-4: Merit Order of Power Plants in Thailand

Merit order	Type of fuel use/ Power plants	Description	Top 3 largest by contracted 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. Lam Ta Khong Hydropower Plant, 1,000.0 MW (EGAT) 2. Bhumibol Dam, 743.8 MW (EGAT) 3. Srinagarind Dam, 720.0 MW (EGAT)
2	Lignite	Second lowest cost. EGAT operates these plants all the time, except during maintenance period.	1. Mae Moh Power Plant, 2,400.0 MW (EGAT)
3	Imported Coal	BLCP Power Plant and Gheco-One are included in this category.	1. BLCP Power Plant, 1,346.5 MW (IPP) 2. Gheco-One, 660.0 MW (IPP)
4	Natural Gas	Thailand relies a lot on natural gas. Higher cost than coal.	1. Bang Pakong Power Plant, 4,384.6 MW (EGAT) 2. Ratchaburi Power Plant, 3,481.0 MW (IPP) 3. Wang Noi Power Plant, 2,027.1 MW (EGAT)
5	Fuel Oil and Diesel	Highest cost. EGAT only operates these plants when there is insufficient supply of natural gas.	

Note: Fuel Oil and Diesel as are usually used as supplementary fuels for natural gas power plant

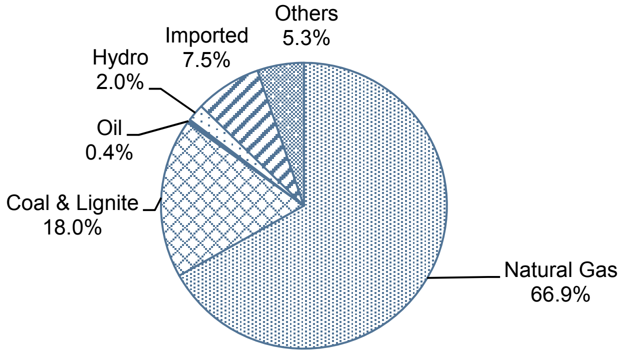
Source: ERC Presentation, 2012[18], Frost & Sullivan Analysis

In 2015, the total electricity generated in Thailand was recorded at 192,190 GWh. Electricity generation in Thailand was largely dominated by natural gas, with 66.9% share or 128,525 GWh. Followed by coal and lignite, which constituted the second largest share of fuel mix, with 18.0% share or 54,582.1 GWh. Imported electricity, with 7.5% share or 14,414.5 GWh, was

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

ahead of hydro electricity generation in terms of electricity generated by different fuel mix with 2.0% share or 3,760.7 GWh. The remaining electricity generated in Thailand were from oil, with 0.4% share or 796.9 GWh and other generation sources including renewable energy, with 5.3% share or 10,110.3 GWh.

Figure 2-4: Electricity Generated by Different Fuel Mix in Thailand, 2015



Source: EPPO Energy Statistics

The electricity generation trend had been on the rise with a CAGR of 4.0% from 164,090 GWh in 2011 to 192,190 GWh in 2015.

Natural gas remained the dominating fuel mix from 66.0% share or 108,261 GWh in 2011 to 66.9% share or 128,525 GWh in 2015 with a CAGR of 4.4%.

Due to the high level of dependence on natural gas in Thailand's electricity generation and depletion of domestic natural gas reserves, which will run out by 2022 at the 2015 rate of natural gas extraction of 4,075.0 million standard cubic feet per day (**"mmscfd"**)[19], concerns have been raised regarding the security of the electricity supply. Coal and lignite, being the cheaper source of energy compared to natural gas, had been increasingly adopted by the Thailand power producers, which had increased its contribution from 19.3% share or 31,712 GWh in 2011 to 20.8% share or 37,572 GWh in 2014 with a CAGR of 6.0%. The increase of power generation by coal-fired plants is also in line with the one of the key initiative under PDP 2010 (Rev.3) to increase proportion of electricity generation from coal-fired power plant. In 2015, however, Thailand's coal and lignite fired power generation declined to 34,582 GWh or 18.0% share as a result of the decreased power generation at the Mae Moh power plant due to limitations of transmission system[20].

Electricity generated from imported sources recorded high growth with a CAGR of 7.5%, from 6.6% share or 10,774 GWh in 2011 to 7.5% share or 14,415 GWh in 2015 mainly attributed by the imported electricity from Laos.

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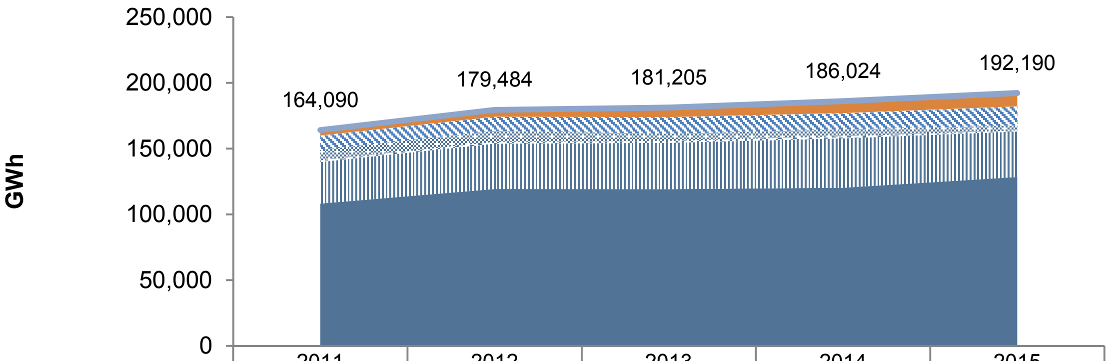
[19] Platts Report on Thailand Oil Gas Exploration, 2015

[20] EPPO: "Energy Situation in year 2015 and trend in year 2016".

Figure 2-5: Historical Electricity Generated by Different Fuel Mix in Thailand, 2011 - 2015



	2011	2012	2013	2014	2015
Others	4,113	5,274	7,234	9,071	10,110
Imported	10,774	10,527	12,572	12,260	14,415
Hydro	7,935	8,431	5,412	5,164	3,761
Oil	1,295	1,300	1,417	1,643	797
Coal & Lignite	31,712	34,583	35,352	37,572	34,582
Natural Gas	108,261	119,368	119,218	120,314	128,525
Total	164,090	179,484	181,205	186,024	192,190

Source: EPPO Energy Statistics

2.3.2 Key Sources of Energy

2.3.2.1 Non-renewable energy

Natural Gas

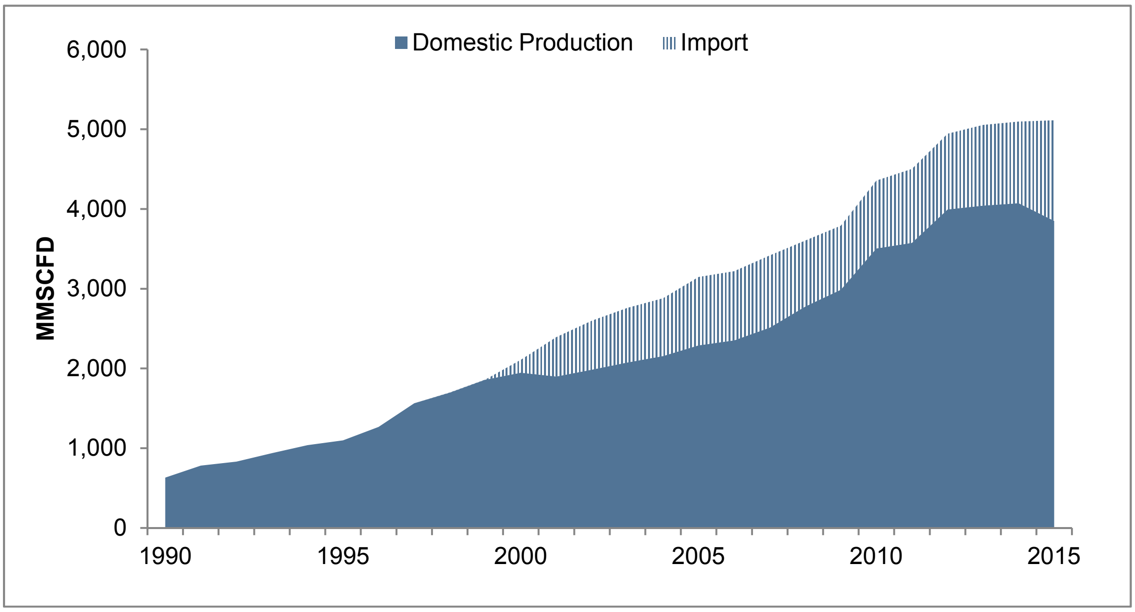
Natural gas has been the dominant energy source for power generation in Thailand over the last three decades. However, there has been a concern of depleting domestic natural gas reserves from 12.7 trillion cubic feet (**"tcf"**) in 2000 to 8.4 tcf as of end of 2013[21] that leads to increasing import of natural gas and LNG. The fuel adjustment tariff has been escalated from 50 satang to 60 satang in May 2014 due to the increasing fuel costs.[22] The tariff hike was mainly attributed to the increase in import LNG for power generation.[23]

In 2015, there were 5,114.0 mmscfd of total domestic Thailand production and import of natural gas. Domestic natural gas production was 3,852.0 mmscfd in 2015, which achieved a CAGR of 4.7% from 1,948.0 mmscfd in 2000. The import of natural gas has recorded high growth with a CAGR of 25.3% from 164.0 mmscfd in 2000 to 1,262.0 mmscfd in 2015. The proportion of

[21] http://blogs.platts.com/2015/03/09/thailand-oil-gas-exploration/
[22] http://www.egat.co.th/en/index.php?option=com_content&view=article&id=197:ft-increased-by-10-satang-per-unit&catid=11:news-release&Itemid=112
[23] http://m.bangkokpost.com/topstories/343442

imported natural gas has grown from 7.8% of the total natural gas supply from 2000 to 24.7% in 2015.

Figure 2-6: Historical Production and Import of Natural Gas in Thailand, 1990 - 2015



*Source: Department of Mineral Fuels (**"DMF"**), PTT Public Company Limited (**"PTT"**), EPPO*

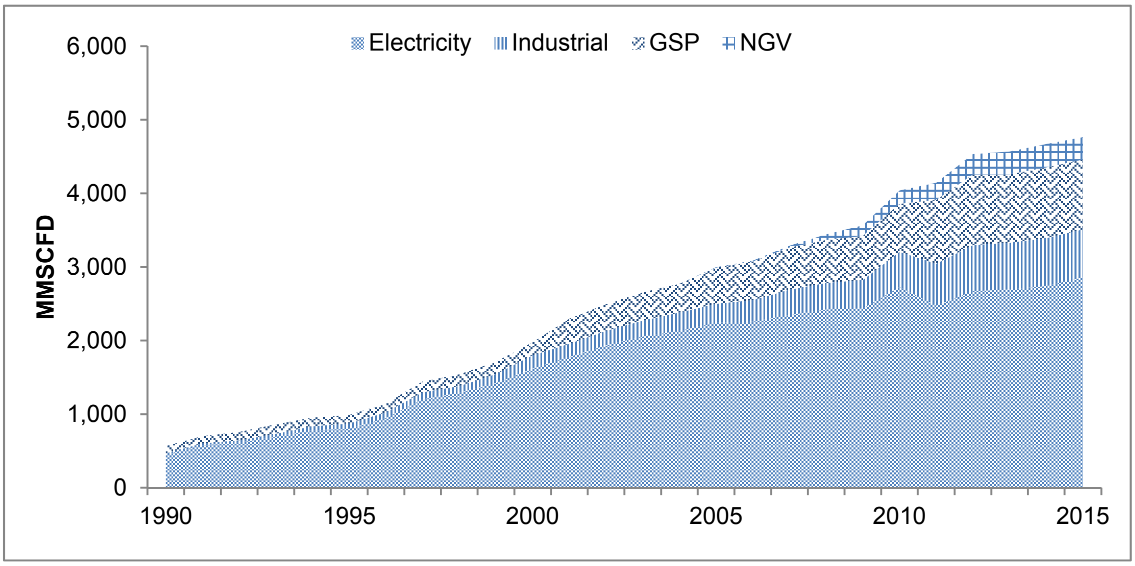
According to the statistics compiled by EPPO, the total consumption of natural gas in Thailand was 4,764.0mmscfd in 2015, of which 60.0% or 2,859.0 mmscfd were consumed for electricity generation. From 2000 to 2015, the total consumption for natural gas recorded a CAGR of 6.0%.

Gas separation plants ("**GSPs**") were the second largest consumer of natural gas, with 19.9% or 950.0 mmscfd consumed in 2015, recorded a CAGR of 11.9% from 175.0 mmscfd in 2000, with the addition of gas separation unit in at PTT plant in Rayong province in 2005 to provide additional petrochimical products such as ethane, propane and liquified petroleum gas (**"LPG"**) for the industry.

There had been increasing consumption of natural gas by the industrial sector, which achieved a CAGR of 8.9%, from 181.0 mmscfd in 2010 to 651.0 mmscfd in 2015, mainly attributed to the expansion of the industrial sector.

Since the introduction of Natural Gas Vehicle ("**NGV**") in 2004, the NGV sector has emerged to be a significant sector for natural gas consumption with 6.4% share or 304.0 mmscfd of the total natural gas consumption by sector in Thailand in 2015. The NGV sector had witnessed an exponential growth with CAGR of 52.2% from merely 3.0 mmscfd in 2004 due to the strong Government push in the utilisation of natural gas in vehicle and the expansion of NGV refuelling stations in Thailand.

Figure 2-7: Historical Consumption Share of Natural Gas by Sector in Thailand, 1990 - 2015



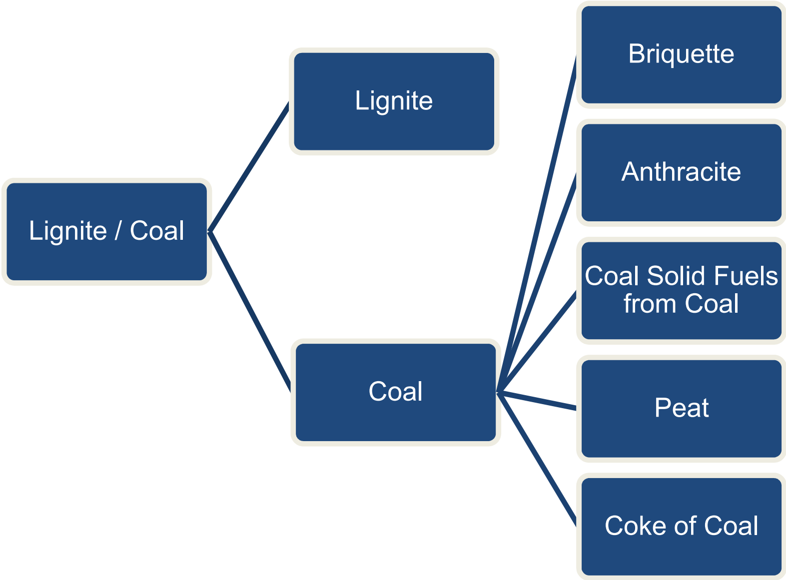
Source: EPPO

Coal

Lignite and coal[24] are used as sources of energy in Thailand for the power generation and industrial sectors. Lignite is produced domestically in Thailand mainly from the mines owned by EGAT. There were a few private producers including Banpu PCL, Siam Cement Group and Green Yellow Company Ltd, which are involved in lignite mining. Coal were fully imported, consist of briquette, anthracite, coal solid fuels, peat and coke of coal.

[24] Lignite, also known as brown coal, composed mainly of volatile matter and moisture continent 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.

Figure 2-8: Type of Lignite / Coal as source of energy in Thailand



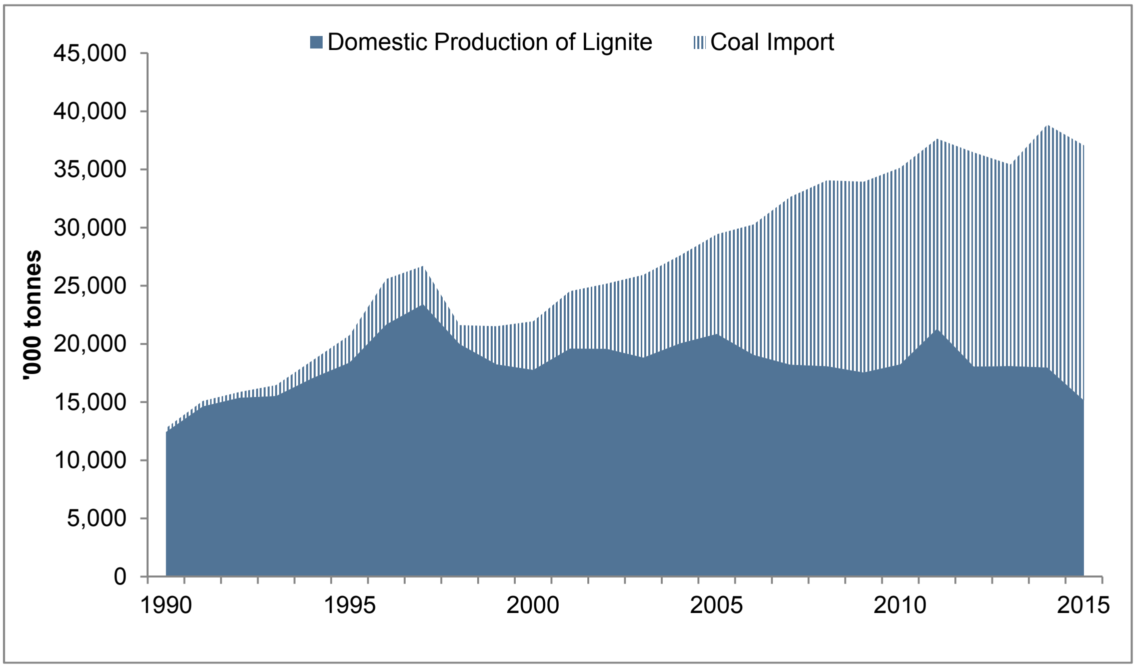
Source: EPPO, Frost & Sullivan

There were 37.1 million tonnes of domestic productions of lignite and coal import in 2015, recorded a CAGR of 3.6% from 22.0 million tonnes in 2000. The share of domestic lignite production and coal import in 2015 were 40.9% or 15.2 million tonnes and 59.1% or 21.9 million tonnes respectively. The domestic production of lignite declined at a CAGR of -3.7% from 18.3 million tonnes in 2010 to 15.2 million tonnes in 2015 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 tonnes, of which 825.0 million tonnes are mineable[25]. The mine is expected to approach depletion by 2047 at current extraction rates of 45,000.0 tonnes per day.

The coal import recorded a growth at a CAGR of 11.7% from 4.2 million tonnes in 2000 to 20.9 million tonnes in 2015, 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.

[25] http://www.austmine.com.au/Portals/25/Content/Documents/Thailand%20Expression%20of%20Interest%20-%20Technologies%20for%20deep%20open-cut%20coal%20mining.pdf

Figure 2-9: Historical Production of Lignite and Coal Import in Thailand, 1990 – 2015



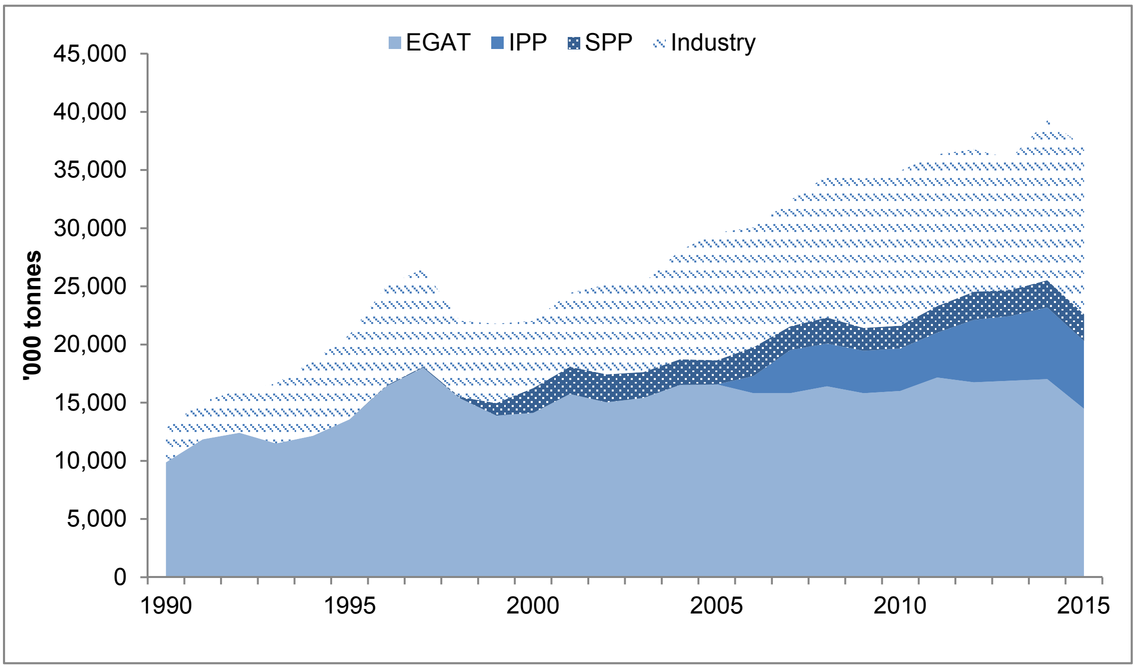
Source: Department of Mineral Resources and EPPO

Coal and lignite consumption in Thailand was 37.0 million tonnes in 2015, and recorded a CAGR of 3.5% from 22.0 million tonnes in 2000.

Lignite and coal were mainly used for power generation, and accounted for 61.1% or 22.6 million tonnes of the total consumption in 2015, of which IPP and SPP consumed 5.8 million tonnes and 2.3 million tonnes of coal respectively and EGAT consumed 14.4 million tonnes of lignite. The consumption of lignite and coal for power generation achieved a CAGR of 2.2% from 16.3 million tonnes in 2000 to 22.6 million tonnes in 2015.

The industrial sector consumed 14.4 million of lignite and coal as fuel source in 2015, and logged a CAGR of 6.3% from 5.8 million tonnes in 2000.

Figure 2-10: Historical Consumption of Coal and Lignite by sector in Thailand, 1990 - 2015



Source: EPPO

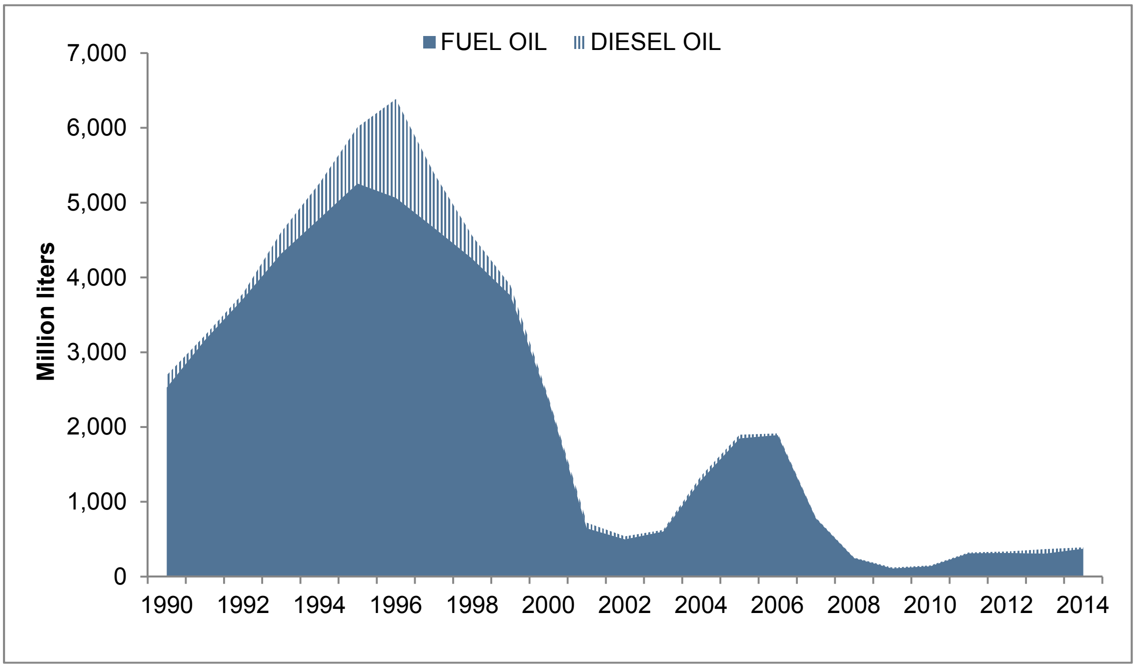
Oil

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 2014, a total of 400.0 million litres of oil were consumed by EGAT for power generation, of which 94.8% or 379.0 million litres were fuel oil.

EGAT has been continuously reduced the fuel consumption in its oil-fired power plant since the peak in 1996 due to the increasing oil prices to minimise its operating costs. Hence, the utilisation of oil for power generation had been on a decline trend with a CAGR of -12.3% from 2,393.0 million litres in 2000 to 400.0 million litres of oil in 2014.

Figure 2-11: EGAT Fuel Consumption in Power Generation in Thailand, 1990 - 2014



Source: EGAT

2.3.2.2 Renewable energy

Hydropower

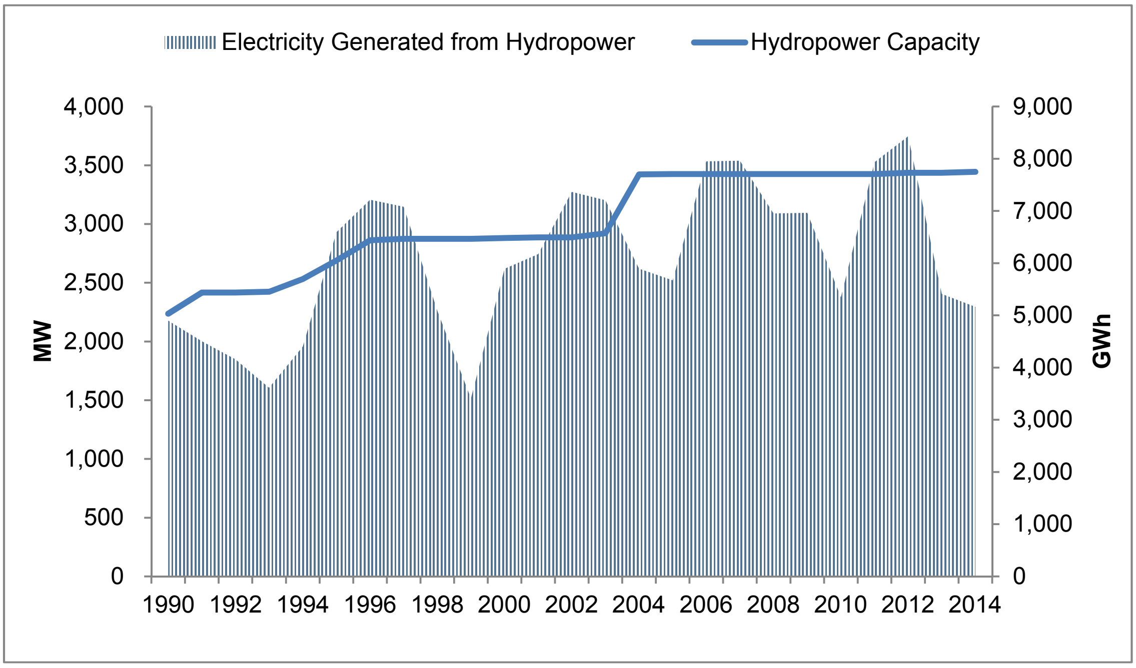
According to EGAT statistics, under the EGAT's power generation fleet, there were 23 hydropower plants with a total installed capacity of 3,444.0 MW in 2014. Between 2000 and 2014, the installed capacity for hydropower plant achieved a CAGR of 1.3% from 2,880.0 MW in 2000. The major addition in the installed capacity is attributed to the Lam Takhong Dam Hydropower Plant with 500.0 MW capacity in 2004.

EGAT added four more hydropower plants in 2015, namely Khun Dan Prakanchol Dam in Nakhon Nayok Province with 10.0 MW installed capacity, Mae Klong Dam in Kanchanaburi Province with 12.0 MW installed capacity, Pasak Jolasid Dam in Lop Buri Province with 6.7 MW installed capacity and Kwae Noi Bamrungdan Dam in Phitsanulok Province with 30.0 MW installed capacity.

Beyond 2015, EGAT has obtained approval for Kiew Komah Dam in Lampang Province with installed capacity of 5.5 MW and is scheduled for commercial operation by 2017. Meanwhile, Chulabhorn Downstream Hydropower Plant in Chaiyaphum Province and Klong Tron Dam in Uttaradit Province, with installed capacities of 1.3 MW and 2.5 MW respectively, are both scheduled for commercial operation by 2018.

The electricity generated from hydropower plants was recorded at 3,761 GWh in 2015, which accounted for only 2.0% of the total electricity generated by various fuel mix in Thailand. Due to its generation flexibility, the electricity generated from hydropower plant is able to accommodate electricity demand and match supply from less flexible electricity sources and variable renewable sources[26]. The electricity generated from hydropower from 1990 – 2014 has been in fluctuation trend due to periodical drought conditions that happened every 5 to 7 years.

Figure 2-12: Hydropower Capacity and Electricity Generated by EGAT in Thailand, 1990 - 2014



Source: EGAT

Solar

Thailand has high renewable power generation potential for solar energy, as the average daily exposure is between 18 – 20 MJ/m^2-day, higher compared to 13 MJ/m^2-day in Japan[27]. 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)[28].

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

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

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[26] IEA: Hydropower Essentials

[27] http://weben.dede.go.th/webmax/content/areas-solar-power-potential

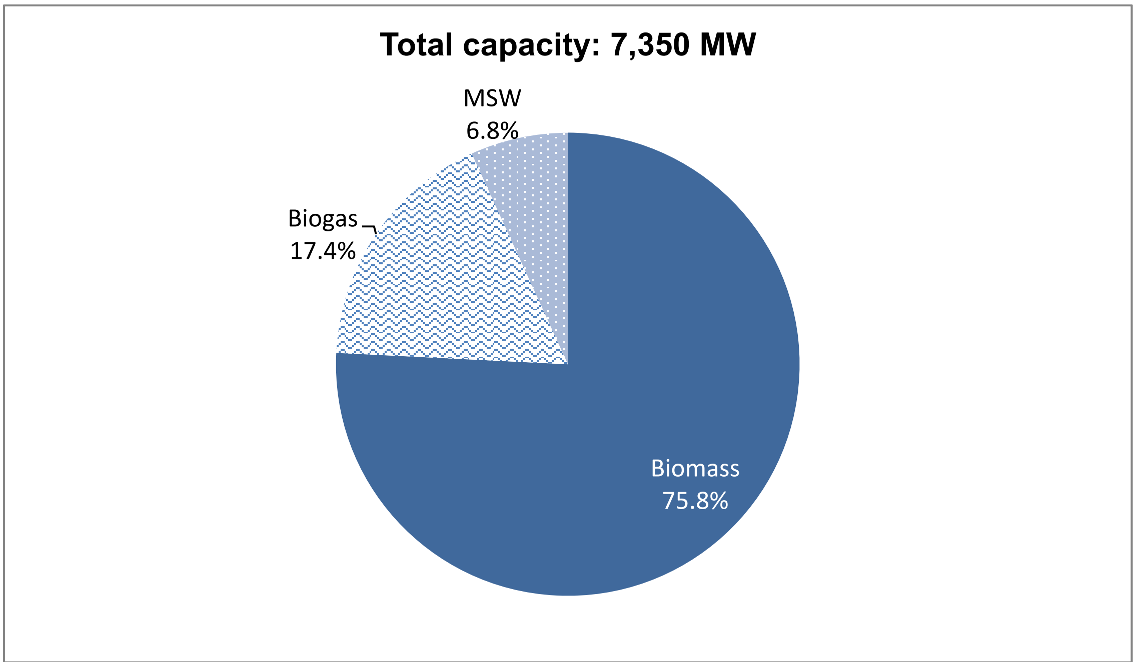
[28] http://www.reeep.org/thailand-2014

expected to be 7,350.0 MW in 2036, of which 75.8% or 5,570.0 MW will be biomass from various agricultural sources, such as rice husks, sugarcane residue, wood scraps and wood chips.

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

The AEDP target for waste to energy from municipal solid waste ("**MSW**")[29] is expected to contribute 500.0 MW, or 6.8 % to the total bioenergy target for electricity generation by 2036.

Figure 2-13: Bioenergy Target for Electricity Generation by 2036 in Thailand



Source: PDP 2015, EPPO

2.3.3 Evolution of Fuel Mix

Electricity generation in Thailand is expected to increase from 192,190GWh in 2015 to 228,238 GWh, as estimated under PDP 2015, in 2020 at a CAGR of 3.5%. In 2015, electricity generation was dominated by natural gas and imported LNG as a fuel source with 66.9% share or 128,525 GWh of the total electricity generated. As PDP 2015 is formulated to diversify Thailand electricity generation fuel mix, fuel dependence on natural gas or LNG imports is expected to decrease from 66.9% in 2015 to 49.4% in 2020 and eventually to 39.4% in 2035.

[29] Waste to energy from MSW is categorized under bioenergy in the AEDP target.

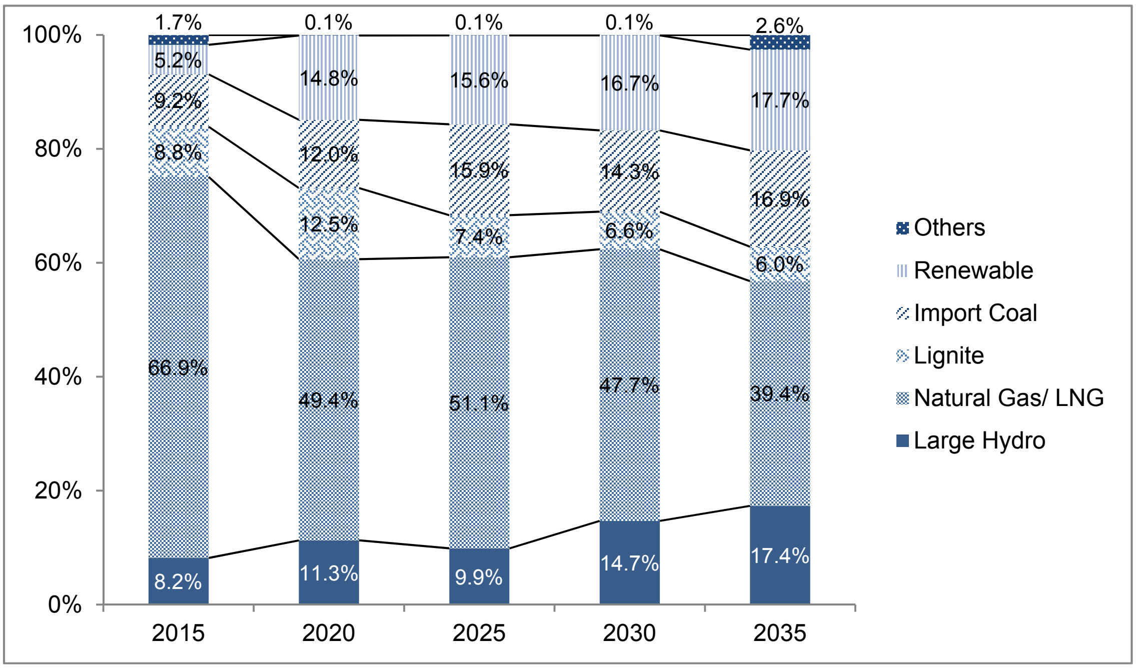
Coal is seen as a potential replacement for the heavy dependence on natural gas. The fuel mix proportion for lignite and imported coal is expected to increase from 8.8% share and 9.2% share in 2015 to 12.5% share and 12.0% share in 2020 respectively. Driven by the promotion of clean coal technology, the share of import coal as electricity generation source is expected to further increase to 16.9% in 2035.

Large hydropower, as a type of renewable source, is expected to gain its share from 8.2% or 15,736GWh in 2015 to 11.3% or 25,761 GWh in 2020, mainly from the increasing import of electricity from the hydropower plant in Laos. The share of large hydro will eventually increase to 17.4% in 2035 with new import of electricity from Myanmar and China.

According to PDP 2015, there will be a strong improvement in the share of renewable energy as source of electricity generation, from 5.2% or 9,985 GWh in 2015 to 14.8% or 33,805 GWh in 2020 with a high CAGR of 27.6%. This is in line with the renewable energy target of 25% in total energy consumption by 2021 including hydropower. A large addition to electricity generation from renewable sources by VSPPs is expected with favourable FiT introduced at the end of 2014.

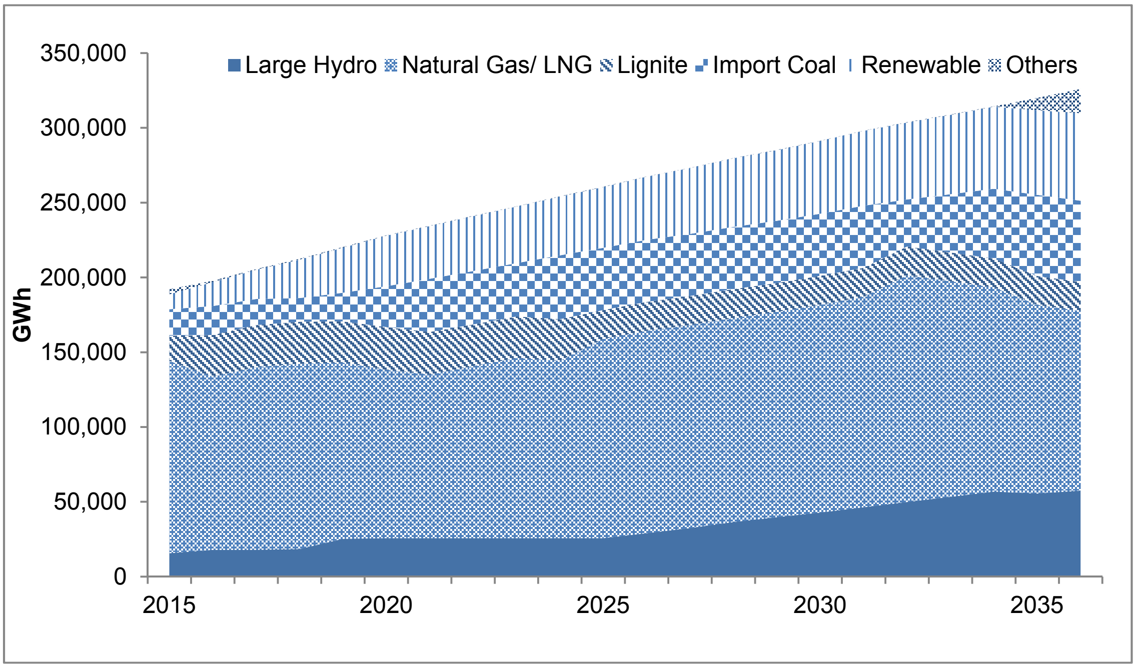
Nuclear power plant is expected to be commissioned in 2035, contributing 8,024 GWh of electricity.

Figure 2-14: Projected Electricity Generation by Fuel Types (%) in Thailand, 2015 - 2035



Source: EPPO

Figure 2-15: Projection of Electricity Generation by Fuel Types in Thailand, 2015 - 2036



Notes:

(1) Electricity generation by large hydro and lignite include import of electricity from Laos;

(2) Others include heavy oil, diesel, interconnection from Tenaga Nasional Berhad Malaysia and nuclear.

Source: EPPO, Frost & Sullivan Analysis

From 2015 to 2024, EGAT is expected to sign PPAs with IPPs with seven projects amounting to a total capacity addition of 8,070.0 MW. The PPAs with SPPs from 2015 to 2019 will have a total capacity of 5,598.0 MW, which comprise 3,660.0 MW of cogeneration projects and 1,938.0 MW of renewable energy projects.

Simultaneously, EGAT is expected to import 3,316.0 MW of contracted generation capacity from five projects in Laos during the same period.

Figure 2-16: Selected Power Plants under construction in Thailand from 2016 to 2024

Expected Commencement Year	Name	Location	Type	Fuel Source	Capacity (MW)
2016	Khao Hin Son Power Station, Units 1-2	Chachoengsao	IPP	Coal	270.0
2017	Khao Hin Son Power Station, Units 3-4	Chachoengsao	IPP	Coal	270.0
2017	Kiew Komah Dam	Lampang	EGAT	Hydro	5.5
2017	Lam Takong Wind Turbine, Phase 2	Nakhon Ratchasima	EGAT	Wind	24.0
2018	Klong Tron Dam	Uttaradit	EGAT	Hydro	2.5
2018	Chulabhorn Downstream Hydropower Plant	Chaiyaphum	EGAT	Hydro	1.3
2019	Krabi Coal-Fired Power Plant	Krabi	EGAT	Coal	870.0
2019	Sepian Xe-Namnoy	Laos	Import	Hydro	354.0

Expected Commencement Year	Name	Location	Type	Fuel Source	Capacity (MW)
2019	Nam Ngiep 1	Laos	Import	Hydro	269.0
2019	Xayaboury	Laos	Import	Hydro	1,220.0
2021	Thepa Power Plant, unit 1	Songkla	EGAT	Coal	1,000.0
2024	Thepa Power Plant, unit 2	Songkla	EGAT	Coal	1,000.0

Source: EGAT, Frost & Sullivan Analysis

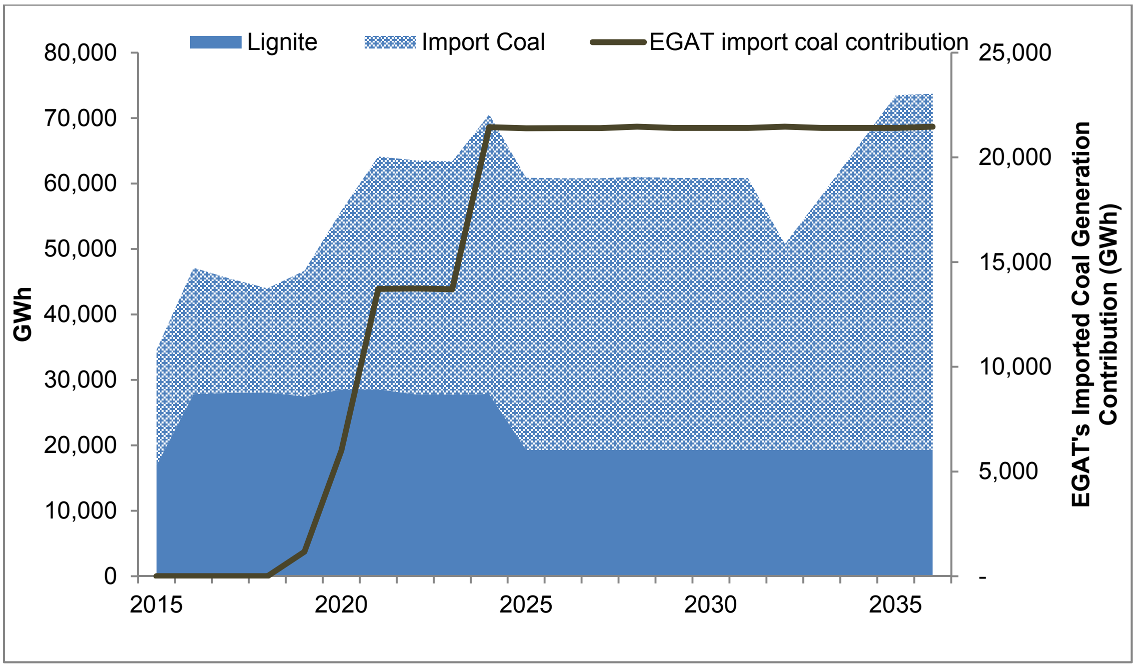
2.3.3.1 Thermal Coal outlook in Thailand

Thailand has lignite reserves of 1.2 billion tonnes[30], as at end of 2014. The domestic lignite produced serves mainly as fuel source to EGAT's power plants. The coal-fired power plants owned by IPP and SPP mainly run on imported coal. As the PDP in Thailand is focusing on fuel mix diversification and gradual reduction in the dependency on natural gas for power generation, lignite or coal is likely to be the alternative fuel source in thermal and combined heat and power (**"CHP"**) plants.

The electricity generation from domestically produced lignite is expected to reach a peak of 28,563 GWh in 2021 before maintaining at 19,280 GWh level beyond 2025. This is due to the expected decommissioning of Mae Moh Coal-fired Power Plant Unit 8 – 9 with capacity of 540.0 MW in 2022 and Unit 10 – 13 with capacity of 1,080.0 MW in 2025. On the contrary, the electricity generation from imported coal is expected to increase at a CAGR of 5.5% from 17,650 GWh in 2015 to 54,365 GWh in 2036. According to PDP 2015, EGAT will start contributing import coal fuel mix starting from 2019 with 1,168 GWh and is expected to increase to 21,464 GWh by 2036. However, a dip for import coal in 2032 is expected from the planned decommissioning of BLCP Power Plant with 1,346.5 MW.

[30] BP Statistical Review of World Energy 2015

Figure 2-17: Projection of Electricity Generation from Lignite and Coal, Thailand, 2015 - 2036



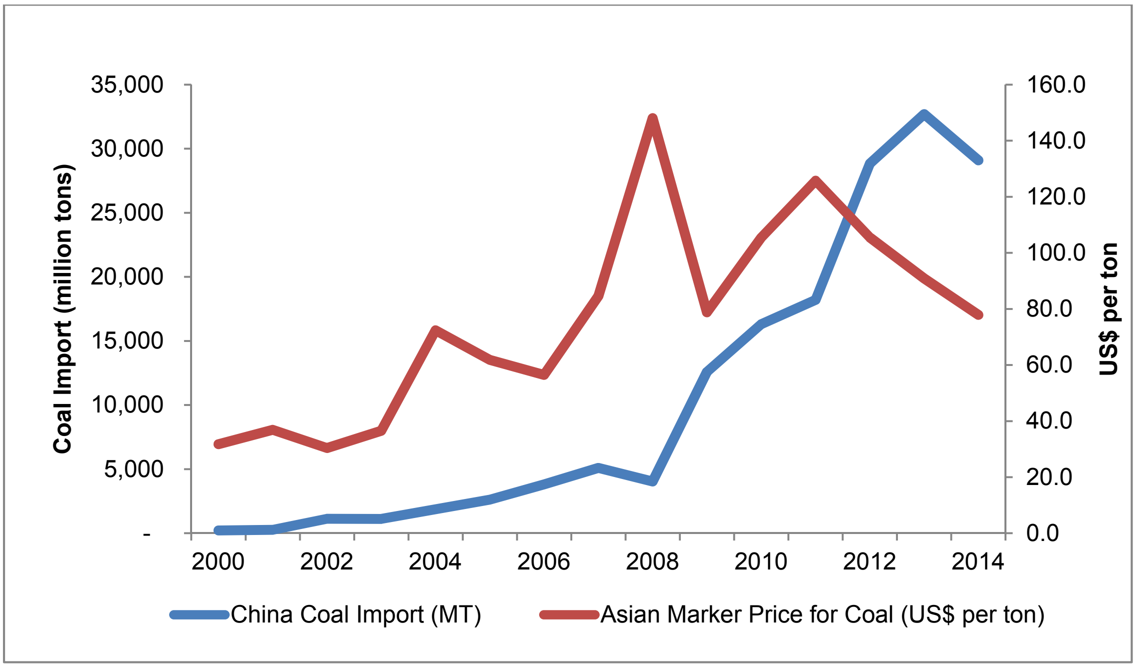
Source: PDP 2015, EPPO

The average cost of imported coal will be one the key determining factors of the success of coal-fired power generation in Thailand. As coal prices are highly influenced by international coal supply and demand conditions, China, being the largest coal importer in the world, plays an important role in the coal industry dynamics.

China coal imports recorded a significant growth at a CAGR of 52.2% from 2008 with 40.0 million tonnes to a peak of 327.0 million tonnes in 2013, before experiencing a decline of 11.3% to 291.0 million tonnes in 2014. The decrease of coal imports has caused the Asian market price for coal to experience a price decline of 14.3% from US$ 90.9 per tonne in 2013 to US$ 77.89 per tonne in 2014.

China coal import growth is expected to be slightly negative in 2015 due to domestic oversupply. The price for coal in the Asia Pacific region is expected to remain under pressure in near term. On the flipside, the gradual decline of coal pricing is likely to result in operational cost advantage for Thailand's coal-fired power generation industry, of which its PDP aims to increase the proportion of coal-fired generation in its power generation mix.

Figure 2-18: China Coal Import (million tonnes) and Asian Marker Price for Coal (US$ per tonne), 2000 - 2014



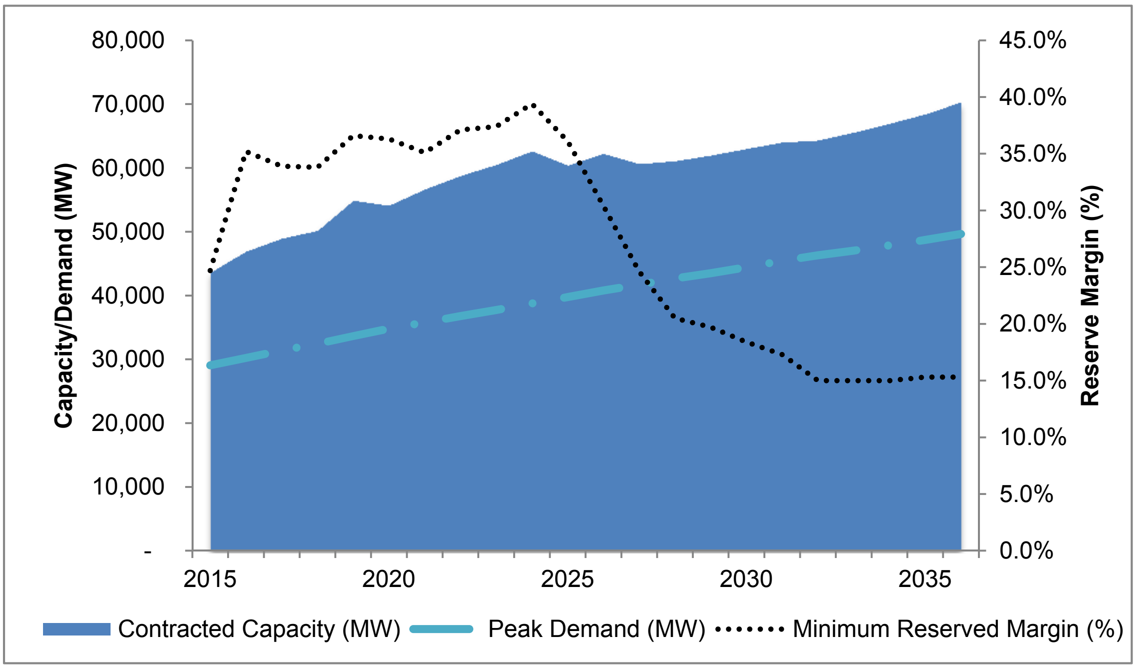
Source: China National Bureau of Statistics, Mysteel Research Institute, BP Statistical Review 2015

2.3.4 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 forecasted at 24.7% in 2015. It is projected to peak at 39.4% in 2024 before maintaining at around 15.0% from 2033 onwards. The increase in the minimum reserve margin in Thailand is mainly supported by the new addition of 14,878.0 MW of CHP plant between 2015 and 2026 and 10,644.0 MW of renewable energy power plant (excluding large hydro) during the same period.

Figure 2-19: Contracted Capacity (MW), Peak Demand (MW) and Minimum Reserve Margin (%) in Thailand, 2015 - 2036



Source: PDP 2015, Frost & Sullivan Analysis

2.3.5 Industry Risks and Challenges

Political Uncertainty

Political uncertainly 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 Government. There was no major policy change in the PDP 2015, as compared to PDP 2010 which was drafted from the previous Government. In addition to that, there is no report of default payment from EGAT on its PPAs term even with the change of Government[31].

Availability of Supply of Fuel

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, had raised concerns about power security. Though there was no power disruption during the natural gas fields shutdown, availability of fuel supply remains a risk for Thailand due to the high dependency on fuel imports.

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[31] Credit Suisse Equity Research on Thailand Power Utilities Sector

Environmental Concerns

Per PDP 2015, there are plans to increase the proportion of coal in the national power generation fuel mix to reduce the current heavy dependence on natural gas. Coal-fired power plants are less environmental friendly as compared to gas-fired power plants[32] as natural gas emits 50.0 – 60.0% less carbon dioxide when combusted in a new efficient natural gas power plant compared to emissions from typical coal plant[33]. There has been protest against the construction of coal-fired power plant by Gulf JP, who won IPP in the south in 1996[34]. As a result, the proposed coal-fired power plant was converted to a gas-fired power plant and relocated to Saraburi. Recent EGAT's plan on building the Krabi coal-fired Power Plant in Nuea Khlong District of Krabi province has also received strong resistance from local residences and NGOs. The Government has set up a joint committee that includes all stakeholders to discuss the feasibility of the 870.0 MW plant following numerous protests.

2.3.5.1 Barriers to Entry

SOEs Monopoly

EGAT, as an SOE, has the sole right in the generation and transmission of electricity in Thailand and has remained as the single largest power producer in the country. The liberalisation 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.[35] There could be risks to new private market entrants of operate at competitive rates with the three SOEs. If there is market abuse by the SOEs, there is insufficient legal protection against any unfair competitive conduct.

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

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[32] Cost and Performance Baseline for Fossil Energy Plants Volume 1a: Bituminous Coal (PC) and Natural Gas to Electricity Revision 3, http://goo.gl/S4m5Dy

[33] Environmental Impacts of Natural Gas, http://goo.gl/aK3qmi

[34] Page 10, Credit Suisse Equity Research on Thailand Power Utilities Sector, https://goo.gl/eVkKG8

[35] Competition Act, B.E. 2542 (1999)

Environmental Concerns

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

2.3.5.2 Product Substitution

There is no specific substitution for power generation activity. However, the Thailand power generation industry faces risk of 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 Government of Thailand has considered nuclear power as a source of fuel for power generation. It is expected to add two nuclear power plants with total installed capacity of 2,000.0 MW towards the end of the PDP in 2035 – 2036.

2.4 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. IPPs generate above 90.0 MW per plant. The SPP program was launched in 1992 and is designed for smaller power plants with capacity of under 90.0 MW. Both the IPP and SPP markets are open to private operators to generate and sell electricity to EGAT.

As at the end of 2014, Thailand's total domestic private power generation[36] installed capacity was 16,780.5 MW. IPPs represented 78.5% or 13,166.7 MW of Thailand's total private power generation installed capacity while SPPs accounted for the remaining 21.5% or 3,613.8 MW.

Based on the effective capacity of the key players, RATCH was the largest player in domestic private power generation sector with a market share of 27.2% or 4,566.6 MW in 2014. Meanwhile, J-Power Holding (Thailand) Company Limited held the second position in terms of market share in domestic private power generation sector with a market share of 17.1% or 2,862.5 MW in 2014.

This is followed by EGCO, who held the third largest market share in the domestic private power generation sector with a market share of 14.0% or 2,354.8 MW in 2014. GLOW and Global Power Synergy Company Limited, each held market share of 11.2% or 1,876.4 MW and 5.6% or 932.5 MW in the same year.

[36] Domestic private power generation includes IPPs and SPPs contracted installed capacity to EGAT based on PPAs.

On the other hand, Banpu Power, which held a 50.0% share in BLCP Power Limited, the largest coal-fired IPP in Thailand and the fourth largest IPP in Thailand with contracted capacity of 1,346.5 MW, has a 4.0% market share based on effective contracted installed capacity in 2014. The BLCP Power Plant has an installed capacity of 1,434.0 MW.

2.4.1 Key Players Profiles

Thailand's top players are mostly consists of local SET-Listed companies partially owned by EGAT.

Table 2-5: Profile of Local SET-listed and Private Companies with Interests in IPPs and SPPs Based on Effective Contracted Capacity (MW) in Thailand, 2014

No	Power Plant	Partner Name	Type	Fuel Type	Equity Stake (%)	2014	
						Contracted Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)
RATCH							
1	Ratchaburi Power Plant	-	IPP	Natural Gas or Fuel Oil	99.99%	3,481.0	3,480.7
2	Tri Energy Power Plant	-	IPP	Natural Gas	99.99%	700.0	699.9
3	Ratchaburi Power's Power Plant	Global Power Synergy (15%)	IPP	Natural Gas	25.00%	1,400.0	350.0
4	Ratchaburi World Cogen (Unit 1)	-	SPP	Natural Gas	40.00%	90.0	36.0
	Total					**5,671.0**	**4,566.6**
J-Power Holding (Thailand) Company Limited							
1	Roi-Et	EGCO (70.3%)	SPP	Rice husk	24.70%	8.8	2.2
2	Egco Cogen Rayong	EGCO (80%)	SPP	Natural Gas	20.00%	60.0	12.0
3	Gulf Cogeneration (Kaeng Khoi), Saraburi	EGGO (50%)	SPP	Natural Gas	49.00%	90.0	44.1
4	SCC Samutprakarn	EGCO (50%)	SPP	Natural Gas	49.00%	90.0	44.1
5	Nong Khae Saraburi	EGCO (50%)	SPP	Natural Gas	49.00%	90.0	44.1
6	GYG Yala	EGCO (50%)	SPP	Wood Scrap, Latex Rubber	49.00%	20.2	9.9
7	GPG Saraburi (Kaeng Khoi 2)	EGCO (50%)	IPP	Natural Gas	49.00%	1,468.0	719.3
8	KP1*2 Saraburi	-	SPP	Natural Gas	90.00%	90.0	81.0
9	KP2*2 Saraburi	-	SPP	Natural Gas	90.00%	90.0	81.0
10	TLC*2 Saraburi	-	SPP	Natural Gas	90.00%	90.0	81.0
11	NNK*2 Chachoengsao	-	SPP	Natural Gas	90.00%	90.0	81.0
12	NLL*2 Rayong	-	SPP	Natural Gas	67.50%	90.0	60.8

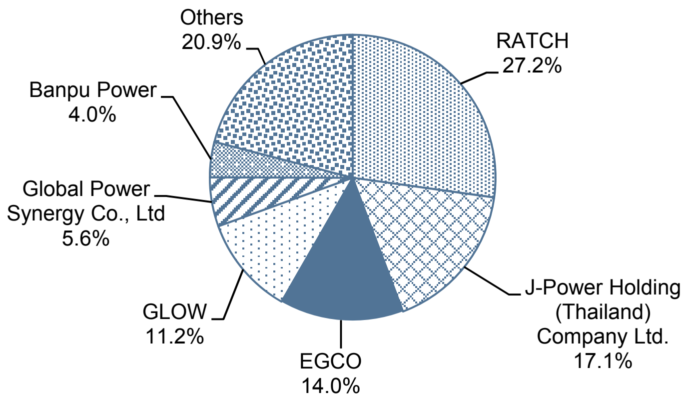
No	Power Plant	Partner Name	Type	Fuel Type	Equity Stake (%)	2014 Contracted Capacity (MW)	2014 Effective Contracted Capacity based on Equity Stake (MW)
13	CRN*2 Pathum Thani	-	SPP	Natural Gas	90.00%	90.0	81.0
14	NK2*2 Saraburi	-	SPP	Natural Gas	90.00%	90.0	81.0
15	Gulf JP Nong Saeng	-	IPP	Natural Gas	90.00%	1,600.0	1,440.0
	Total					**4,057.0**	**2,862.5**
EGCO							
1	Khanom Electricity Generating Company Limited (KEGCO)	-	IPP	Natural Gas or Fuel Oil	100.00%	748.2	748.2
2	Gulf Power Generation Company Limited (GPG)	J-Power (49%)	IPP	Natural Gas	50.00%	1,468.0	734.0
3	BLCP Power Limited	Banpu Power (50%)	IPP	Bituminous (Coal)	50.00%	1,346.5	673.3
4	EGCO Cogeneration Company Limited (EGCO Cogen)	J-Power (20%)	SPP	Natural Gas	80.00%	60.0	48.0
5	Roi-Et Green Company Limited (Roi-Et Green)	J-Power (24.7%)	SPP	Rice husk	70.30%	8.8	6.2
6	Gulf Cogeneration Company Limited (GCC)	J-Power (49%)	SPP	Natural Gas	50.00%	90.0	45.0
7	Samutprakarn Cogneration Company Limited (SCC)	J-Power (49%)	SPP	Natural Gas	50.00%	90.0	45.0
8	Nong Khae Cogeneration Company Limited	J-Power (49%)	SPP	Natural Gas	50.00%	90.0	45.0
9	Gulf Yala Green Company Limited (GYG)	J-Power (49%)	SPP	Wood Scrap, Latex Rubber	50.00%	20.2	10.1
	Total					**3,921.7**	**2,354.8**
GLOW							
1	Glow IPP @ Chonburi	-	IPP	Natural Gas	95.00%	713.0	677.4
2	Gheco-One @ Rayong	-	IPP	Coal	65.00%	660.0	429.0
3	Glow Energy Phase 2	-	SPP	Natural Gas	100.00%	180.0	180.0
4	Glow SPP 2/Glow SPP 3	-	SPP	Natural Gas / Coal	100.00%	300.0	300.0
5	Glow SPP 1	-	SPP	Natural Gas	100.00%	110.0	110.0

No	Power Plant	Partner Name	Type	Fuel Type	Equity Stake (%)	2014	
						Contracted Capacity (MW)	Effective Contracted Capacity based on Equity Stake (MW)
6	Glow SPP 11 Phase 1 (fomerly known as Glow SPP 11)	-	SPP	Natural Gas	100.00%	90.0	90.0
7	Glow SPP 11 Phase 2 (fomerly known as Glow SPP 12)	-	SPP	Natural Gas	100.00%	90.0	90.0
	Total					**2,143.0**	**1,876.4**
Global Power Synergy Co., Ltd							
1	GPSC Sriracha	-	IPP	Natural Gas	100.00%	700.0	700.0
2	RPCL Ratchaburi Power	RATCH (25%)	IPP	Natural Gas	15.00%	1,400.0	210.0
3	Bangpa-in Cogeneration	-	SPP	Natural Gas	25.00%	90.0	22.5
	Total					**2,190.0**	**932.5**
Banpu Power							
1	BLCP Power Limited	EGCO (50%)	IPP	Bituminous (Coal)	50.00%	1,346.5	673.3
	Total					**1,346.5**	**673.3**

Note: Partnership (% owned) data provided for top players only.
Source: EGAT, respective players' company profiles, Frost & Sullivan

2.4.2 Market Share and Ranking

Figure 2-20: Market Share (%) of Local SET-listed and Private Companies with Interests in IPPs and SPPs Based on Effective Contracted Capacity (MW) in Thailand, 2014



Note: Others include Thai Power Supply, BPK Power Supply, Amata Power, TPT Utility, Sime Darby Power, Siam Power Generation, Mungcharoen Biomass etc.
Source: EGAT, respective players' company profiles, Frost & Sullivan

2.4.3 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 holiday[37]. Finalisation of PDP 2015 in April this year increases confidence for private companies in the power sector development direction under the leadership of Government sector.

2.5 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, it 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.
- Economy – To appropriately price electricity tariff to reflect the cost of energy. Slowdown of construction of new power plant and reduce energy import to ensure efficient energy consumption.
- Ecology – To reduce and minimise environment impact by reducing carbon dioxide emissions and promote 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 under revision 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 19,635.0 MW in 2036, from approximately 7,279.0 MW in 2014.

The focus of the AEDP will be revised with emphasis on power generation from waste, biomass and biogas. The allocation of renewable energy generation capacity will be allocated based on the demand and potential in regions / provinces. Solar and wind power will be promoted at a later stage during the AEDP once the cost of generation is competitive to the gas-fired

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

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.

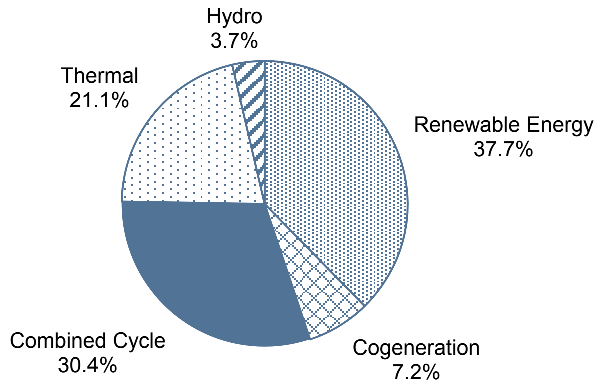
The EEDP outlined targets to reduce overall energy consumption by 20.0%, from 151 million tonnes of oil equivalent (**“mtoe”**), in the projected BAU case energy consumption in 2030, to 121 mtoe in the energy efficiency plan case.

2.6 OUTLOOK AND PROSPECTS

In Thailand, electricity generation is forecasted to be 228,238 GWh in 2020 with a CAGR of 3.7% from 190,285 GWh in 2015. There will also be additional installed capacity of 15.3 GW from 2015 to 2020, of which 8.7% or 1.3 GW will be contributed by coal-fired power generation.

According to the PDP 2015, there will be a total additional installed capacity of 57.5 GW from 2015 to 2036, of which 37.7% or 21.6 GW will be contributed by renewable energy. This shows a clear direction from the Government of Thailand in encouraging the production of electricity from renewable energy sources. Out of the 21.6 GW of new renewable energy power plant, 55.9% or 12.1 GW will be constructed within the country and the remaining additional renewable energy capacity is expected to be constructed and imported from the neighbouring countries. Combined cycle and thermal power generation represented 30.4% or 17.5 GW and 21.1% or 12.1 GW of the new installed capacity respectively. Coal and lignite are expected to contribute 61.0% or 7.4 GW as fuel sources of new thermal power plants. There has been an increase of targeted coal/ lignite-fired power plants of 10.0% or 3.0 GW from 4.4 GW of new coal-fired power plants that consists of 51.0% of the new thermal power plant to be added in the previous PDP 2010 (Rev. 3).

Figure 2-21: Additional Installed Capacity by Type of Power Plant, Thailand, 2015 - 2036



Source: PDP 2015

2.6.1 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 7 IPP projects amounting to a total capacity of 8,070.0 MW. During the same period, 97 SPP projects are expected to be commissioned with a total capacity of 5,922.0 MW, of which 41 projects will be of new co-generation plant with total capacity of 3,660.0 MW; 25 projects of renewal contracts for co-generation plant with total capacity of 424.0 MW and 31 renewable energy projects with total capacity of 1,838.0 MW.

With these planned projects, Thailand remains an attractive country for private utilities. However, for projects that rely on imported natural gas and imported coal as fuel sources, there has been concern regarding fuel cost fluctuation. Since 1991, the Automatic Adjustment Mechanism, that incorporates Automatic Fuel Adjustment (or F_t) 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 utilities, 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 Projects[38]

Thailand is strategically located to leverage on electricity imports and the currently established or future development of transmission infrastructure in the neighbouring countries, such as Laos, Myanmar, Cambodia and Malaysia.

[38] http://www.carecprogram.org/uploads/events/2014/Regional-Energy-Trade-Workshop/Presentation-Materials/009_104_209_Session3-3.pdf

Laos has the most extensive transmission network with 2,111.0 MW existing and 6,062.0 MW 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 capacity of 2,465.0 MW will be added between 2015 and 2023.

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

Thailand – Cambodia has an existing interconnection of 100.0 MW capacity for electricity export from Thailand to Cambodia. An estimated of 2,200.0 MW interconnected transmission network will be added post year 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 300.0 MW, and is expected to be commissioned in 2016.

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

Clean Coal Technology

In an effort to reduce its heavy reliance on natural gas as the major source of fuel for its power generation fuel mix, Thailand has drafted a PDP focusing on fuel diversification. According to PDP 2015, there will be an increase in the ratio of electricity produced by power plants using coal as the fuel source. However, the recent Krabi coal-fired power plant has received strong protests from the local community due to environmental and health impact concerns. The Government has decided to go ahead with the plan and ensured that the power plant will be built in accordance to clean coal technology. EGAT in the past has initiated the adoption of clean coal technology by replacing the ageing generators at its Mae Moh power plant with integrated gasification combined-cycle (**"IGCC"**) system.

Thailand's decision to build more coal-fired power plants in future is of considerable attraction for the coal-fired power generation industry. However, the construction of coal-fired power plants in new locations may still be subjected to objections from local communities for environmental reasons unless strong education and awareness of clean coal technology gathers consensus among the general public.

According to the new legal emission standards for new power plants by the Ministry of Natural Resources and Environment, new coal-fired power plants are subjected to more stringent emission standards. New coal-fired power plants with larger than 50.0 MW in capacity are subjected to limits of 180 ppm of SO2 emission, 200 ppm of NOX emission and 80 mg/cu. m of particulate matter.

Table 2-6: Thailand Legal Emission Standards for NOX, SO2 and Particulate Matter by Type of Power Plant

Type of Power Plant	Emission Limit		
	SO2	NOX	Particulate Matter
Mae Moh Coal-fired power plant Units 1-3 Units 4-7 and 8-13	 1,300 ppm 320 ppm	 500 ppm 500 ppm	 180 mg/cu. m 180 mg/cu. m
Other Existing Coal-fired power plant of any size	700 ppm	400 ppm	320 mg/cu. m
New Coal-fired power plant 50 MW or less	360 ppm	200 ppm	80 mg/cu m.
New Coal-fired power plant above 50 MW	180 ppm	200 ppm	80 mg/cu.m.
New Oil fuel power plant	260 ppm	180 ppm	120 mg/cu.m.
New Natural gas power plant	20 ppm	120 ppm	60 mg/cu.m.
New Biomass power plant	60 ppm	200 ppm	120 mg/cu.m.

Note:

(1) Emission limit for new power plants applicable to Commercial Operation Dates after 20th December 2009.

(2) Reference conditions are 25°C at 101.3 kPa (1 atm) or 760 mmHg on a dry flue gas basis, with 50% of excess air or 7% of O2 during combustion.

Source: Ministry of Natural Resources and Environment

3 ANALYSIS OF LAOS POWER GENERATION INDUSTRY

3.1 BACKGROUND OF THE POWER GENERATION INDUSTRY IN LAOS

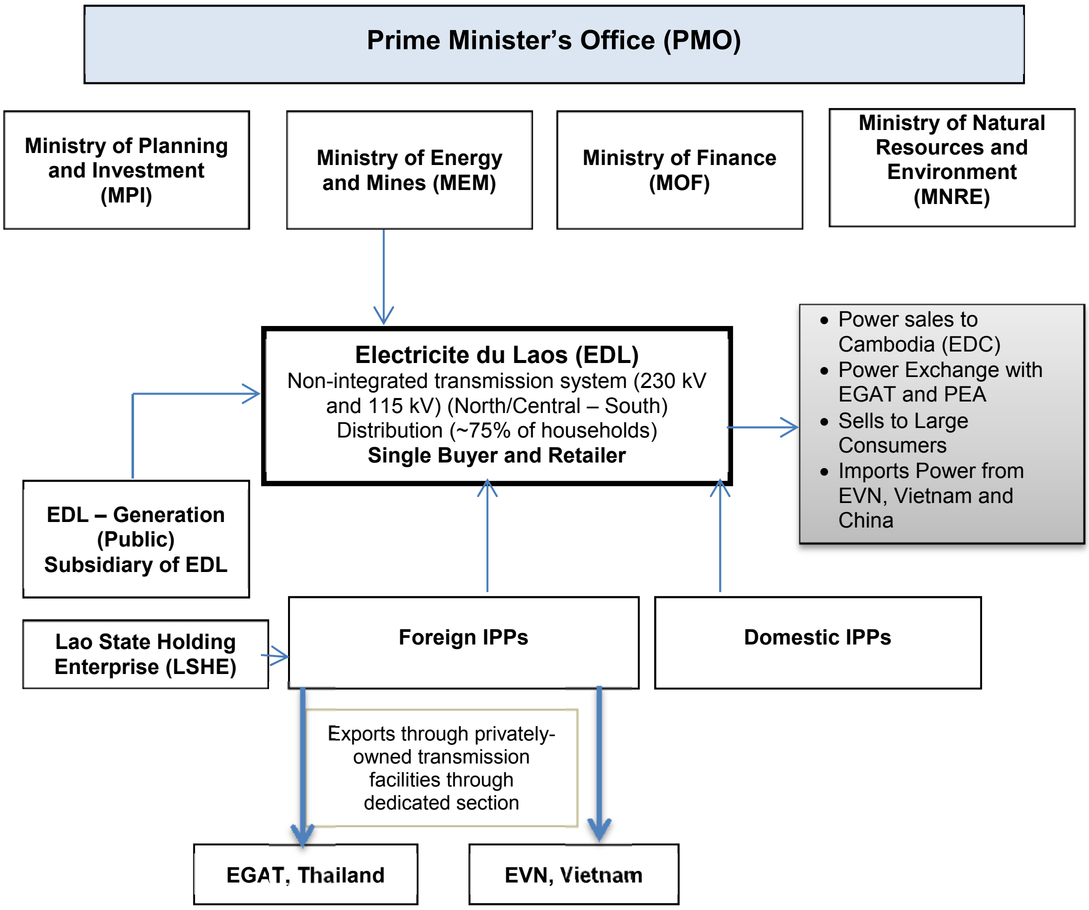
The Ministry of Planning and Investment (formerly known as the Department of Domestic and Foreign Investment of Lao PDR) facilitated economic reforms to attract FDIs into the country. The power sector in the country has been opened to private FDI since 1990 to facilitate economic growth and alleviate poverty. In Laos, the power sector strategy and its legal framework are developed and updated regularly by the Ministry of Energy and Mines ("**MEM**") to meet the evolving international financing requirements. Since the 1990s, the Government of Laos had implemented the following initiatives:

- Memorandum of Understanding ("**MOU**") on the power exchange program was signed with the Royal Thai Government in 1933, 1996, 2003, and 2007 under which 1,500.0 MW was to be supplied to Thailand. This is to increase to 7,000.0 MW by 2020.
- In 1998 and 2006, MOUs were signed with the Government of Vietnam for 3,000.0 MW and 5,000.0 MW respectively.
- In 1999, the Agreement on Cooperation in the power sector was signed with Cambodia. In 2010, Cambodia agreed to import electricity (300.0 – 400.0 MW) from Laos by 2015.

Electricite du Laos ("**EDL**") is a state-owned corporation under the MEM, which owns and operates the country's main generation, T&D assets, as well as manages electricity imports into its grids and exports from its stations. EDL also has a project development role and has been the implementing agency for Government hydropower 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[39].

[39] EDL

Figure 3-1: Industry Structure of Laos Power Market, 2014



Source: Department of Energy Promotion and Development, MEM

3.1.1 Pricing Structure

Laos has only two types of PPA that are differentiated based on size of the project's installed capacity and types of project developers, namely the IPP and SPP. In Laos, power plant developers above 15.0 MW installed capacity are classified as IPPs and power plant developers with less than 15.0 MW installed capacity are classified as SPPs. IPPs are further divided into two categories: (1) IPP Domestic ("**IPPD**"), whereby IPP power plants under this category are developed for 100.0% domestic market consumption and (2) IPP Export ("**IPPX**"), whereby IPP power plants under this category are mainly intended for exports to foreign markets with a small proportion used for domestic market consumption.

In Laos, any foreign IPP intending to develop a power plant has to obtain the approval from the MEM. The IPP will be given 18 months to conduct a feasibility study. If the project plan is feasible from all aspects (technical, financial, and economical), the IPP has to sign a power development agreement with the Ministry. Thereafter, IPPs are expected to engage with the local community on the project details, secure environmental impact assessment reports, arrange project funding, and work with a local partner. Subsequently, the PPA contract with EDL is negotiated and signed. The PPA contract periods between IPPs and EDL are usually in the range of 20 to 25 years, based on the design life of the power plant. PPAs can be renewed if it has been specified in the concession agreement ("**CA**"). If there is no such specification in the CA, then the ownership of the power plant gets transferred to the Government of Laos once the PPA expires. This mechanism is similar to the BOT model in public private partnerships (**"PPPs"**).

Laos' electricity tariff is likely to increase until 2017. The electricity tariff is set by the regulatory committee in the MEM.

Table 3-1: Historical and Projected Electricity Tariff Trends in Laos, 2011-2017F (in Laos Kip)

Year	2011	2012	2013	2014F	2015F	2016F	2017F
Low Voltage (Residential)							
0-25 kWh	269	3331	328	334	341	348	355
26-150 kWh	320	442	390	398	405	414	422
>150 kWh	773	780	941	960	979	999	1,019
Low Voltage (Non-Residential)							
Embassies, International Organizations	1,077	1,152	1,312	1,338	1,365	1,392	1,420
Service Business, Temporary	835	998	1,017	1,037	1,058	1,079	1,101
Education Business and Sports	NA	781	799	815	831	848	865
Entertainment Business	1,106	1,152	1,347	1,374	1,401	1,429	1,458
Government Organization	656	781	799	815	831	848	865
Agriculture, Irrigation	399	471	486	496	506	516	526
Industries	591	692	720	734	749	764	779
Medium Voltage (22 to 35 kV)							
Service Business, Temporary	709	898	864	881	898	916	935
Education Business and Sports	NA	703	678	692	706	720	734
Entertainment Business	NA	1,094	1,280	1,305	1,331	1,358	1,385
Government Organization	557	703	678	692	706	720	734
Agriculture, Irrigation	340	424	414	422	431	439	448
Industries (less than 5 MW)	502	623	611	624	636	649	662

Year	2011	2012	2013	2014F	2015F	2016F	2017F
Industries (more than 5 MW)	NA	647	660	673	687	700	714
High Voltage	647	647	660	673	687	700	714

Note: NA – Not available
Implemented from March 2012 to December 2017
Source: EDL

Table 3-2: Classification of Export Tariff from EDL to EGAT

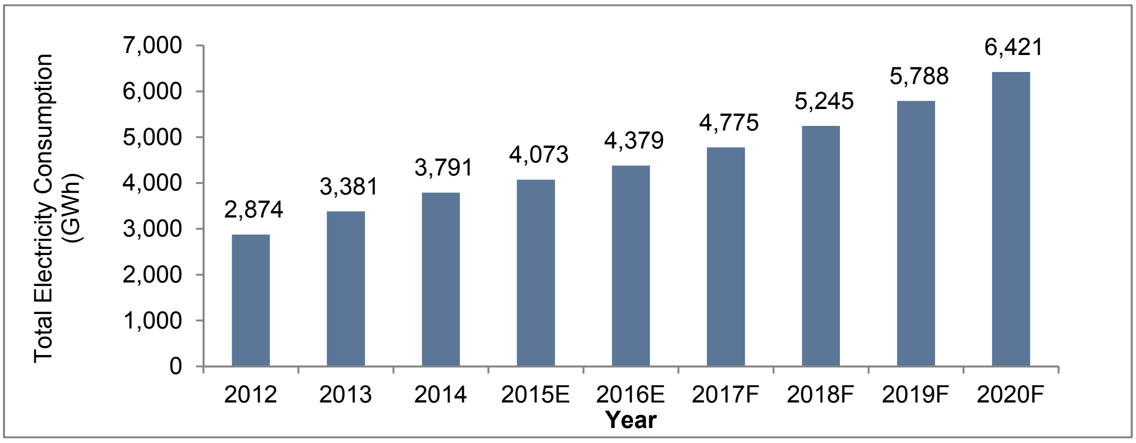
Export Tariff from EDL to EGAT, Thailand in 115 kV		
Peak (9:00-22:00 h)	1.60 Thai Baht/kWh	Monday-Friday
Off-Peak (22:00-9:00h)	1.20 Thai Baht/kWh	Monday-Friday
Off-Peak (00:00-24:00h)	1.20 Thai Baht/kWh	Saturday, Sunday and Thai official holidays

Source: EDL

3.2 DEMAND CONDITIONS

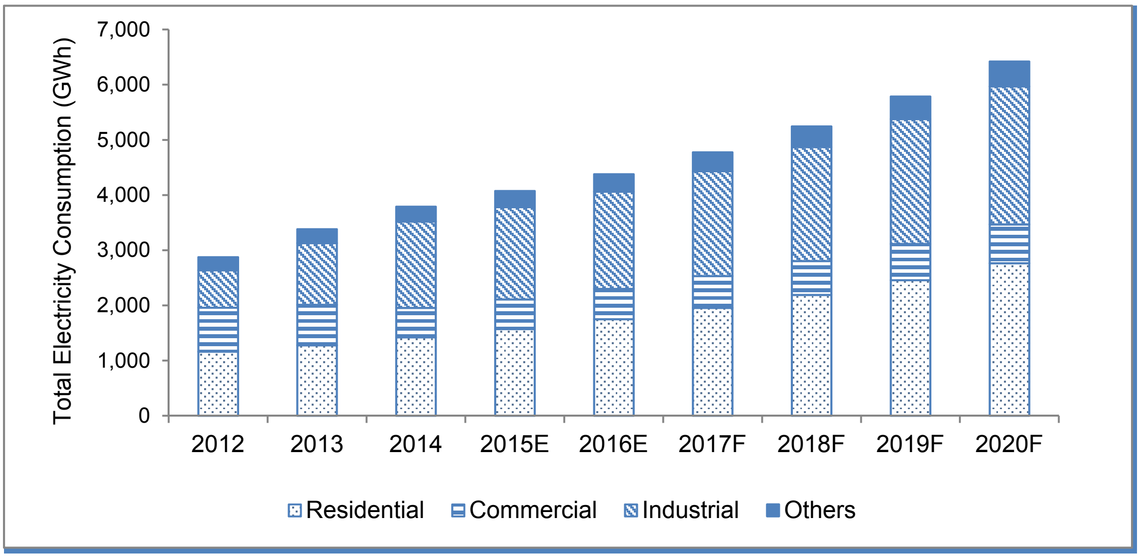
The power demand in Laos continues to grow in tandem with the growing urbanisation of the country. Laos has been focusing on improving its basic infrastructure which includes accessibility to reliable and stable electric power. EDL continues to import electricity from Thailand especially during the summer months to meet the domestic market's demand.

Chart 3-1: Historical and Projected Electricity Consumption (GWh) in Laos, 2012 – 2020F



Source: Electricity Consumption data from 2012 to 2014 taken from EDL, Frost & Sullivan analysis

Chart 3-2: Historical and Projected Electricity Consumption (GWh) by Consumer Group in Laos, 2012 – 2020F



Note: Others include Government offices, irrigation, international organizations, education and sport business
Source: Electricity Consumption data from 2012 to2014 taken from EDL; Frost & Sullivan analysis

Table 3-3: Historical and Projected Electricity Consumption (GWh) by Consumer Groups in Laos, 2012 – 2020F

Year	Electricity Consumption (GWh)				
	Residential	Commercial	Industrial	Others*	Total
2012	1,161.0	796.7	680.9	235.6	2,874.2
2013	1,278.4	733.0	1,118.2	251.4	3,381.0
2014	1,424.1	532.1	1,564.4	270.7	3,791.3
2015E	1,572.3	538.4	1,670.8	291.8	4,073.3
2016F	1,749.9	551.9	1,761.0	315.8	4,378.6
2017F	1,956.4	577.8	1,898.4	342.6	4,775.2
2018F	2,191.2	614.2	2,065.4	374.5	5,245.3
2019F	2,458.5	656.0	2,263.7	409.7	5,787.9
2020F	2,763.4	704.6	2,501.4	451.5	6,420.8

Note: Others include Government offices, irrigation, international organization, education and sport business
Source: Electricity Consumption data for 2012 to 2014 taken from EDL, Frost & Sullivan analysis

3.2.1 Key Growth Drivers & Constraints

Growth Drivers

On-going Industrial Development

The on-going development of the two major industrial sectors, namely mining and cement sectors, are the main growth drivers for the power sector. In 2012, mining sector stood for 8.0 - 11.0% of the country's GDP and accounted for about 20.0% of the Government's total domestic revenue[40]. In 2014, Thailand-based Siam Cement Group and China-based Hongshi Holding Group reported interests respectively in building cement plants in Laos[41].

There are 10 Special and Specific Economic Zones ("**SEZs**") in Laos driving the demand for reliable electricity. The SEZs will require better power generation infrastructure to ensure a reliable power supply to the mining and cement sectors for their operations. The SEZs were one of the Government of Laos' initiatives to attract FDI into the country and to help accelerate infrastructure development, services, labour productivity, and to facilitate the transfer of modern technologies from the investing countries. The Government of Laos plans to develop more than 25 SEZs, between 2015 and 2025, in the border regions and remote areas of the country[42].

Need to Achieve 90.0% Electrification Ratio Target

There are still large parts of rural areas that are poorly electrified in Laos. As of 2014, electrification ratio in Laos stood at 87.0% of all households. However, EDL needs to increase its power generation capacity to support the Government's target of electricity access target to 90.0% of all households by 2020. This call for increased investments in the power sector, achieved through the development of new power generation plants and grid extension projects, reduced T&D system losses, and facilitation of off-grid renewable energy projects in the rural areas.

High Hydropower Potential

Laos is well known for its hydropower resources with an estimated potential capacity of 26,000.0 MW, due to its extensive network of rivers,, which covers approximately 35.0% of the Mekong River's flow[43]. For hydropower development, the CA framework is well established in Laos. The Government of Laos is keen to exploit the country's abundant hydropower potential, which will thereby increase power export revenues for the country. The majority of the power plants under construction, and those being planned for execution between 2015 and 2020, are hydropower plants. Out of the 20 power projects that are currently under construction, 19 are hydropower plants and only one is a coal-fired project. Furthermore, of the additional 33 power projects for which MOUs have been signed, 32 projects are hydropower plants and only one is a wind power project.

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[40] World Bank report on Lao PDR Economic Monitor June 2013: Sustaining Growth, Maintaining Macroeconomic Stability

[41] Global Cement News

[42] Laoembassy news

[43] International Rivers: Laos

Growth Constraints

Public Opposition against Construction of New Power Plants

The construction of new large coal-fired and hydropower plants face stiff public opposition due to the perceived negative impacts caused for the local population living in and around the project development sites. For example, there is an increasing pressure to delay or halt the construction of a 260.0 MW project in the Lower Mekong River as the environmental and social impact has resulted in public concerns. Therefore it is important for project developers to engage and educate the local populace about the benefits of these projects and address all their concerns during the course of project design and execution. Initiatives implemented to mitigate the community's concerns include the establishment of Community Development Funds, giving preferential electricity rates to local residents, and providing local residents access to services offered to projects or preferential access to common resources[44].

Lack of Adequate Fossil Fuel Resources

The country continues to rely heavily on hydropower generation to meet its electricity requirements as there is lack of resources such as oil, gas and coal. Laos has limited proven lignite reserves of 810 million tonnes, out of which as of June 2014, 487 million tonnes has been identified at Hongsa, in Xayaboury province alone. Laos has no proven oil and gas reserves and no oil refineries. All refined petroleum fuel sources for transportation, household, industrial, commercial and other consumer needs are imported. Simultaneously, the majority of the installed hydropower capacity is export-oriented. To satisfy domestic market requirements, the country imports electricity from its neighbouring countries. As of 2015, only 10.1% of the total installed capacity of IPPs is dedicated for domestic consumption and only 27.9% of total installed capacity owned by EDL is dedicated for domestic consumption[45]. Although Laos has significant hydropower potential, it lacks funds to develop them. Hence, their power development strategy is based on CA schemes where funding is provided by foreign investors mainly based in Thailand and Vietnam. The foreign investors provide funds for the construction of the power plants and transmit the generated electricity back to their country of origin. After 20 - 25 years, as per the CA, all assets will be transferred to the Government of Laos or EDL which will then use the power plants to generate electricity for domestic consumption.

The investment in hydropower plant usually takes 10 years[46] to break-even and investors can reap the profit for the next 10 -15 years[47]. However, hydroelectric dams are usually built to last for 100 years[48]. In Laos, electricity is exported as a part of the CA terms.

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[44] World Bank: Lao PDR 2010 Social Impact Mitigation report

[45] Powerinprogress.org

[46] Based on primary interviews conducted with EDL by Frost & Sullivan

[47] Based on primary interviews conducted with EDL by Frost & Sullivan

[48] WaterPowerMagazine.com: 'Life-span of Storage Dams' Feb 2010

3.3 SUPPLY CONDITIONS

3.3.1 Installed Capacity

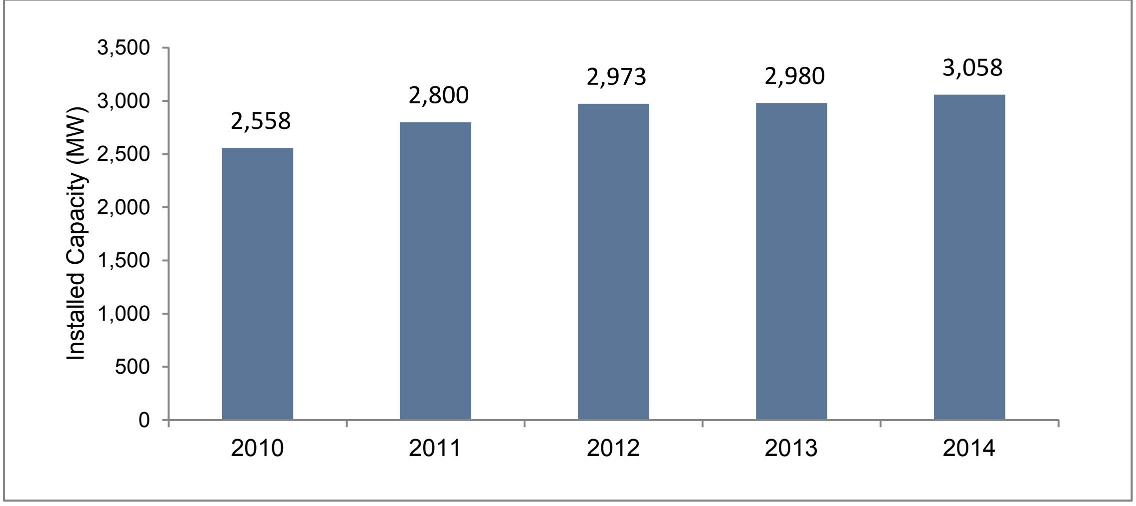
Laos' installed capacity, from 2012 to 2014, has been dominated by hydropower projects. The hydropower potential of Laos is estimated at 26,000.0 MW, but as of 2014 only 2,994.0 MW has been installed. Out of this, 2,295.0 MW capacity is exported and only 699.0 MW capacity is used for the domestic market. The country has plans to increase its installed capacity, between 2015 and 2020, mainly through developing hydropower projects along its major rivers. Upon completion, majority of the capacity generated from these hydropower plants are likely to be exported to neighbouring countries, such as China (Yunnan province), Vietnam, Myanmar, Thailand and Cambodia. By 2020, Laos has agreed to export 7,000.0 MW to Thailand and 5,000.0 MW to Vietnam[49]. The hydropower projects under construction are mostly developed by EDL and EDL in collaboration with foreign IPPs.

Hydropower 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 as well as to improve the electrification ratio and meet the growing power demand.

The Hongsa Mine-Mouth Power Plant ("**Hongsa Power Plant**") is Laos' first major coal-fired power plant with an installed capacity of 1,878.0 MW. Located in the Xayaboury province, Hongsa Power Plant operates three fully operational power plant units over a 25-year concession period to provide base load power to both Thailand and Laos. Unit 1, 2 and 3 of the power plant were completed and commenced operation in June 2015, November 2015 and March 2016, respectively. Out of the total capacity, 1,473.0 MW is expected to be exported to EGAT, Thailand, the single largest off-taker for this project, while 100.0 MW is likely to be used for domestic market consumption and the remaining capacity will be for on-site power use. The project's initial stakeholders include Banpu Power, RATCH, and Lao Holding State Enterprise ("**LHSE**"). In June 2015, RATCH sold its 40.0% equity stake in Hongsa Power Plant to its subsidiary RH International Corp. (Singapore) Pte Ltd. as a part of a restructuring initiative within the company. Hongsa Power Plant operates as a mine-mouth power plant, which comprises a lignite-fired power plant, a lignite mine, a limestone mine, and supporting infrastructure. Mine-mouth power plants typically provide higher reliability in power supply as there is a minimal risk of fuel shortage.

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

Chart 3-3: Historical Installed Capacity (MW) in Laos, 2010– 2014



Source: Historic 2010 data taken from Department of Electricity, MEM, 2011 - 2014 taken from EDL,

3.3.2 Key Sources of Energy

3.3.2.1 Non-renewable energy

To date, Laos has yet to identify proven oil and natural gas reserves in the country. While oil and gas exploration activities are still on-going in the province of Savannakhet, the indication of available oil and natural gas reserve is still inconclusive. As a result, all refined petroleum fuel resources required for Lao's industrial and commercial application are imported. The coal power market is at a nascent stage of growth, with lignite[50] being used for the country's first lignite-fired Hongsa Power Plant, which has been completed in 2016 with a lignite mine located nearby the power plant. As of June 2014, reserve status of the lignite mine in Hongsa, Xayaboury province is 487 million tonnes. To operate the power plant for 26 years, 371 million tonnes is required. Lignite will be mined and delivered to the power plant at 14 million tonnes per year. Other lignite deposits of nearly 51 million tonnes[51] are found in Xiengkhouang province.

The hydropower market has been developed based on the country's existing hydropower potential (26,000.0 MW) and three important principles of sustainability: economic sustainability, social sustainability and ecological sustainability. Projects having an installed capacity of more than 50.0 MW or inundating more than 10,000 hectares of land at their full supply level are

[50] Also known as brown coal, lignite is a soft brown combustible sedimentary rock formed from naturally compressed peat and has relatively low heat content

[51] Executive Summary on Lao PDR Mineral Resources, Ministry of Industry, Dec 2004, Table 3

deemed as large hydropower projects[52]. Laos, which covers approximately 35.0% of the Mekong River's flow[53], is a hotbed for development of hydropower projects. Being a widely adopted and proven technology in Laos, hydropower has been the fastest growing segment for power generation in Laos growing from 671.0 MW in 2008[54] to 2,994.0 MW in 2014 and its dominance in the power generation market is likely to continue towards 2020.

3.3.2.2 Renewable energy

In 2011, the country introduced its first Renewable Energy Development Strategy (**"REDS"**), which outlines the Government of Laos' plans to develop biomass, biofuel and wind energy with a desire to see renewable energy sources standing for 30% of its national energy consumption by 2025. To date, renewable energy such as wind and solar power are being experimented with for off-grid electrification purpose but have not been developed on a commercial basis.

Laos receives a solar irradiation of between 3.5 and 5.0 kWh/m^2 per day. In 2014, the Lao Ministry of Science and Technology signed a MOU with the AL-PNTC Consortium to conduct a feasibility study to explore the potential of developing a 50.0 MW solar PV plant in the country.

In Laos, hydropower projects with a capacity below 15.0 MW are classified as "small hydropower" There is an estimated potential of around 2,000.0 MW for such hydropower production. The Government of Laos intends to develop around 650.0 MW of small hydropower capacity between 2015 and 2025.

Table 3.1: Renewable Energy Development Plan ("REDP") until 2025

Renewable Energy Type	Potential (MW)	2011 (MW)	2015 (MW)	2020 (MW)	2025 (MW)
Small Hydropower	2,000	12	80	134	400
Solar	511	1	22	36	33
Wind	>40		6	12	73
Biomass	938		13	24	58
Biogas	313		10	19	51
Solid waste	216		9	17	36
Geothermal	59		-	-	-
Total Installed Capacity		**13**	**140**	**243**	**728**

Source: REDS in Lao PDR published in 2011

In order to encourage growth in the renewable energy sector, financial incentives for developing renewable energy projects have been provided by the Government of Laos:

- Import duty exemptions on production machinery, equipment and raw materials;

[52] UN Environment Programme: "Report on Economic, Social and Environmental Costs and Benefits of Investments in Savannakhet Province"

[53] International Rivers: Laos

[54] REEEP.org: Lao 2012

- Import duty exemptions on chemical materials necessary for biofuels production within 7 years;
- Potential income tax exemptions depending on activities, investment areas and size of investment;
- Subsidies on unit product price[55] depending on energy type and time period.

Additionally, other non-fiscal incentives are also available for renewable energy projects, including:

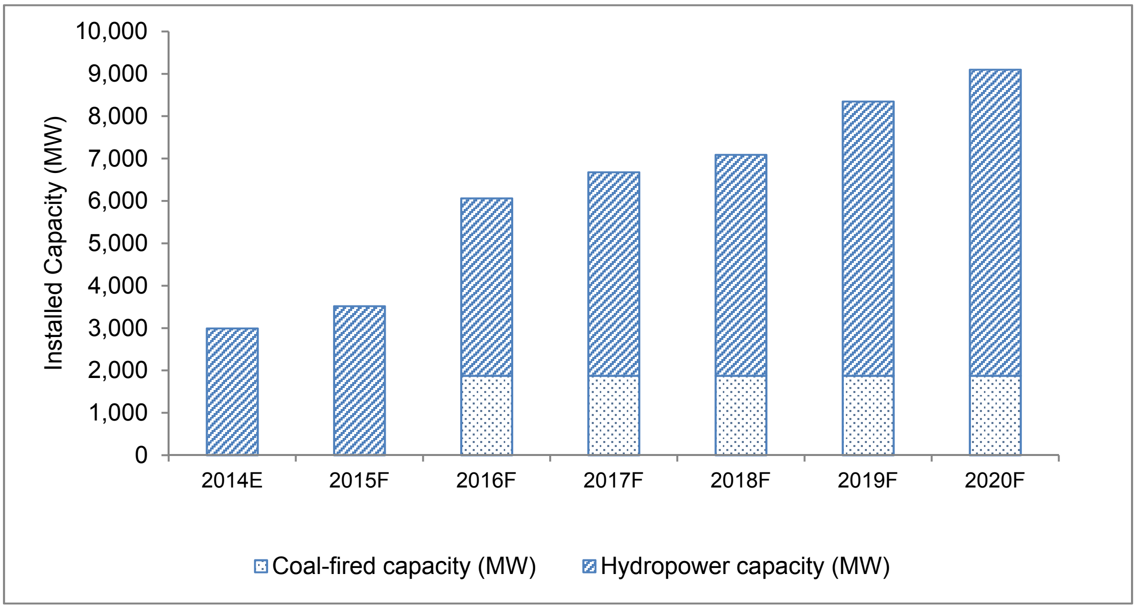
- Up to 75 years leasing term (for enterprise construction land);
- Permission to transfer earnings to country of origin;
- Allowance for foreign workforce employment constituting not more that 10.0% of the enterprise's total labour.

3.3.3 Evolution of Fuel Mix

Unlike other countries in SEA, Laos' installed capacity base has been derived solely from hydropower plants, due to lack of oil and gas reserves and low reserves of thermal coal. However, this situation has changed from 2016 onwards with the commissioning of the first coal-fired Hongsa Power Plant. Apart from this power plant, no other coal-fired power plant has been planned for construction between 2016 and 2020. Therefore, the dominance of hydropower plants is likely to continue till 2020.With the development of renewable energy capacity, the country's fuel mix is also likely to change between 2015 and 2020. This is contingent upon the development of concrete Government policies to promote renewable energy.

[55] "Eurostat" glossary on 'Subsidies on Products': Subsidies on products are subsidies payable per unit of a good or service produced or imported.

Chart 3-4: Projected Installed Capacity (in MW) in Laos, 2014 – 2020F



Note: Installed capacity projections exclude hydropower projects for which only MOU has been signed and planned renewable energy projects.
Source: EDL, Platts Reports, Frost & Sullivan

Figure 3-1: Selected Power Plants under construction in Laos, 2017-2020

Expected Commencement Year	Name	Fuel Source	Installed Capacity (MW)
2017	Nam Lik 1	Hydro	64.5
2018	Nam Phay	Hydro	86
2018	Nam Tha 1	Hydro	168
2019	Sepian Xenamnoy hydropower plant	Hydro	410
2019	Xayaboury hydropower plant	Hydro	1,260
2019	Nam Ngiep 1	Hydro	290
2019	Nam Pha	Hydro	130
2019	Don Sahong	Hydro	240
2020	Nam Phak	Hydro	45
2020	Nam Ou -1,2,4 and 7	Hydro	732

Source: MEM, Department of Energy Business

3.3.3.1 Thermal Coal outlook in Laos

According to the Department of Energy Policy and Planning, MEM, coal mining activity in Laos is very limited in operation. Coal is mainly produced in northern Laos and in the Vientiane province. Identified mineable reserves were about 370.0 million tonnes out of which 413,409 tonnes were exploited by 2009. Around 100,985 tonnes was supplied for domestic market industrial consumption (cement, steel, etc.). About 810 million tonnes[56] of total proven lignite reserves has been identified in the country and the major lignite reserve of 487 million tonnes as of June 2014 are located at Hongsa in Xayaboury province, north-west Laos.

Hongsa Power Plant is the only coal (lignite)-fired power plant operating in Laos as of July 2016. Besides this project, no other coal-fired power plant has been planned in the country until 2020. Due to the availability of domestic lignite resources, Laos has a relatively low dependency on coal or lignite imports for power generation. However, the country is highly dependent on power generation equipment imports as there is lack of a domestic manufacturing base.

3.3.4 Reserve Margin

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

Unlike its neighbouring countries in SEA, Lao's power plants run almost entirely on hydropower. As a result, the reserve margin in Laos is volatile and dependent on seasonal factors. For example, Laos' reserve margin can reach to almost 30%[57] during the rainy season from July to September. During the non-rainy season, Laos mainly relies on imports of electricity for domestic consumption. Laos 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, Laos' dependence on power imports during the non-rainy season is likely to decline.

3.3.5 Industry Risks and Challenges

Lack of Centralized Power Grid

Laos has no integrated national power grid. EDL's power transmission system comprises of four separate power grids operating in four different areas and consists of 115 kV and lower-voltage lines and substations. The four power grids are also connected to the transmission systems of Thailand, Vietnam and the Yunnan province of China for power exports at the 22 kV, 35 kV, or 115 kV levels. There are medium-voltage connections to neighbouring countries that are not connected to the 115 kV grids but provide power to isolated demand centres in the Lao PDR. All these medium-voltage grids are connected to the Thai transmission network, and export hydropower to Thailand. By 2020, hydropower will be exported to Cambodia and Vietnam by 2020 over high-voltage links as well. Although several power generation projects are being planned or in development, the limitation of T&D infrastructure will limit the economic benefit of these projects.

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[56] "Energy Sector Development in Lao PDR", MEM (July 2013)

[57] Based on primary interviews conducted with EDL by Frost & Sullivan

Lack of skilled personnel

The lack of skilled domestic labour has created a strong barrier to the development of the electricity industry. It is difficult to import labour with technical and regulatory expertise, as expatriate labour is usually expensive for a country such as Laos. The poor quality of the labour force and the migration of skilled labour to neighbouring countries make it challenging for Laotian enterprise to find suitable and competent workers in the power market. Adequate measures need to be taken to improve the quality of education and to develop job-relevant technical skills to create a strong local workforce within the country.[58]

3.3.5.1 Barriers to Entry

Underdeveloped Regulatory Framework and Business Environment Increases Entry Difficulty

Laos still ranks poorly in the "ease of doing business" rankings compiled by the World Bank when compared to other ASEAN countries. In 2014, it was ranked in the 148th position (out of 189 countries). There is an urgent need to streamline and simplify procedures for business registration, tax registration, and licensing procedures. Further, the Government of Laos needs to adopt a more transparent process of awarding concessions to hydropower project developers and improve project agreement negotiation capabilities to sustain investors' interest[59].

[58] Referred from 'Labor Mitigation in the Greater Mekong Sub-region' World Bank report (Nov 2006) and East Asia Forum news.

[59] 'Energy Sector in the Lao PDR', ADB report (Oct 2010)

3.4 Competitive Landscape

3.4.1 Key Player Profiles

Table 3-4: Profile of IPPs based on Effective Capacity (MW) in Laos, 2014

No	Power Plant	Equity Stake (%)	2014			
			Plant Capacity MW	Effective capacity based on equity stake MW	Power Purchasers	Partner Names
EDF France					EGAT – 95% EDL – 5%	EDF France, EGCO Thailand, LHSE
1	Nam Theun 2	40%	1,070	428.0		
	TOTAL		**1,070**	**428.0**		
EGCO Thailand						
1	Nam Theun 2	35%	1,070	374.5		
	TOTAL		**1,070**	**374.5**		
LHSE						
1	Nam Thuen 2	25%	1,070	267.5		
	TOTAL		**1,070**	**267.5**		
CK Power Public Company Limited					EGAT - 100%	CH. Karnchang (Thailand) 28.5%; EDL (Laos) 25%; RATCH (Thailand) 25%; Bangkok Expressway PCL (Thai) 12.5%; Shlapak Group (US) 4%; PT Construction & Irrigation Co., (Laos) 4%; TEAM Consulting Engineering (Thailand) 1%
1	Nam Ngun 2	42%	615	258.3		
	TOTAL		**615**	**258.3**		
Ratchaburi Holding Plc						
1	Nam Ngun 2	24.75%	615	152.2		
	TOTAL		**615**	**152.2**		
Sinohydro					EDL – 100%	Sinohydro (China) and EDL (Laos)
1	Nam Ngum 5	85%	120	102.0		
	TOTAL		**120**	**102.0**		
GMS Power					EGAT - 95% EDL – 5%	EDL 60%; Statkraft (Norway) 20%; GMS Power (Thailand) 20%
1	ThuenHinBoun	20%	500	100.0		
	TOTAL		**500**	**100.0**		
Statkraft						
1	ThuenHinBoun	20%	500	100.0		
	TOTAL		**500**	**100.0**		
China International Water & Electric Corp. (a wholly owned subsidiary of China Three Gorges Corporation)					EDL – 100%	EDL 20%; China International Water &

No	Power Plant	Equity Stake (%)	2014				
			Plant Capacity MW	Effective capacity based on equity stake MW	Power Purchasers	Partner Names	
1	Nam Lik 1-2	80%	100	80.0		Electric Corp 80%	
	TOTAL		**100**	**80.0**			

Source: Company Annual Reports

EDF France

The EDF Group's (a France-based company) activities in SEA are focused on developing the electricity sector in the Greater Mekong Sub-region. The Nam Theun 2 Power Company (**"NTPC"**), in which EDF has 40.0% stake was established in 2002 in Laos for the development, construction and operation of the 1,070.0 MW capacity hydropower plant.

EGCO Thailand

EGCO Group operates 23 power plants with a total equity contracted capacity of 3,767.0 MW in 5 countries in the Asia Pacific region – Thailand, Laos, the Philippines, Indonesia and Australia. The company is also a key stakeholder in a hydropower plant under construction in Laos. It has 12.5% stake in the 1,280.0 MW Xayaboury power project that is expected to be commissioned by 2019.

LHSE

LHSE is a 100% Laotian SOE. It was established as a Business Company in conformity with the Business Law and the Prime Minister's Decree. The primary function of LHSE is to hold, manage and maintain, on behalf of the Government, shares in NTPC and any other Power Project Companies, which are acquired by LHSE or transferred to it by the Government, in an efficient and business-like manner.

CK Power Public Company Limited ("CK")

CK was founded by the group of CH. Karnchang Public Company Limited. The Company operates its core business as a holding company by holding shares in other companies engaging in core business of production and distribution of electricity generated from various types of energy. The Company classifies its investments into three business sectors as follows:

1. Hydropower Business: Southeast Asia Energy Limited (**"SEAN"**), which holds shares representing 75.0% of the registered and paid-up capital of Nam Ngum 2 Power Co., Ltd. (**"NN2"**) in Laos.

2. Cogeneration Power Business: The company has 65.0% equity stake in Bangpa-in Cogeneration Limited.

3. Solar Power Business: The company has 100.0% equity stake in Bangkhenchai Co., Ltd., 30.0% equity stake in Nakhon Ratchasima Solar Co. Ltd. and 30.0% equity stake in Chiangrai Solar Co., Ltd.

The Company is developing two hydropower projects in Laos. The first project is a 160.0 MW Nam Bak hydropower plant for the domestic market which is under contract negotiations and implemented by its subsidiary SEAN. It is expected to start commercial operation by 2018. The second project is a 1,285.0 MW Xayaboury hydropower plant, implemented by its major shareholder CH. Karnchang Public Company Limited (holding 30.0% stake in this project), which is under construction and expected to start commercial operation by 2019.

RATCH

RATCH is a leading IPP in Thailand and as of June 2015, RATCH accounts the total equity installed capacity of 6,578.1 MW. A capacity of 5,863.0 MW has commercially been operated and 715.2 MW is under development and construction phases. At present, RATCH's operations are located in Thailand (4,952.0 MW capacity), Laos (1,096.5 MW capacity), Australia (509.5 MW capacity) and Japan (20.1 MW capacity).

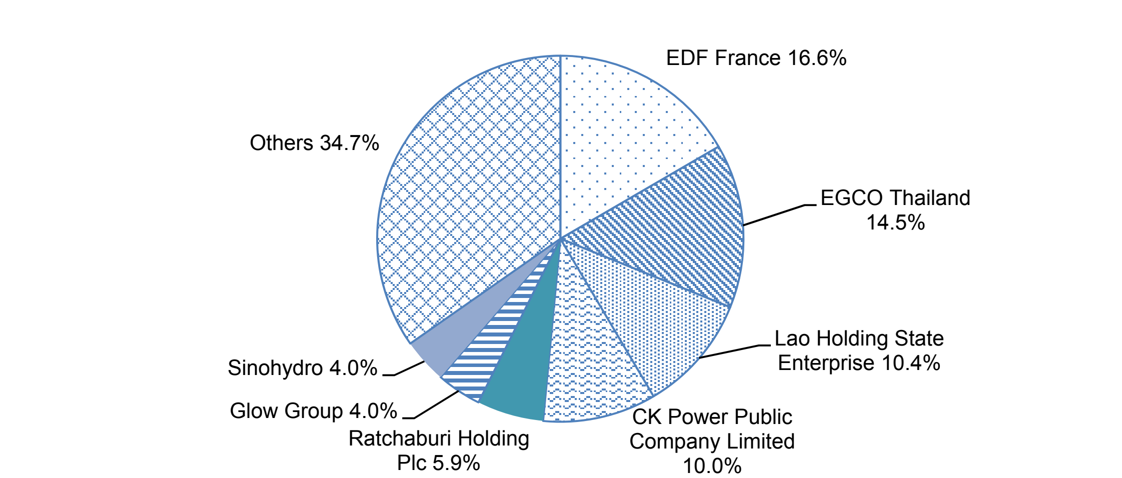
RATCH-Lao Services Company Limited was founded in 2007 and based in Vientiane, Laos. It was established to operate and maintain power generation plants in Laos. It operates as a wholly owned subsidiary of RATCH, currently serving operation and maintenance for Nam Ngum2 hydropower plant.

The Hongsa Power Plant's initial stakeholders include Banpu Power, RATCH, and LHSE. In June 2015, RATCH sold its 40.0% equity stake in Hongsa Power Plant to its subsidiary RH International Corp. (Singapore) Pte Ltd. as a part of a restructuring initiative within the company.

3.4.2 Market Share and Ranking

In 2014, the total installed capacity in Laos was 2,994.0 MW, out of which IPPD capacity was 289.0 MW and IPPX capacity was 2,295.0 MW. Based on the effective capacity of IPPs in 2014, EDF France was the largest player in the IPP segment with a 16.6% market share followed by EGCO Thailand at 14.5%.

Chart 3-5: Market Share (%) of IPPs based on Effective Capacity (MW) in Laos, 2014



Note: Others include companies like GMS Power, Statkraft, China International Water & Electric Corp. etc.

Source: Internationalrivers.org, Department of Energy Promotion and Development's "Electric Power Plants in Laos", Company Annual Reports

3.4.3 Competitive trends

Laos adopts a competitive and transparent bidding process for new power project developments. Project developers with a registered legal entity in Laos are eligible to participate in the bidding process. Tendering processes are usually set by the consulting partner of the investors, but mostly consists of a two-step process which involves technical and pricing bids.

To date, EGAT is the largest customer of the Laotian power industry. Hence, several new hydropower projects under construction are predominantly being developed for electricity export to Thailand. Foreign investors are vying against each other to build power plants and sell power to their respective power utility companies, with EDL acting as an intermediary company.

3.5 Relevant Laws and Regulation

The Government of Laos plans and policies involve rapid and simultaneous development in the power sector by:

- Expanding the generation, transmission, distribution and off-grid development to increase the domestic electrification ratio for the country from the current level of about 60.0% (in early 2008) to a target of above 90.0% by 2020;
- Increasing Government revenues from IPP export investments and honouring power export commitments with neighbouring countries. Promoting 500 kV grid development within the Greater Mekong Sub-region to integrate the power systems of Lao PDR and its neighbours.

Applicable laws to the Power Market:

Foreign Investment Law (2004)

Foreign investors may invest in the Laos in the following forms:

1. Business cooperation by contract;

2. Joint ventures between foreign and domestic investors; and

3. One hundred percent (100%) foreign-owned enterprises.

The State shall consider granting incentives for foreign investment in accordance with the sectors and zones of investment promotion as provided in Articles 16 and 17 of this law.

<u>Article 16: Promoted Activities</u>

The Government defines promoted activities as follows:

1. Production for export;

2. Activities relating to agriculture or forestry, and agricultural, forestry and handicraft processing activities;

3. Activities relating to industrial processing, industrial activities using modern techniques and technology, research and development, and activities relating to the protection of the environment and biodiversity;

4. Human resource development, skills development and public health;

5. Construction of infrastructure;

6. Production of raw materials and equipment to be supplied to key industrial activities; and

7. Development of the tourism industry and transit services.

Article 17: Promoted Zones

The Government determines 3 promoted zones for foreign investment based on geographical location and socio-economic conditions. The zones are as follows:

Zone 1: Mountainous, plain and plateau zones with no economic infrastructure to facilitate investments.

Zone 2: Mountainous, plain and plateau zones with a moderate level of economic infrastructure suitable to accommodate investments to some extent.

Zone 3: Mountainous, plain and plateau zones with good infrastructure to support investments.

The details of the promoted zones for foreign investment shall be determined by the Government.

Article 18: Incentives Related to Duties and Taxes

Foreign investment enterprises investing in activities within the promoted sectors and zones determined in Article 16 and 17 of this law shall be entitled to the following duty and tax incentives:

- Investments in Zone 1 shall be entitled to a profit tax exemption for 7 years and thereafter shall be subject to profit tax at the rate of ten percent (10.0%).
- Investments in Zone 2 shall be entitled to a profit tax exemption for 5 years, and thereafter shall be subject to a reduced profit tax rate of half of fifteen percent for 3 years and thereafter a profit tax rate of fifteen percent (15.0%).
- Investments in Zone 3 shall be entitled to a profit tax exemption for 2 years and thereafter shall be subject to a reduced profit tax rate of half of twenty percent for 2 years and thereafter a profit tax rate of twenty percent (20.0%).
- Profit tax exemption starts from the date the foreign investment enterprise carries out operations. For tree plantation activities, profit tax exemption commences from the date the enterprise starts making a profit.
- Profit tax exemption starts from the date the foreign investment enterprise carries out operations. For tree plantation activities, profit tax exemption commences from the date the enterprise starts making a profit.

- Once the profit tax exemption period is over, the foreign investment enterprise must pay profit tax in accordance with the laws and regulations.

Source: Translation Endorsed by the Law Committee of the National Assembly of the Lao PDR

In addition to the incentives mentioned above, foreign investment enterprises shall be entitled to the following incentives:

1. During the tax exemption period and during the tax reduction period, the enterprise is entitled to an exemption of minimum tax;

2. The profit used for the expansion of licensed business activities shall be exempted from profit tax during the accounting year;

3. Exemption from import duties and taxes on equipment, spare parts and vehicles directly used for production, on raw materials which do not exist domestically or which exist but are insufficient, and on semi-finished products imported for processing or assembly for the purpose of export; and

4. Exemption from export duty on export products.

Raw materials and semi-finished products imported for processing or assembly for import substitution shall be exempted from import duties and taxes or shall be subject to reduced rates of import duties and taxes.

Special economic zones, industrial zones, border trade areas and other specific economic zones must follow the laws and regulations of such specific areas.[60]

One Stop Service ("OSS") Unit

The Investment Promotion Department, operating under the Ministry of Planning and Investment has established OSS to facilitate foreign investors throughout the process of applying for investment licenses. OSS also offers aftercare services to existing investors. To obtain an Investment License and to register a foreign enterprise, an Investment Application Form must be submitted to OSS unit, with the following documents:

• Articles of Association of the company;

• Feasibility Study/Business Plan;

• Investor's Curriculum Vitae, Passport Copy, and six 3x4 photos;

• Bank Statement/Financial Statement certifying investment solvency;

• Letter of Authorization/Power of Attorney/Board resolution authorizing the investment;

If a joint venture company is to be established, a Joint Venture Agreement must be submitted.

3.6 OUTLOOK AND PROSPECTS

Hydropower in the Electricity Mix Remains Strong

Laos has leveraged its hydropower potential both for meeting the domestic power market's requirements as well as to earn export revenues. With a significant potential still largely untapped, the country has put forth plans to augment its hydropower capacity from 2017 until 2020. Many large hydropower projects are under construction, with some of them solely developed to meet the country's growing domestic power demand.

Table 3-5: List of Hydropower Plants under Construction for Domestic Market Consumption in Laos, 2017 - 2020

Name of the Power Plant	Installed Capacity (MW)	Expected Year of Commercial Operation
Nam Lik 1	64.5	2017
Nam Phay	86.0	2018
Nam Tha 1	168.0	2018
Nam Pha	130.0	2019
Don Sahong	240.0	2019
Nam Phak	45.0	2020
Nam Ou -1,2,4 and 7	732.0	2020

Source: MEM, Department of Energy Business

Slow Uptake of Renewable Energy

Currently, Laos 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[61]. Though financial incentives exist for developing renewable energy projects, the uptake of renewable energy is likely to be slow between 2015 and 2020, as the power transmission grid needs to be strengthened, central and local authorities need to be educated, and adequate local competencies need to be set up.

3.6.1 Country Attractiveness

Laos is an attractive market for investments in the hydropower segment of the power sector. Large untapped hydropower potential, conducive business climate with a stable political setup, special economic zones, low risk from natural disasters and low labour costs make it an

[61] Renewable Energy Development Strategy in Lao PDR' October, 2011

attractive destination in SEA. Being a landlocked country, Laos is strategically located to provide electricity export access to neighbouring countries like China, Vietnam, Thailand, and Cambodia.

Incentives from the Government of Laos in the form of 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.

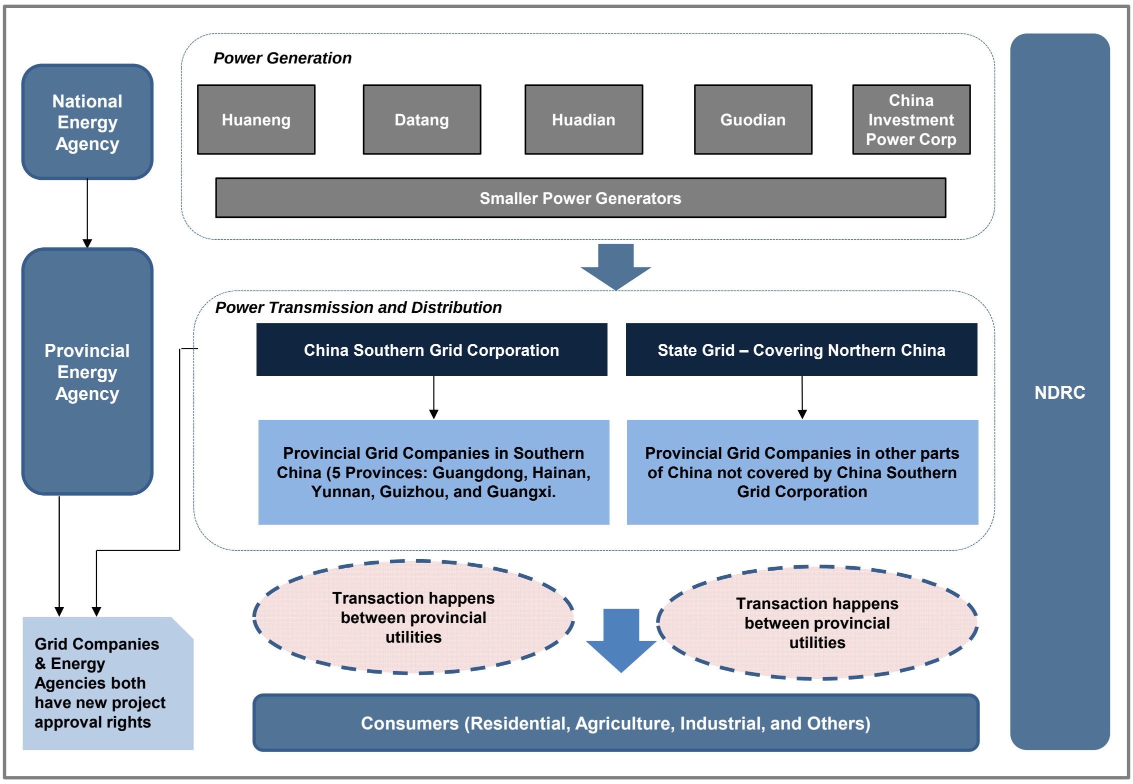
4 ANALYSIS OF CHINA POWER GENERATION INDUSTRY

4.1 BACKGROUND OF THE POWER GENERATION INDUSTRY IN CHINA

Introduction, history and development milestones

The electricity supply industry in China consists of power generation companies and grid companies. Grid companies offer transmission, distribution and retail of electricity. The grid companies, State Grid and China Southern Grid, were formed in 2002 after the separation of power generation from the power utilities. Prior to this, Chinese power supply industry consisted of National Electric Company and independent power plants. National Electric Company owned T&D assets and power generation assets. The State Council decided to separate the power generation assets that were under the management of the National Electric Company to form the five national power generation groups, namely China Datang Corporation, China Huaneng Group, China Huadian Corporation, China Guodian Corporation, and China Investment Power Corporation. The T&D assets were allocated into two grid companies: The State Grid Company and China Southern Power Grid Company. In addition to the five national power generation groups, there are also 22 notable regional power generation groups that mainly focus on regional development or one type of power generation, e.g., China General Nuclear Electric Group, with a focus on developing and operating nuclear power generation projects, and China Changjiang Three Gorges Group, with a focus on the operation of Three Gorges Dam hydropower plant. Zhejiang Energy Group, owned by Zhejiang Provincial Government, focus on developing power generation capacity within Zhejiang province as well as investing in other energy businesses, such as coal transportation, natural gas pipelines construction, and energy services businesses. Zhejiang Energy also has explored other provincial energy markets, such as Xinjiang, where the provincial policy allows other energy companies to invest within their jurisdictions.

Figure 4-1: Industry Structure of the Power Generation Industry in China



Source: Frost & Sullivan

The structure of the current electricity sector in China was formed in 2002. The governing authority of national electricity industry is the National Energy Agency ("**NEA**"). Provincial Energy Agencies, under the guidance of and in collaboration with the NEA, manage the electricity generation, T&D companies within their own jurisdictions. Within each provincial jurisdiction, the power generation sector includes the power plants owned by the five national power generation groups or by the Provincial Government.

Two grid companies, the State Grid Company and China Southern Grid Corporation, own the entire power T&D assets in China. China Southern Grid Corporation covers the five provinces in the Southern China, namely Guangdong, Hainan, Yunnan, Guizhou, and Guangxi. The State Grid Company covers all the other provinces in China.

IPP needs to work with the local provincial grid company to negotiate the technical and commercial aspects of grid connection.

The National Development and Reform Commission ("**NDRC**") has the overarching authority over reform and development of the electricity industry. This includes pricing, industry structure reform, and development of goals for both renewable and non-renewable energies, amongst others.

Pricing Structure

China's electricity supply and demand still follows the central planning model and has not developed into a free-market mechanism. It is determined within a province or region based on the guidance price fixed by the NDRC and adjusted within a small range by the provincial electricity authority and provincial Price Authority according to the individual supply and demand situation in each province. As a result, the electricity prices might not reflect the power generation cost.

The prices in China's electricity market include the following three types[62]:

- Standard Pricing: This is the price payable to power generators and vary by different fuel types. This price is mainly determined by the Government. Under the 'Implementation Suggestion of Using Pricing Mechanism to Encourage and Guide Private Sector to Invest', issued by NDRC in July 2012, select regions with abundant electricity are given the choice to experiment 'bidding mechanism' between generators and grid companies.

  Standard price = Unit fixed cost / operating hours + unit variable cost

- Retail price: It is set by the central Government, adjusted by regional electricity and pricing authorities to reflect the regional economic conditions, electricity supply and demand conditions. Retail pricing is comprised of Electricity Purchase Cost, Electricity T&D Loss, and various Government subsidies.

- T&D price: price paid by the generators to the grid companies who offer grid-connection and T&D services.

  T&D price = Average Retail Price – Average Generation Cost

Among the above three types of price, retail price as well as T&D prices do not reflect the generation cost, demand and supply dynamics.

Subsequent to the electricity price adjustment notice published in May 2013[63], NDRC published the 'Circulate on On-grid-price for Coal Cower Reduction and Commercial and Industrial Customer Power Price Reduction' in April 2015. It announces the reduction of an average of RMB 0.02/Kwh for coal-fired power on-grid-price and the reduction of retail prices for industrial and commercial customers. It also tries to promote the electricity price market mechanism by suggesting electricity consumers to negotiate directly with the power suppliers where possible.

[62] 'Discussion on Price Reform in China', Zhangqin, StateGrid Energy Research Institute, Periodical Energy Technology and Economics, Feb 2011.

[63] National Development and Reform Committee Notice on Adjusting Customer Group Segmentation for Electricity Sales Price, 24 May 2013. It outlines the steps required to gradually adjust the pricing mechanism from previously consumer sector-based pricing to load type-specific pricing, and specifies the pricing for three consumer groups, namely residential, agriculture, and industrial consumers.

China is amidst reforming the electricity sector, which includes the pricing reform. In the ‘Suggestions on Further Deepening the Regulatory Reform in Electricity Sector’, issued in March 2015 by The State Council, it announced the following:

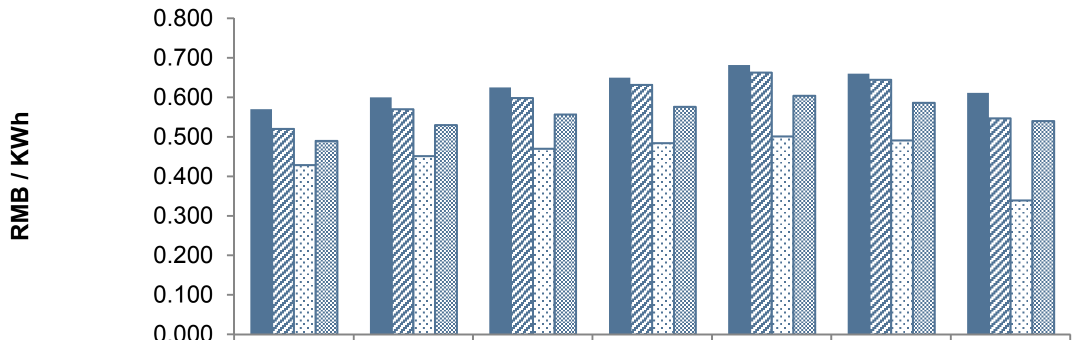
- Orderly open up the pricing outside the T&D pricing;
- Gradually open up the distribution and retail sectors;
- Deepen the research on regional grids development and T&D mechanism that suits China’s conditions.

NDRC subsequently issued ‘Speeding Up the T&D Price Reform’ in April 2015, in which:

- Anhui, Hubei, Ningxia, and Yunnan provinces are listed as provinces to experiment ‘allowed cost plus reasonable return’ mechanism;
- Reform the regulatory approach towards grid companies. Grid companies are to be paid according to the T&D price set by the Government, instead of the current pricing model;
- Gradually promote the market mechanism on standard pricing (on-grid-price) and retail price.

In late 2015, reform was implemented in the retail segment where retail licenses were issued to independent operators and T&D price are given a different framework outside the current experimental provinces, which subsequently led to downward revision of retail tariffs in China.

Chart 4-1: Retail Tariff in China, Hebei; Shandong and Shanxi, 2014



	2010	2011	2012	2013	2014	2015	2016
National Average	0.570	0.600	0.625	0.650	0.682	0.660	0.611
Shandong	0.520	0.570	0.599	0.631	0.663	0.644	0.547
Shanxi	0.43	0.45	0.47	0.48	0.50	0.49	0.34
Hebei	0.49	0.53	0.56	0.58	0.60	0.59	0.54

Source: Hebei Pricing Authority, Shanxi Pricing Authority, Shandong Pricing Authority, Frost & Sullivan estimates

When comparing the retail tariff of electricity in Hebei, Shanxi and Shandong with the national average retail tariff, it is noted that retail tariff in all 3 provinces are lower than the national average. This is because to the 3 provinces are rich in fuel resources, which in turn drive the cost of electricity generation down.

4.2 DEMAND CONDITIONS

The four consumer groups, namely residential, industrial, service industry, and agricultural[64], accounted for about 12.0%, 73.0%, 12.0%, and 3.0% of the total electricity consumed in 2014 respectively. The steel manufacturing, chemicals, non-ferrous metal manufacturing and construction material manufacturing industries consumed most of the electricity used in the industrial consumer group. This ratio is expected to change between 2015 and 2020 when industrial consumer group is expected to consume a smaller portion, whereas residential and commercial consumer groups are going to take a higher share of the total electricity consumption. In the transition toward a post-industrial society[65], the service sector is expected to gain faster development between 2015 and 2020.

In 2014, the average power consumption per capita in China is about 4,000 KWh. Among which, Ningxia and Qinghai where high energy consuming industries are concentrated, and Suzhou, Wuxi, and Dongguan, etc cities where high-end manufacturing sectors are, the average power consumption per capita is above 10,000 KWh.

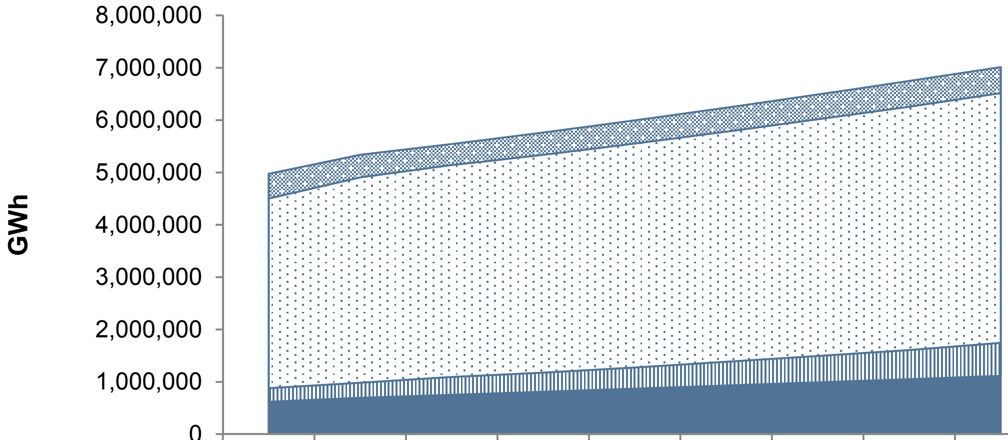
Table 4-1: Electricity Consumer Group Segmentation[66], China, 2015

Segment	Definition
Agriculture and Other Consumer Group	Agriculture, forestry, animal husbandry, fishery and water conservancy; public lighting, and others
Industrial Consumer Group	Manufacturing, mining, electricity generation, energy, and construction.
Service Industry Consumer Group	Offices, transportation storage, post, warehouse and retail trades, entertainment, sports, hotels, and catering services.
Residential Consumer Group	Urban and rural households, government organisations, armies, and schools.

Source: China Statistics Yearbook

[64] The segmentation follows the way electricity consumer groups are segmented by the China National Statistics Department.
[65] The Post-industrial Future is Nigh, 19th February 2013, The Economist
[66] Industrial Classification (GB/T 4754-2011)

Chart 4-2: Total Electricity Consumption by Consumer Group, China, 2012 - 2020



	2012	2013	2014	2015E	2016F	2017F	2018F	2019F	2020F
Agriculture & Others	470,500	432,000	399,270	425,804	441,559	457,897	474,839	492,408	495,980
Industrial	3,623,2	3,923,7	4,048,1	4,161,4	4,278,0	4,397,8	4,520,9	4,647,5	4,771,3
Service Industry	260,700	287,800	338,270	367,023	407,396	452,209	501,952	557,167	631,504
Residential	621,900	698,900	759,721	812,902	871,431	934,174	994,895	1,054,5	1,117,8
Total	4,976,3	5,342,4	5,545,4	5,767,2	5,998,4	6,242,0	6,492,6	6,751,6	7,016,7

Source: China National Statistics, 2014, Strategic Energy Development Plan 2014 - 2020 by the Office of the State Council, November 2014, Frost & Sullivan

China's demand for electricity has rapidly increased since the economic reform in the early 1980s, at rates surpassing those of population growth. Between 1980 and 2014, the electricity consumption increased from 300,500 GWh to 5,545,411 GWh, at a CAGR of 9.0%. The electricity consumption per capita has grown from about 300 KWh in 1980 to 4,095 KWh in 2014 at a CAGR of 8.0%.

From 2013 to 2015, due to slowing global economic condition combined with China's slowing demand for steel, non-ferrous metal, construction materials, etc., the demand for electricity has been growing at a lower CAGR of 3.0%. Nonetheless, the recent devaluation of RMB is expected to boost the export market in China, which in turn support the industrial activities and thereby electricity consumption in the country. Meanwhile, China is also in the process of implementing the 'Structural Adjustment' of its economy, with the aim to reduce the proportion of contribution of high energy-consuming sectors in the total economic output and increasing the share of high value-added industry sectors. In parallel with the energy efficiency measures across the nation, China's electricity is expected to grow at a CAGR of 4.0% from 2015 to 2020, which is slower than the CAGR of 10.4% achieve between the period of 2005 and 2012[67]. From 2015 to 2020, demand from the service sector is expected grow at the fastest pace among all sectors at a CAGR of 11.5%, while electricity consumption from the industrial sector is expected to grow the slowest at a CAGR of 2.8% in the same period.

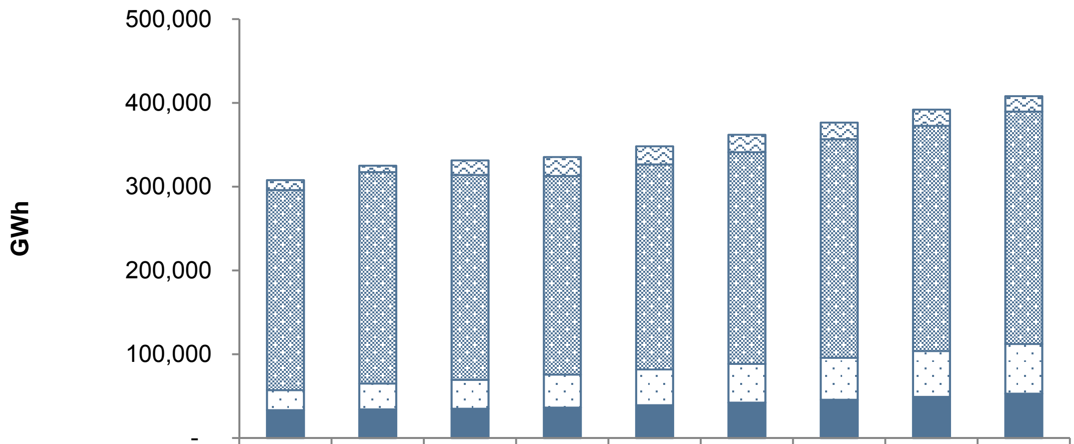
[67] Source: China Statistics Yearbook 2014

4.2.1 Hebei

The industry structure in Hebei is heavily skewed towards high energy intensive heavy industry sectors. Steel manufacturing, cement production and sheet glass industries have been the pillar industries in Hebei province. In 2012, the income of heavy industry contributed to the 80.0%[68] of the total industrial output in Hebei. This was considerably higher than the national average of 72.0%.

Under the requirements of NDRC, Hebei is expected to shut down 60.0 million tonnes of steel production capacity by 2017. Hebei province has also issued documents to move the additional capacity of cement and glass to other provinces[69]. This resulted in the electricity consumption by the industrial sector to drop by 7.4% whereas the service industry grew by 9.6% from January to April 2015. At the same time, Hebei Provincial Government has initiated strategies and plans to foster the development in other less environmentally impactful industries, including high-end equipment manufacturing, information and electronics technologies, biotechnologies, and pharmaceutical. These initiatives reflect the intended efforts by Hebei province and the guidance from the State Government that Hebei province is gradually shifting from previously heavy industry towards high value added sectors. With the factors considered above, electricity consumption in Hebei province is expected to grow at CAGR of 4.0% between 2015 and 2020.

Chart 4-3: Electricity Consumption by Sector, Hebei Province, 2012 - 2020



	2012	2013	2014	2015E	2016F	2017F	2018F	2019F	2020F
Agriculture & Others	11,707	7,709	17,376	22,542	21,640	20,775	19,944	19,146	18,362
Industrial	238,868	252,290	244,500	237,165	244,754	252,586	260,669	269,011	277,474
Service Industry	23,897	30,910	34,424	39,341	42,685	46,313	50,250	54,521	59,167
Residential	33,327	34,210	35,110	36,339	39,210	42,307	45,649	49,256	53,046
Total	307,799	325,119	331,410	335,387	348,289	361,982	376,512	391,933	408,049

Source: Hebei Province Statistics, Hebei Development and Reform Committee, Frost & Sullivan estimates

[68] Discussion on the Correlation of Hebei Industry Structure, Energy Consumption and Haze, Li Rui, Caijun, Macroeconomy Management, July 2014.
[69] Work Plan to Relocate Over-Capacity of Steel, Cement, and Glass etc. to Overseas, Hebei Provincial Government, November 2014.

4.2.2 Shanxi

Similar to Hebei, Shanxi's industry structure has been strongly skewed towards the heavy industry sectors, which resulted in high electricity consumption. These industries comprise coal production, metallurgy, equipment manufacturing, power generation, foods and beverage industries amongst others. As of 2014, the coal production industry is the single largest industry in Shanxi, which contributes about 50.0% to the total revenue of industrial sector in the province, followed by the metallurgical sector (about 15.0%) and the equipment manufacturing sector (about 10.0%).

The overall falling demand for coal, especially China domestic demand, as well as the downtrend of coal prices in recent years has significantly affected Shanxi's economy. This led to Shanxi being ranked as the province with lowest GDP growth rate in the country with its GDP growth dropping from 10.1% in 2012 to 4.9% in 2014[70]. As a result of stagnant coal sector development, the electricity consumption in Shanxi grew at a CAGR of only 1.6% from 176,579 GWh in 2012 to 182,260 GWh in 2014, of which the industrial sector power usage only grew 0.6%.

In 2010, Shanxi was selected to be the ninth zone for economic reform in the document issued by NDRC, the "Shanxi Province National Resource-based Economic Transition Comprehensive Reform Zone". Shanxi since has gradually increased the investment in equipment manufacturing and other forms of energies development other than coal. As a result, in the first half of 2015, the output from equipment manufacturing in Shanxi grew by 19.1%, coal seam gas sector grew 15.6%, service sector income grew 9.8% on the previous 6 months[71].

Being resource rich and located in central China, Shanxi positions itself as a resource supplier to other provinces, while exploring the opportunities in less energy consuming industrial sector[72]. In particular, Shanxi aims to establish itself as a base for advanced equipment manufacturing: rail equipment manufacturing, advance coal chemical sector, advanced coal mining machinery manufacturing, and new energy (ethanol, electric, and LNG) vehicle system manufacturing, etc.

Parallel to the promotional policies for manufacturing industry, Shanxi Provincial Government also issued 'Implementation Plan on Shanxi Province: Accelerating Manufacturing Industry Based Service Sector Structuring and Upgrading' in December 2014. It lists logistics, research and development, finance, information technology services, energy conservation services, certification and inspection, e-commerce, business consulting services, human resources services, and technological outsourcing, etc. as its strategic focus to foster economic growth in the province.

With these policies and associate financial support to actively promote the development in industrial sector and service sector, in conjunction with on-going improving living standard of its

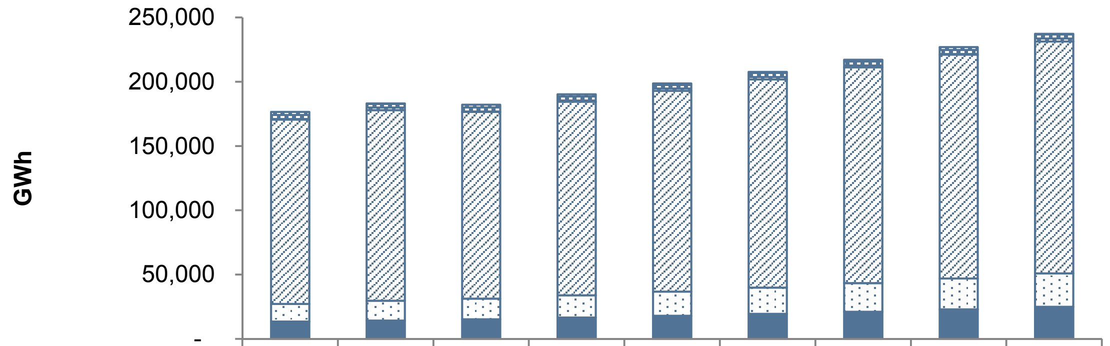
[70] Shanxi Provincial Statistics, 2014.

[71] The State Council, 31 July 2015, retrieved from: http://www.gov.cn/xinwen/2015-07/31/content_2906596.htm

[72] 2015 Implementation Suggestions on Industrial Sector Restructuring and Upgrading, by Shanxi Provincial Industry & Information Technology Bureau, June 2015.

households, the total power consumption in Shanxi is expected to reach 237,350 GWh by 2020, growing at a CAGR of 4.5% between 2015 and 2020.

Chart 4-4: Electricity Consumption by Sector, Shanxi Province, 2012 - 2020



	2012	2013	2014	2015E	2016F	2017F	2018F	2019F	2020F
Agriculture & Others	5,944	5,238	5,710	5,744	5,779	5,813	5,848	5,883	5,934
Industrial	143,405	148,237	145,210	150,583	156,154	161,932	167,924	174,137	180,386
Service Industry	13,750	15,460	16,010	17,371	18,847	20,449	22,188	24,074	26,108
Residential	13,480	14,300	15,330	16,618	18,014	19,527	21,167	22,945	24,922
Total	176,579	183,235	182,260	190,316	198,794	207,722	217,126	227,039	237,350

Source: Shanxi Statistics Bureau, Shanxi Provincial Government; Frost & Sullivan estimates, 2015

4.2.3 Shandong

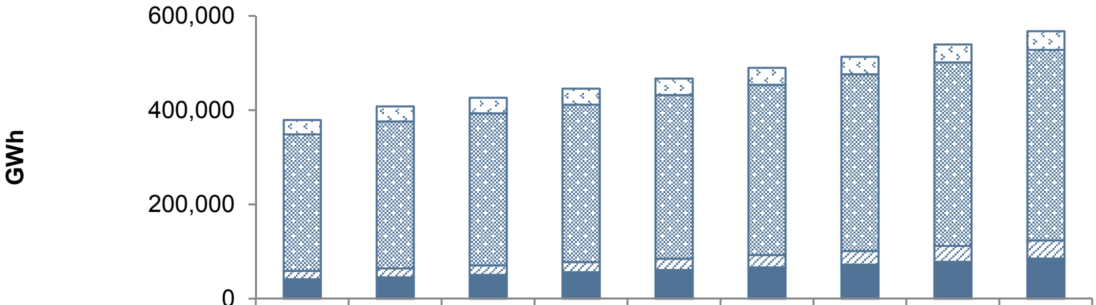
Shandong is one of the largest industrial provinces in China and was ranked first in terms of provincial industrial revenue between 2005 and 2009. Shandong's economy skews heavily towards heavy industries, such as equipment manufacturing, smeltering, chemical and steel manufacturing, petrochemical and cement industries. This has led to a high energy dependent economy. Shandong has been exploring the approaches to shift the industry structure towards less energy intense industries and more high-value added industries that have more technological components and more service oriented industry structure.

In 2015, Shandong Provincial Government issued two documents:

- Shandong Province Action Plan to Promote Industry Repositioning and Rebalance (2015-2020);
- Shandong Province 22 Key Industries Repositioning and Upgrade Implementation Plan, issued in April 2015.

These two documents delineate the targets and implementation steps to gradually improve the industrial structure and energy efficiency through reduction of the production capacity of high energy consuming manufacturing capacity in cement production, glass manufacturing, gypsum plasterboard production, low power mechanical and electric equipment production, such as compressors, pump, welding machine, amongst others. On the other, it plans to improve the investment in areas including high-end equipment manufacturing, pharmaceutical, information technology and new material manufacturing. Nonetheless, electricity consumption in Shandong is expected to continue to grow at CAGR of 5.0% between 2015 and 2020.

Chart 4-5: Electricity Consumption by Sector, Shandong Province, 2012 - 2020



	2012	2013	2014	2015E	2016F	2017F	2018F	2019F	2020F
Agriculture and Others	30,536	31,974	32,901	33,855	34,837	35,847	36,887	37,957	39,815
Industrial	289,900	311,756	322,979	334,283	347,655	361,561	375,300	389,562	404,365
Services Sector	17,640	18,970	20,013	21,514	23,666	26,269	29,159	33,532	38,562
Residential	41,324	45,600	50,616	56,184	61,072	66,385	72,160	78,438	85,190
Total	379,400	408,300	426,510	445,837	467,230	490,062	513,506	539,489	567,933

Source: Shandong Statistics Bureau 2013, Electricity Demand Forecast During the Economic Transitioning (Shandong Province), Periodical Modern Economic Information, Issue 5, 2013, Frost & Sullivan.

4.2.4 Key Growth Drivers & Constraints

Growth Drivers

Industrialisation Process

The industrialisation process in China begun in 1955, during which the population in the country involved in the agriculture sector was approximately 85.0% of the overall population. By 2010, this proportion dropped to about 55.0%[73]. Industrialisation process has led to a period of rapid growth in energy consumption. From 1995 to 2014, the national electricity consumption multiplied by 5.5 times and grew at a CAGR of 9.4%. The development of the energy-demanding heavy industries, such as the steel manufacturing, non-ferrous metal processing, petro-chemical, and construction material manufacturing industries, has made industrial sector accounting for over 70.0% of the total electricity consumed annually since 1990s. Despite a slowdown in growth in the industrial sector, China is still considered to be in the late stage of the industrialisation process[74]. The electricity consumption per capita in China was 4,095 KWh in 2014. This is considerably lower than the electricity consumption per capita in the US, Canada, which is about 13,000 KWh and 15,630 KWh respectively. The key characteristics in the late industrialisation stage include transitioning away from high energy consuming

[73] China Statistics Bureau

[74] The New Chinese Economy: Dynamic Transitions Into the Future Elias C. Grivoyannis, 27 March 2012, Palgrave macmillan publishing

industries, growing share of output in services sector and high-value added industries as well as improving living standards for both urban and rural households. It is estimated that by 2020 the electricity consumption per capita in China is to reach 5,000 KWh[75].

Continuous Economic Growth

Since the economic reform in China in the 1980s from a previously centrally-planned and closed economy to an open economy that is more market oriented, Chinese economy has been growing at an unprecedented pace. In the US dollar terms, the GDP of China grew from US$189.7 billion in 1980 to US$10,360.1 billion in 2014 at a CAGR of 12.5%[76]. The strong growth greatly stimulated the demand for electricity. The 18th Communism Part of China National Congress set the target that the GDP in 2020 doubles that of 2010. This target requires the GDP to grow at an annual rate of 6.6% from 2014 to 2020.

Chinese economy has been manufacturing- and infrastructure construction-driven; as a result, its electricity consumption per unit of GDP doubles the global average[77]. In 2013, Chinese GDP was the second highest in the world (the US: US$16,768.0 billion, China: US$9,490.0 billion[78]), whereas China's electricity consumption of 5,342,400 GWh in 2013 was 12.0% higher than that of the US (4,686,400 GWh). This contrast shows that China's economy currently still depends upon the sectors that are heavy energy consumers.

Standardisations of Renewable Energy Prices

A clear on-grid-tariff is an important factor to boost investors' confidence in renewable energy power generation. "Trial Measurements for Renewable Power Price and Cost Allocation" issued in 2006 by NDRC was the first policy exploring financial methods to support the development of renewable energies in China. The subsidies for wind power generation began in 2009, while subsidies for solar PV power generation began in 2013. Prior to this, distributed PV power generation capacity had been subsidized on a project-investment basis; the wind power had been purchased with an unified price, but in the 2009 policy, the wind power on-grid-tariff was segmented into different regions according to wind resource availability and terrain features. These two policies greatly spurred the wind power and PV power generation investment.

Growth Constraints

Structural Industry Change

The Chinese economy is shifting from a reliance upon the growth of the energy-intensive industries to that of the cleaner and higher value-added industries. In the first half of 2015, the GDP grew 7.0%, while the electricity consumption grew at 1.3%[79], the lowest growth since 2010. The GDP in the first quarter of 2015 grew at 6.4%, which is lower than the service sector's growth rate of 7.9%. This shows the trend of an industry structural change towards a cleaner and more energy-efficient growing stage.

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[75] Frost & Sullivan, 2015
[76] World Bank
[77] China Climate Change Info-Net, 3 July 2014
[78] World Bank
[79] Statistics Office, China Electricity Council, July 2015

It has been estimated that the industrial sector's contribution to the GDP is expected to reduce from 46.8% in 2015 to 46.5% in 2020, and further down to 45.4% in 2030; in comparison, the service sector's share in the GDP is expected to increase from 45.8% in 2015 to 47.9% in 2020. This is expected to greatly compromise electricity consumption growth from 2015 to 2020.

Energy Efficiency

78.6%[80] of China's electricity is generated from coal[81]. This resulted in severe impact on the air quality in large cities across China. The Government of China has issued a number of policies to encourage the adaptation of energy efficiency methods to reduce carbon emission:

- The Guidance on Speeding up the Development of Energy Efficiency and Environment Protection Industry, the State Council, 2013.
- The Guidance on Ameliorating Issues of Severe Overcapacity, the State Council, 2013.
- Notice on 2014-2015 Action Plans for Energy Efficiency, Emission Reduction, and Low Carbon, the State Council, May 2014.

The power generation industry and consumers are encouraged to reduce the dependence upon carbon-intensive coal-produced electricity as well as reduce the overall energy consumption. For instance, Shanxi Province, a large coal producing province in China, has been slowly reducing its coal-fired power generation in line with the national policies. In terms of percentage of coal-fired power generation compared to total installed capacity, the province achieved a 7.0% reduction from 90.0% in 2013 to about 83.0% in 2014. The currently efficiency requirement for coal-fired power plant in China is shown in the table below.

Table 4-2: Efficiency Standard Requirement at Coal Power Plants in China, effective from September 2014

Type of Power Plant	Capacity per generating unit (MW)	Coal Consumption (gram coal equivalent / KWh)
Super Supercritical	1,000	⩽ 284
	600	⩽ 292
Supercritical	600	⩽ 302
	300	⩽ 312
Sub-critical	600	⩽ 313
	300	⩽ 323
Super High Voltage	200 125	⩽ 355

Source: "National Standard: The Norm of Energy Consumption per Unit Product of General Coal-fired Power Set (GB 21258 – 2013)" issued by General Administration of Quality Supervision, Inspection and Quarantine of China, and Standardization Administration of China, 2013.

[80] CEA, 2014
[81] CEA, 2014

Nevertheless, the high efficiency and sound economics of coal-fire power generation makes coal power generation still an appealing option if the environmental protection standard is strictly implemented. In 2020, the coal power generating capacity is about 1,121 GW[82], growing at 5.5% between 2014 and 2020.

However, high emission standards and energy efficiency requirement are implemented on the coal power plants. It is announced in the Action Plan for Coal Power Generation Energy Efficiency and Emission Reduction Upgrade and Modification (2014-2020) that the Government of China aims to reduce the modified existing generating units to reach an average efficiency of <310 gce/KWh, among which existing power plants with generating units of 600 MW and above to reach an average efficiency of < 300 gce/KWh by 2020. It is also accentuated in the same Action Plan that new coal power plants (including approved projects that have condition to change the generating units technical specifications) in principle are required to adopt the super supercritical generating units with capacity over 600 MW. The supercritical generating units typically achieve energy efficiency rate of approximately 41%, while the average net efficiency of thermal power plants in China was 38.6% in 2014[83]. This Action Plan has replaced the Special '12th Five-year' Plan for Clean Coal Technology Development issued in May 2012 which includes focus on the treatment of coal to reduce the pollutant content in the coal.

Climate Change Commitment

In the APEC Summit held in Beijing November 2014, the Government of China signed a joint announcement with the US Government in which China promises to increase the proportion of non-petro fuel in the total energy consumption to 20% by 2030. In the "National Climate Change Planning (2014 – 2020)" issued by the NDRC in September 2014, 'energy saving' is a key strategy in addition to the commitment to increase the share of renewable energies in energy mix. It also pledges that by 2020 the primary energy consumed will be less than 4,800 million tonne coal equivalent. These measures reflect the Government's shift in focus in power generation development from conventional power generation to renewable energy power generation in future.

4.3 SUPPLY CONDITIONS

4.3.1 Installed Capacity

Despite slowing economic conditions, especially the slowdown in manufacturing sector which is one of the largest electricity users in the country, the China power generation industry still requires base load power sources to meet the overall growth in electricity demanded. The installed capacity of power generation industry in China grew at a CAGR of 8.4% from 1.1 terawatt (**"TW"**) in 2012 to 1.3 TW in 2014. With slowing economy China's, the power generation industry is also expected to enter into a slower phase of growth. It is forecast that

[82] Frost & Sullivan estimates, 2015

[83] China Electricity Council, published on China Power Enterprise Management

the installed power generation capacity is expected to grow from 1.5 TW in 2015 to 2.0 TW in 2020 at a CAGR of 6.2%.

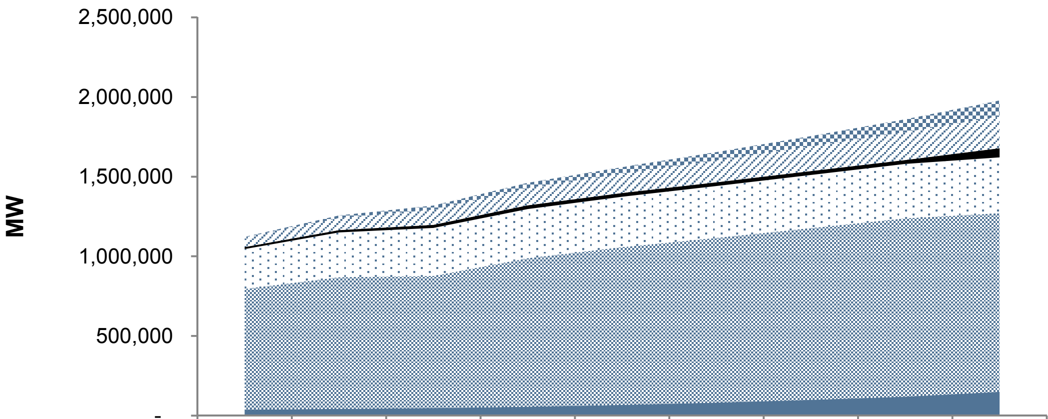
The fuel mix of China's power generation has been evolving, but coal is still the largest contributor that accounted for about 67.5% of the total installed capacity in 2012, followed by hydropower (about 22.2%), wind power (5.5%), natural gas (3.4%) and nuclear power (1.1%). The share of coal powered electricity generation in China is considerably high by international standard. In light of the heavy pollution in most Chinese large cities and the commitment to mitigate the climate change, Chinese National Government has launched a number of initiatives to reduce the share of coal in the fuel mix. It is estimated that by 2020, the share of coal-fired power plants capacity in China will be reduced to about 55.0%, 10.0% lower than its current level[84].

In 2007, the State Council of China issued 'Circulate of Suggestions on Accelerating the Shutdown of Small Thermal Power Plants'. The policy aims to shut down low efficient and high polluting power generation units and replace with large capacity, high efficiency and lower carbon emission power generation units in order to achieve higher efficiency of coal use and carbon emission reduction. Most coal-fired power plants in China are under 200.0 MW in capacity with operational age over 20 years. Since the issuance of the policy, these power plants are mostly replaced with supercritical coal-fired power plants with capacity between 600.0 MW and 1000.0 MW. An example of power plant under this initiative is the 1,320.0 MW Shanxi Luguang Power Plant, in which Banpu Power owns 30.0% of equity interest. The plant has 2 units with an installed capacity of 660.0 MW respectively, and is expected to achieve commercial operation in 2017.

It is easier to obtain approval from the NDRC on new coal-fired power generation projects, if the projects fall under the policy of 'Replacing the Small and Highly Polluting Units with Large and Cleaner Units'. This policy has proven to have greatly improved the energy efficiency with the amount of coal consumed per KWh reduced from 356 grams in 2007 to 321 grams in 2013[85] .

[84] National Climate Change Planning, September 2014, by the National Development and Reform Committee; Energy Development Strategic Action Plan 2014 – 2020, November 2014, by the Office of the State Council of China
[85] How to Develop the Efficient and Clean Coal Power Generation in China, Mao Jianxiong, Department of Thermal Energy Engineering, Tsinghua University, 13~16 January 2015, at IEA Clean Coal Centre Shandong / Hebei Clean Use of Coal & Energy Saving Emission Reduction Conference

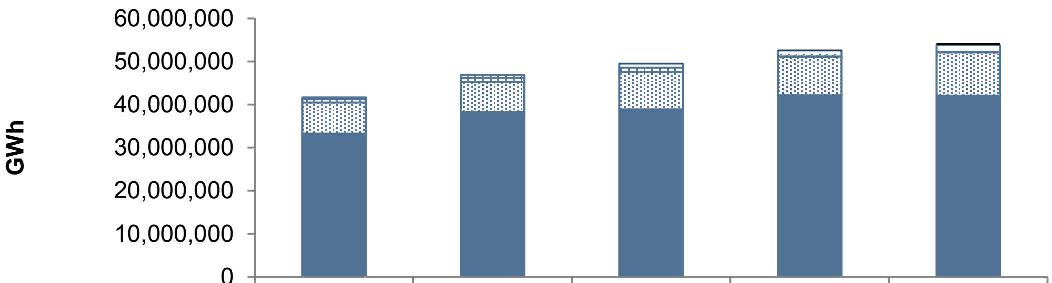
Chart 4-6: Installed Power Generation Capacity by Fuel Type, China, 2012 - 2020



	2012	2013	2014	2015E	2016E	2017F	2018F	2019F	2020F
Others	-	82	94	104	112	121	131	142	152
Solar	3,410	15,890	26,520	33,097	41,305	51,549	64,333	80,287	100,000
Wind	61,420	76,520	95,810	108,265	122,340	138,244	156,216	176,524	200,000
Nuclear	12,570	14,660	19,880	23,764	23,764	24,460	24,460	24,460	58,000
Hydro	249,470	280,440	300,000	307,800	315,803	324,014	332,438	341,081	350,000
Coal	758,000	827,088	830,000	933,174	990,606	1,035,0	1,079,7	1,119,5	1,121,3
LNG (Incl. CSG)	38,270	43,000	48,000	56,000	67,704	81,854	98,962	119,645	150,000
Total	1,123,1	1,257,6	1,320,3	1,462,2	1,561,6	1,655,3	1,756,3	1,861,6	1,979,5

*Source: China Electric Association (**"CEA"**), 2014; National Action Plan for Energy Strategy (2014 - 2020), Office of the State Council of China, November 2014; Frost & Sullivan, 2015.*

Chart 4-7: Electricity Generated by Fuel Types, China, 2010 - 2014



	2010	2011	2012	2013	2014
Solar	-	-	34,100	158,900	476,700
Wind	446,200	703,300	959,800	1,383,000	1,534,000
Nuclear	738,800	863,500	973,900	111,500	132,574
Hydro	7,221,700	6,989,500	8,721,100	8,921,000	10,045,000
Thermal (Coal & LNG)	33,319,300	38,337,000	38,928,100	42,216,000	42,127,435
Total	41,726,000	46,893,300	49,617,000	52,790,400	54,315,708

Source: China Statistics Yearbook, 2014; Frost & Sullivan.

4.3.1.1 Hebei

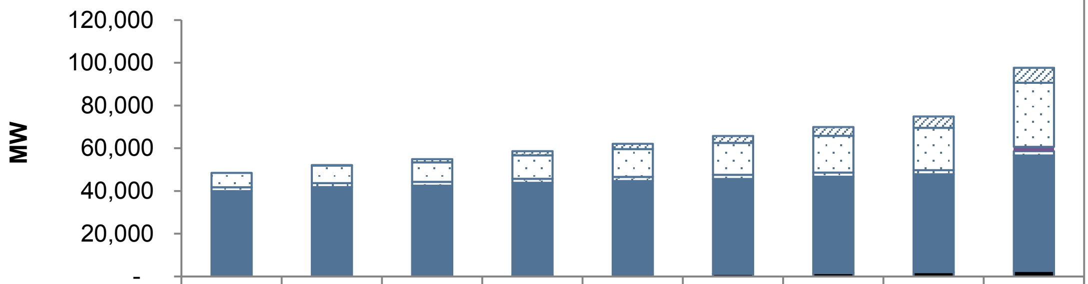
Hebei Province has had a skewed industry structure towards heavy industry. 7 out of the top 10 most polluted cities in 2014 announced by the Environment Ministry of China are within Hebei Province. Coal that contributes to 93.0% of the primary energy source in Heibei is considered as the major cause of pollution. Meanwhile, Hebei province's adjacency to the capital city Beijing and the pollutants that have floated over Beijing area has caused severe concerns. As such, Hebei Province has adopted drastic measurements to reduce emission. Hebei is one of the focused regions in National Climate Change Planning (2014 – 2020) to shut down small coal-fired power plants and adopt renewable energies aggressively. In July 2015, the State Council approved Zhangjiaokou to be a demonstrative zone for renewable energies[86]. Besides, according to the 12th Five-year Plan for Atmospheric Pollution Prevention in Key Areas, selected cities in Hebei are listed as "Under Critical Control Area" whereby only CHP plants or large coal-fired power plants intending to replace small inefficient coal-fired power plants will be approved under the coal-fired power plants category.

In addition, Hebei province is rich in solar and wind energy resources that offer great potential to renewable energy utilisation. In 'Work Plan to Enhance the Atmospherically Pollution Prevention in Energy Industry', jointly issued by NDRC, NEA, Ministry of Environment Protection in May 2014, Hebei province is to cut down 4,000.0 tonnes of coal consumption, and most of this is in power generation.

Looking forward, the newly added capacity include large capacity coal-fired power generating units, wind and solar plants, and nuclear. The first nuclear plant owned by China Nuclear Huadian Hebei Nuclear Power Company has been approved and plans to start the construction in 2016 in Cangzhou, Hebei Province with commercial operation expected by end of 2020.

[86] Zhangjiakou Renewable Energy Demonstrative Zone Development Plan, NDRC and NEA, July 2015

Chart 4-8: Installed Power Generation Capacity by Fuel Type, Hebei Province, 2012 - 2020



	2012	2013	2014	2015E	2016F	2017F	2018F	2019F	2020F
Others	-	16	25	30	35	42	50	60	65
Solar	-	251	1,500	1,935	2,496	3,220	4,154	5,358	7,000
Wind	6,750	8,250	9,130	11,000	13,000	14,950	17,193	19,771	30,000
Nuclear	-	-	-	-	-	-	-	-	2,000
Hydro	1,790	1,810	1,837	1,865	1,893	1,921	1,950	1,979	2,009
Coal	39,990	41,870	42,500	43,070	43,716	44,372	45,037	45,713	54,000
Natural Gas	-	-	-	780	998	1,278	1,636	2,094	2,680
Total	48,530	52,197	54,992	58,680	62,138	65,783	70,020	74,976	97,754

Notes: Others include geothermal, biothermal, tidal power generation, amongst others.
Source: Hebei Province Statistics; Hebei Development and Reform Committee; Hebei Cangzhou Haixing Nuclear Project Announcement, by Hebei Cangzhou September 2014; Frost & Sullivan estimates

4.3.1.2 Shanxi

Shanxi Province is the largest coal producing province in China. As of 2014, the 10 largest power plants by installed capacity are coal-fired power plants, and the coal production is Shanxi amounted to 25.0% of the total coal production in China[87]. Being rich in coal resources, Shanxi exports about 30.0% of electricity generated to the neighbouring provinces. As coal price has experienced a drastic drop since 2012, the Shanxi provincial Government, under the approval and guidance of the Chinese central Government, initiated a series of policies to sustain the provincial economy and Government revenue. The strategy includes positioning Shanxi as an energy-oriented economy with an installed capacity growing faster than the national average level for export of electricity to other provinces. By 2020, Shanxi plans to have 25.6% of the installed capacity running on natural gas, which includes coal seam gas ("**CSG**"). Shanxi is estimated to have over 10,000 billion m^3 CSG reserve, which accounts for about one third of the national CSG reserve[88].

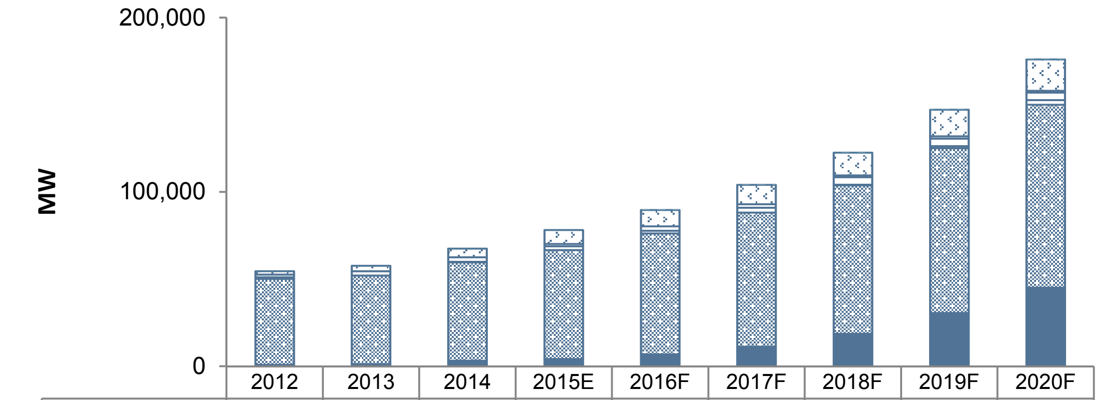
According to 'Suggestions on Promoting the Safe and Green Development, and Clean and High efficient Utilisation of Coal', issued by NEA, Ministry of Environment Protection, and Ministry of Industry and Information Technology in December 2014, coal rich provinces, such as Shanxi, Shaanxi, Inner Mongolia, Xinjiang and Ningxia are guided to develop 9 coal-fired power generation bases with over 10,000.0 MW total installed capacity each. These coal-fired

[87] Extracted from 'Shanxi Province Returns to be the Largest Coal Producer', Sinoergy, December 2014

[88] Extracted from Beijixing Power website: http://news.bjx.com.cn/html/20150819/654563.shtml

power generation plants will be in a clean, energy efficient and water efficient fashion. The coal-fired power generated in these locations is to be transmitted to the eastern regions where power generation capabilities are comparatively lower. Electricity is transmitted via the 3 super high voltage transmission lines and 1 ultra-high voltage transmission line.

Chart 4-9: Installed Power Generation Capacity by Fuel Type, Shanxi Province, 2012 - 2020



	2012	2013	2014	2015E	2016F	2017F	2018F	2019F	2020F
Others	-	-		-	10	20	30	40	50
Solar	15	35	85	135	153	173	195	221	250
Wind	1,980	3,160	5,000	8,000	9,408	11,064	13,011	15,301	18,000
Hydro	2,430	2,430	2,882	3,418	4,054	4,808	5,702	6,763	8,000
Coal	49,301	50,845	56,387	62,533	69,349	76,909	85,292	94,588	105,000
LNG (Incl. CSG)	824	1,200	3,200	4,130	6,810	11,230	18,519	30,537	45,000
Total	54,550	57,670	67,554	78,216	89,784	104,203	122,749	147,450	176,300

Source: China Electric Association, 2014; Implementation Plan on National Action Plan for Energy Strategy (2014-2020), Office of Shanxi Provincial Government, January 2015; Frost & Sullivan.

Table 4-3: Top Power Plants by Installed Capacity in Shanxi, 2014

No.	Name	Location	IPP (Yes/ No)	Installed Capacity (MW)
1	Yangcheng International Power Plant	Lincheng Yangcheng, Shanxi	Yes	2,100.0
2	CPIC Shentou Power Plant	Pingshuo, Shanxi	Yes	2,000.0
3	Datang Shentou Power Plant	Pingshuo, Shanxi	Yes	2,000.0
4	Zhangshan Power Generation Co	Changzhi, Shanxi	Yes	1,800.0
5	Zhaoguang Power Plant	Huozhou, Shanxi	Yes	1,800.0
6	Tongmei Xuangang Power Plant	Datong Xuangang, Shanxi	Yes	1,320.0
7	CPIC Hejin Power Plant	Hejin, Shanxi	Yes	1,300.0
8	Wangqu PP	Changzhi, Shanxi	Yes	1,200.0
	Zhangshan PP	Changzhi, Shanxi	Yes	1,200.0
	Hequ PP	Hequ, Shanxi	Yes	1,200.0
	Liulin PP	Liulin, Lvliang, Shanxi	Yes	1,200.0
	Guodian Gaohe Power Plant	Changzhi, Shanxi	Yes	1,200.0

No.	Name	Location	IPP (Yes/ No)	Installed Capacity (MW)
	Xianghuan Power Plant	Wuxiang, Shanxi	Yes	1,200.0
	Shanxi Yangguang Power Generation Co.	Yangquan, Shanxi	Yes	1,200.0
	Datang Yuncheng Power Plant	Yuncheng, Shanxi	Yes	1,200.0
	Datang Taiyuan No.2 Power Plant	Taiyuan, Shanxi	Yes	1,200.0
	Guodian Taiyuan No.1 Power Plant	Taiyuan, Shanxi	Yes	1,200.0

Source: Wood McKenzie; Frost & Sullivan

4.3.1.3 Shandong

Shandong Province traditionally relies on the coal-fired power generation. The coal power generation capacity in Shandong was 72,020.0 MW, 90.0% of the total power generation capacity in 2014. Shandong has been actively observing the Central Government's advocacy and policies to reduce energy consumption and improve air quality. Under the guidance of the State Council to implement the 'Suggestions on Accelerating the Shutdown of Small Thermal Power Plants', Shandong has been shutting down small coal-fired power plants, while constructing new large supercritical unit power plants. This is in line with the 12th Five-year Plan for Atmospheric Pollution Prevention in Key Areas, in which selected cities in Shandong are listed as "Under Critical Control Area", whereby only CHP plants or large coal-fired power plants intending to replace small inefficient coal-fired power plants will be approved under the coal-fired power plants category. Approvals for CHP plants are expected to be favoured by the Provincial Government due to its higher efficiency than power only plants. Nonetheless, the province has overseen the shutting down of a total of 2,052.0 MW and 456.0 MW of small coal-fired power in 2010 and 2014 respectively.

According to NDRC, Shandong province is required[89] to

- Meet the target of reducing coal consumption by 20 million tonnes by 2017;
- Increase the proportion of imported electricity;
- Replace coal-fired facilities at the petrochemical factories with natural gas, or the energy supply is to be provided by the adjacent steam/power plants;
- Hold off approval of new petrochemical plants;
- Hold off approval of new coal-fired boilers (including the ones used for power generation) in prefecture-level[90] cities or above; hold off approval of coal-fired boilers with smaller than 20 steam tonnes capacity in smaller cities;
- Utilise coal in high efficiency power plants that have proper pollution control measurements in place;
- Initiate demonstrative distributed natural gas power generation projects.

[89] 'Work Plan to Enhance the Atmospherically Pollution Prevention in Energy Industry', NDRC, NEA, Ministry of Environment Protection, May 2014.

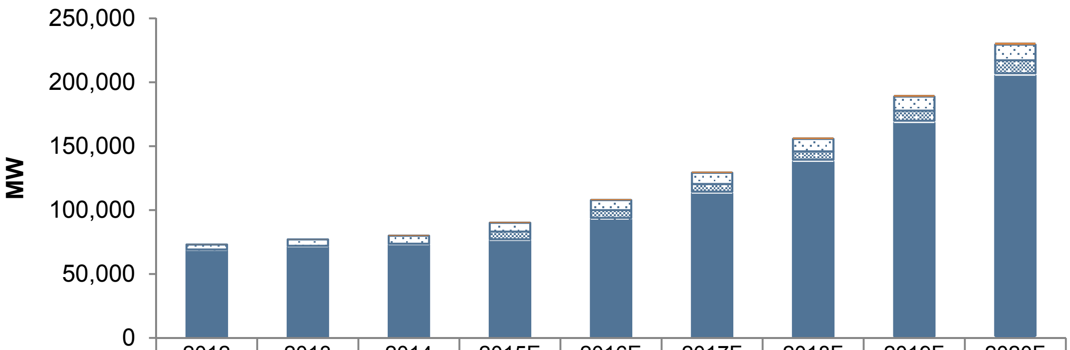
[90] Prefectural-level city is an administrative division of the China, ranking below a province and above a county in China's administrative structure.

The above initiatives encourages the update of natural gas and renewable energy in the electricity generation fuel mix, and reduce the growth of coal-fired power plants in Shandong province.

At the same time, Shandong is a province that has invested heavily in renewable energies. In 2012, the installed capacity of wind farm in Shandong reached 3,820 MW. The province was ranked fourth in China among all the provinces, accounting for 5.2% of total national installed capacity of wind power generation. In 2014, Shandong Province was listed as one of the nine bases[91] to develop large wind power plants along with the required power T&D projects.

In terms of solar PV power generation, the total installed capacity of registered solar PV power plants which are qualified for national clean energy subsidies was 1,000.0 MW as of 2014. On top of that, Shandong Development and Reform Commission have also offered additional subsidies to distributed and concentrated PV power plants, which led to expedited growth in the solar PV power generation capacity in Shandong.

Chart 4-10: Installed Power Generation Capacity by Fuel Type, Shandong Province, 2012 - 2020



	2012	2013	2014	2015E	2016E	2017F	2018F	2019F	2020F
Others	-	-	25	50	53	55	58	61	64
Solar	66	118	600	690	794	913	1,049	1,207	1,388
Wind	3,820	5,000	6,224	6,971	7,807	8,744	9,794	10,969	12,285
Nuclear	-	-	-	6,000	6,000	6,000	6,500	8,000	10,200
Hydro	1,077	1,078	1,164	1,257	1,358	1,467	1,584	1,711	1,848
Coal	67,727	70,524	72,020	75,261	91,818	112,018	136,662	166,728	203,408
Natural Gas	460	460	561	685	835	1,019	1,243	1,517	1,850
Total	73,150	77,180	80,594	90,914	108,665	130,216	156,890	190,192	231,043

Source: Shandong Statistics Bureau 2013; Electricity Demand Forecast During the Economic Transitioning (Shandong Province), Periodical Modern Economic Information, Issue 5, 2013; Frost & Sullivan.

[91] National Action Plan for Energy Strategy (2014-2020), Office of the State Council of China, September 2014.

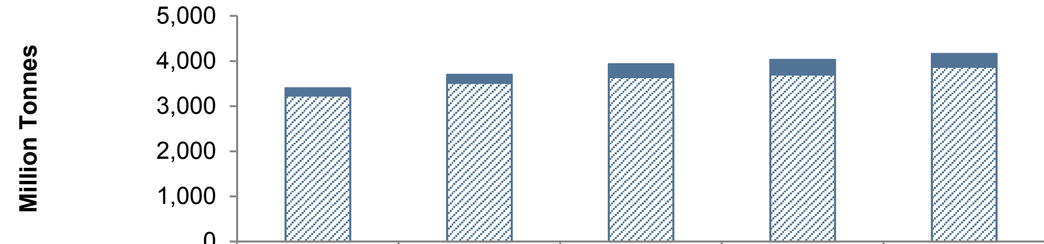
4.3.2 Key Sources of Energy

4.3.2.1 Non-renewable energy

Coal

Since 2009, China became net importer of coal. The country's coal import stood at 163.0 million tonnes in 2010 and grew to 327.0 million tonnes in 2013 before dropping by 11.3% to 290.0 million tonnes in 2014. Factors leading to this decline include shrinking energy intensive industries, such as the steel manufacturing, non-ferrous metal processing and construction material manufacturing industries as well as the State Government's determination in improving air quality. China's international commitment in meeting the 20.0% share of fuel mix in 2030 has also led to lower growth in coal demand from 9.0% in 2011 to 3.2% in 2014. Nonetheless, imported coal volume grew at a CAGR of 15.5% throughout the period. Meanwhile, domestic coal production in China expanded at a CAGR of 4.6% from 3,235.0 million tonnes in 2010 to 3,870.0 million tonnes in 2014.

Chart 4-11: Coal Supply – Domestic Production and Import, China, 2010-2014



	2010	2011	2012	2013	2014
Import	163	182	288	327	290
Domestic Production	3,235	3,516	3,645	3,700	3,870

Source: China Statistics Yearbook 2014, Frost & Sullivan

LNG

LNG has been serving a small, but growing portion of primary energy sources in China. Currently LNG accounts for about 4.0% of the total primary energy sources in China, which is considerably lower than the global average level of 24.0%. It is forecast that by 2025, the LNG proportion in the primary energy sources in China is going to reach 8.0%[92]. In the attempt to replace some of the coal in power generation with natural gas to lower emission and improve air quality, China has significantly increased the domestic natural gas production and infrastructure as well as securing supply of LNG via imports.

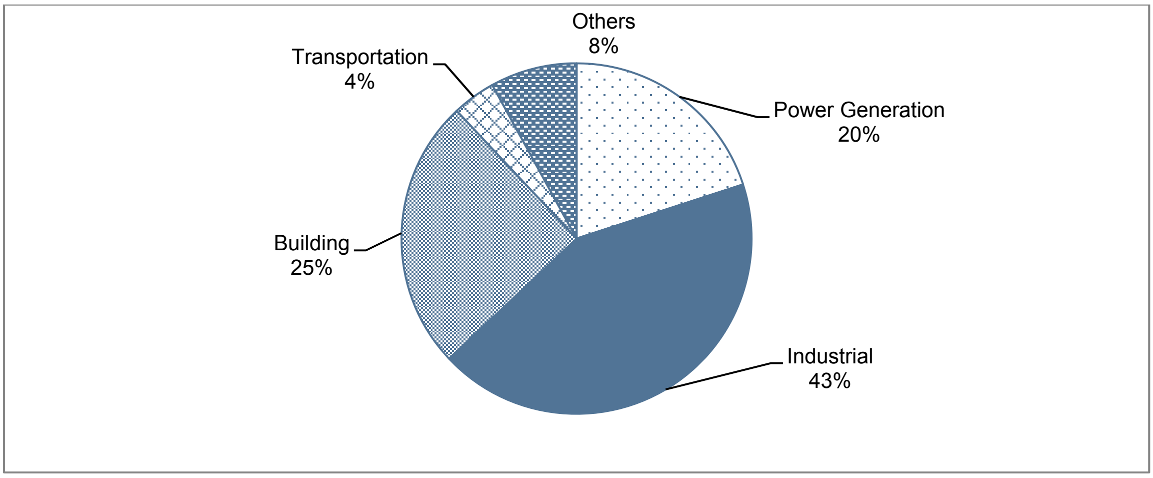
[92] General Electric, LNG Age of China, 2013.

China is estimated to have 62.0 trillion m^3 of LNG reserve as of 2013 based on the most recent survey[93]. China imported 53.0 billion m^3 of LNG, which accounts for 31.6% of its consumption in 2013. The import share is expected to continue to grow until 2020, reflecting a high level of dependence on imports. To this end, China has signed long term LNG supply agreement with Russia and Australia. PetroChina has also invested in Australia, Mozambique and Canada to secure LNG supply in the long term. In the policy issued in April 2014 titled 'Suggestions on Mechanism Ensuring Stable Long-term LNG Supply' by NDRC, it is required for Government agencies at all levels to collaborate in order to secure the LNG supply via the following initiatives:

- Meet the supply target of 40.0 billion m^3 by 2020;
- Develop coal-to-gas conversion capacity to 11.2 billion m^3 in 2020 to meet the engineering gas demand;
- Develop shale gas and meet the annual LNG production target and LNG import target (both through pipeline and cargo ship);
- Fulfil the daily peak hour LNG supply that is stipulated in the seasonally (or monthly) LNG supply contracts;
- Encourage the participation from various stakeholders in LNG storage infrastructure investment, construction, and operation;
- Establish LNG monitoring, forecasting, early warning mechanism;
- Promote the reform to rationalize the LNG price with alternative energies.

LNG is used in China for building heating, residential use, industrial fuel, and as fertiliser and chemical feedstock. In 2013, the total consumption of LNG in China was 168 billion m^3, an increase of 13.9% on 2012 consumption, which place the country as the third largest LNG consumption country in the world.

Chart 4-12: LNG Consumption Split by End-user Sectors, China, 2012



Source: China in LNG Age, General Electric, 2013

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93 Dynamic Evaluation of National Oil & Gas Resource, Ministry of Land and Resources, January 2013.

4.3.2.2 Renewable energy

Hydroelectric power

In China, hydropower generation has been explored more extensively than other renewable sources, such as wind and solar PV power generation. China's hydropower reserve is mainly located in the South, Southwest and Northwest regions of the country, where the upstreams and chief branches of two largest rivers are located. By the end of 2014, China's hydroelectricity power generation installed capacity is about 300.0 GW. According to the target set in the Action Plan of National Energy Strategy (2014-2020), China's is to have 350.0 GW installed hydroelectricity power generation capacity by 2020.

Since the completion of Three Gorges Dam, the largest hydropower plant in the world with an installed capacity of 22.4 GW, China has been cautious in maintaining appropriate level of projects in hydroelectricity power generation to minimise environmental impact. Currently, China's hydroelectricity development degree stood at 39.0% (the ratio of reservoir storage capacity). China plans to achieve 80% in the hydroelectricity development degree by 2050, which is the similar to the current level in the US[94].

Wind Resources[95]

The on-shore wind power resources are mainly located in the west and northeast part in China. The most recent survey done by China Meteorological Administration determines that the total available on-shore wind power resources available for development range between 2000.0 and 3400.0 GW. This study takes into account wind at Grade 3 (wind power density ≥ 300 W/m^2) and above and excludes areas which are 3500 metre above sea level in Tibetan plateau.

Meanwhile, the estimated offshore wind resource capacity is also about 500.0 GW in the coastal waters where the water depth is less than 50 metres. China plans to focus on the utilisation of on-shore wind resources prior to 2020 while experimenting coastal water off-shore wind power generation. After 2020, China will gradually develop off-shore wind power generation.

Solar Resources

Solar resources are determined by the latitude, altitude, geographical features and climate conditions. China has rich solar resources with over two third of areas having accumulative sunshine hours 2000 hours annually. The overall solar resources distribution in China features that higher altitude locations have more solar resources than on the lower altitude regions, and western dry areas have more solar resources than the eastern humid areas.

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[94] The 'hydropower development degree' data is extracted from 'China's Hydropower Prospects in 2050, Zhang Boting, at World Hydropower Congress, 2015.

[95] The information in this section is extracted from 'Energy Technology Roadmap – Wind Power Development Roadmap 2050', by Energy Research Institute of NDRC and IEA, 2011

Tibet, Qinghai, Xinjiang, South Inner Mongolia, North Shaanxi, Hebei, Southeast Guangdong and Southeast Fujian are the regions with high level of solar radiation. In particular, at Tibetan plateau, the annual solar radiation exceeds 1800 KWh/m[296].

4.3.3 Evolution of Fuel Mix

Currently China's power generation capacity is heavily dependent on coal-fired power plants. In 2014, the coal-fired power plants constituted 61.0% of the total installed capacity in China. The electricity generated from coal sources was also about 70.0% of the total electricity generated in 2014. The installed capacity of renewable energy and cleaner fuel, such as natural gas power plants has been experiencing rapid growth.

Natural gas is considered a clean, efficient and economically sound alternative to coal as a type of fuel. The acceleration of natural gas development in China was announced since August 2011 by the State Council of China via the document titled 'Comprehensive Action Plan on Energy Conservation & Emission Reduction'. In this regard, natural gas is positioned to be an important fuel source to adjust the country's electricity fuel structure. Domestic production of LNG largely comes from west part of China such as in Shanxi, Shaanxi and Xinjiang provinces. The project 'Transporting LNG from West to the East', offshore LNG development and importing LNG from overseas have supported the growing demand for LNG in electricity power generation.

Natural gas in China has been mainly used for distributed power generation. In a document issued collectively by NDRC, Ministry of Housing and Urban Rural Development, and NEA in October 2014, titled 'Implementation Details of Natural Gas Distributed Energy Demonstration Projects', it announces the local Government agencies are given more authorities in approving application for natural gas distributed energy demonstration projects. Special licensing mechanism to operate natural gas distribution power is considered and encouraged to undergo experiment. It is believed that this document will accelerate the development of natural gas distributed power generation industry in China.

Table 4-4: Selected Planned New Generation Capacity Projects, China, until year 2018

Expected Commencement Year	Name	Location	IPP (Yes/ No)	Capacity (MW)
2016 onwards	China Resources Bohaixinqu PP	Cangzhou, Hebei	Yes	1,200
2016 onwards	Huaneng Hanfeng PP	Handan, Hebei	Yes	1,200
2016 onwards	Huanghua PP	Huanghua, Hebei	Yes	2,000
2016 onwards	Wangqu PP	Changzhi, Shanxi	Yes	1,200
2016 onwards	Zhangshan PP	Changzhi, Shanxi	Yes	1,200

96 China Renewable Energy Association, 2015.

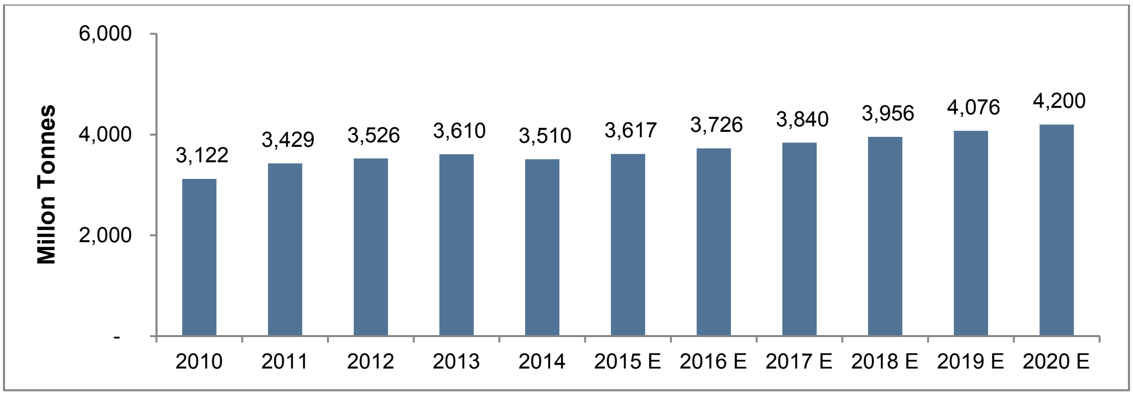
Expected Commencement Year	Name	Location	IPP (Yes/ No)	Capacity (MW)
2016 onwards	Hequ PP	Hequ, Shanxi	Yes	1,200
2016 onwards	Lishi CHP	Lvliang, Lishi, Shanx	Yes	700
2016 onwards	Liansheng Liulin Coal Gangue PP	Lvliang, Lishi, Shanx	Yes	600
2016 onwards	Liulin PP	Lvliang, Lishi, Shanx	Yes	1,200
2016 onwards	CPIC Shentou PP	Pingshuo, Shanxi	Yes	2,000
2016 onwards	Xishangzhuang PP	Yangquan, Shanxi	Yes	1,200
2016 onwards	Huaneng Tongchuan PP	Tongchuan Shaanxi	Yes	1,200
2016 onwards	Huaneng Fugu Duanzhai PP	Yulin Fugu, Shaanxi	Yes	2,000
2016 onwards	Datang Changshan CHP	Songyuan, Jilin	Yes	660
2016 onwards	CPIC Songhuajing CHP	Jilin	Yes	300
2016 onwards	Xuzhou Coal Gangue PP	Xuzhou, Jiangsu	Yes	600
2016 onwards	Dongsheng CHP	Ordos Dongsheng, Inner Mongolia	Yes	600
2016 onwards	Dafanpu PP	Ordos Zhungeer, Inner Mongolia	Yes	600
2016 onwards	Guodian Jingmen CHP	Jingmen, Hubei	Yes	1,320
2016 onwards	Pannan PP	Panxian, Guizhou	Yes	1,200
2016 onwards	Datang Heshan PP	Laibin Heshan, Guangxi	Yes	600
2017 onwards	Guodian Baoding Xibeijiao CHP	Baoding, Hebei	Yes	600
2017 onwards	Shanxi Luguang Power Plant	Changzhi, Shanxi	Yes	1,320
2017 onwards	Guodian Handan Dongjiao CHP	Handan, Hebei	Yes	600
2018 onwards	Huaneng Yulin Beijiao CHP	Yulin, Shaanxi	Yes	700
2018 onwards	Huarun Jinzhou PP	Jingzhou, Liaoning	Yes	2,000
			Total	**24,700**

Note: Based on publicly available information.
Source: Beijixing Electric Industry website; Shanxi Provincial Government; Hebei Provincial Government; Shandong Provincial Government; Frost & Sullivan, 2015

4.3.3.1 Thermal Coal outlook in China

China coal reserve is estimated to be 5,900.0 billion tonnes in 2014[97]. China has been actively consolidating the coal industry through shutting down small and sub-standard coal mines, and introducing modern technologies and higher safety standards to large mines. Nonetheless, the coal manufacturing capacity in China is about 5.0 billion tonnes, which is higher than the current consumption of about 3.6 billion tonnes. The over capacity has led to the continuous drop of coal prices from its peak in 2012. According to the target set in Energy Development Strategic Action Plan 2014 – 2020, November 2014, by the Office of the State Council of China, the coal consumption is expected to rise to about 4.2 billion by the end of 2020.

Chart 4-13: Coal Consumption, China, 2010.-.2020

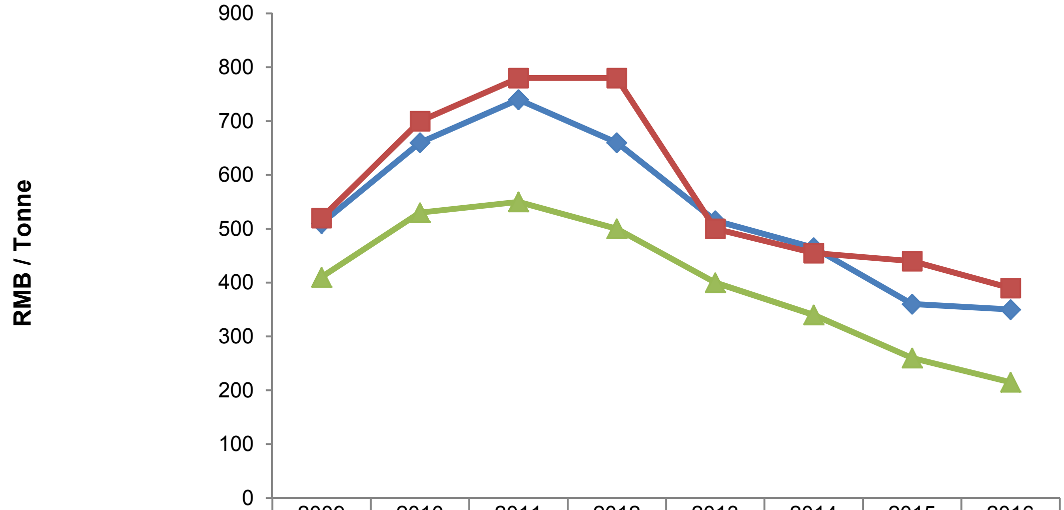


Source: China Statistics, 2014; Office of State Council of China, September 2014; Frost & Sullivan

According to China Coal Price Index, the thermal coal grade (4800 – 5500 KJ) that is mostly used for power generation, price dropped 18.0% from the same period in 2014. The price for coal in Shanxi province, largest coal producing province in China, is the lowest, albeit it has been trending in sync with prices in other locations. The prices for thermal coal in three provinces have all dropped about 50.0% from its peak in 2011.

[97] National Coal Reserve Potential Survey, Ministry of Land and Resources of China, 2014

Chart 4-14: Historical Thermal Coal Prices in 3 Provinces, China, 2009 - 2015



	2009	2010	2011	2012	2013	2014	2015	2016
Qinhuangdao	510	660	740	660	515	465	360	350
Yunzhou, Shandong	520	700	780	780	500	455	440	390
Lingshi, Shanxi	410	530	550	500	400	340	260	215

Note: 1) the prices are spot prices on 1 June every year, or the closest date to 1 June;
2) Prices are for coal products with 5,000 Kcal/Kg.
Source: China Coal Trading Daily, Frost & Sullivan

Persistent low coal prices resulted in reforms in China coal industry. This includes reduction of maximum working days of miners from 330 days to 276 days beginning May 2016 as well as closure of inefficient coal mines. Reduction in coal production capacity, coupled with increasing demand in line with economic growth is likely to restrict coal supply, which consequently will lead to gradual growth in coal prices in 2017 and 2018.

4.3.4 Reserve Margin

According to the Chinese Electric Encyclopaedia, reserve margin is defined as the additional power generation capacity used to meet the demand outside of the normal load demand. Reserve margin includes load reserve margin, accident reserve margin, and maintenance reserve margin. In an electricity market where market mechanism is at work, reserve margin is critical as the power suppliers would face high penalty for failing to supply power as dictated in the power purchase contracts. However, since the China's electricity market is still operating under the central planning model and does not implement a market-based electricity trading mechanism, the requirement to maintain a reserve margin is not observed. There has not been enough statistics regarding reserve margin in China either due to the absence of data on accurate maximum load[98]. Nevertheless, China has been experiencing long-term electricity

[98] Insufficient data, challenging to determine power generation over capacity. 1 June 2015, China Energy Newspaper.

shortage which led to a continuous investment and construction in power generation capacity endeavouring to meet the demand.

4.3.5 Industry Risks and Challenges

Coal Power Generation

China became the largest coal importer in the world in 2012. The heavy dependence of China's power generation on coal as main fuel source has led to its great vulnerability to coal supply. According to the China Statistics Yearbook, imported coal has risen from 4.8% of total coal consumption in 2010 to 7.0% in 2014. As of 2014, China imported a total of 197.5 million tonnes of coal, of which import from Indonesia stood at 50.9% followed by Australia at 17.4%.

Nevertheless, the available coal resources in China are of lower quality. According to China Coal Processing and Utilisation Society, due to over excavation, the coal resources in Southeast of China is approaching depletion and are of poor quality while the coal resources in Northwest of China are mainly jet coal and lignite coal which have low calorie value[99].

In addition, the Government of China has placed greater focus on the coal quality requirement. Announced in January 2015, Temporary Administrative Measurements on Commodity Coal Quality announces that coal products with over 16.0% dust content and 3.0% sulphur content are not allowed to be consumed in Beijing, Tianjin and Hebei, as well as Yangtze delta and Pearl Delta areas. This restriction limits the available amount of coal for consumption by the coal-fired power plants in those regions which in turn will result in the need for import for higher quality coal.

Challenges of LNG Power Generation in China[100]

China does not own the core technology of gas power generation. The Chinese gas power generation industry relies heavily on imports on key components of gas power plants, such as burner, turbine blades and heated components. Besides, gas power generation operators depend on the technical knowledge of manufacturers when required to overhaul the generating units and make adjustment of combusting parameters in the generating units.

Meanwhile, the supply of LNG has not been coordinated well in China. In some regions, the installed capacity for LNG power generation has been growing but this has not been matched by corresponding increase in the supply of LNG. At the same time, consumption of LNG in China follows a seasonal trend, with winter being the peak season when LNG is needed for both heating and power generation, while demand for LNG during spring and autumn is relatively low. However, the dispatch of LNG has not been customised to suit the seasonal pattern, whereby in some regions there are abundant of LNG during low season and insufficient LNG supply during peak season. As such, insufficient regulatory framework to administer the entire supply chain of LNG power generation sector is hampering the development of the

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[99] Extracted from website of China Climate Change Info-net:
http://www.ccchina.gov.cn/Detail.aspx?newsId=40057&TId=63
[100] Gas-powered Electricity Generation Safety and Security Monitoring Report, NEA, 2012

industry. In this regard, standards and procedures to ensure the security of LNG sources and efficient running of LNG power plant are required to be developed by the authorities.

4.3.5.1 Barriers to Entry

Delay in approval for small size coal-fired power plants in select regions

China is moving towards replacing small and inefficient coal-fired power plants with large coal-fired power plants utilising clean technology in view of environmental concerns. As such, in selected cities such as Tianjin, Beijing, Shandong and Hebei, the Provincial Governments are delaying the approval for new coal-fired boilers (including the ones used for power generation) in prefecture-level cities or above as well as for coal-fired boilers with smaller than 20 steam tonnes in capacity.

Stringent regulation on emission control

The Government of China currently implements stringent emission control standard on coal-fired power plants to improve air quality. In the Report on the Work of the Government (2013), the State Council declared the determination to initiate and deepen the air pollution control plans and further enhance the uptake of low emission technologies and equipment used in coal-fired power plants. Two more policies and circulates issued in 2014, the '2014 - 2015 Energy Efficiency and Emission Reduction Low Carbon Development Action Plan'[101] and the 'Coal Power Energy Efficiency and Emission Reduction Upgrade and Modification Action Plan 2014 – 2020'[102] provided greater level of requirement on emission control. The latter requires all the new coal-fire power generating units to be installed with highly efficient sulphate-removing, nitrogen-removing and dust-removing facilities in East region (including Liaoning, Beijing, Tianjin, Hebei, Shandong, Shanghai, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan, et al 11 provinces and cities). In July 2015, Hebei Environmental Protection Bureau issued new standard: Atmospheric Pollutant Emission Standards

Table 4-5: Atmospheric Pollutant Emission Standards in Hebei

Atmospheric Pollutant Emission Standards in Hebei (July, 2015), effective from Jan 2016	NOx (mg/m^3)	SOx (mg/m^3)
Existing and new unit with > 65t/h power (exclude grate furnace, spreader stoker)	50	35
Existing and new unit with > 65t/h power (exclude grate furnace, spreader stoker) – but are considered using low calorie value coal by the authorities	100	50
Using grate furnace and spreader stoker, with new or existing units > 65t/h power	300	300

[101] Issuer: Office of the State Council of China, March 2014.

[102] Issuer: Office of the State Council of China, September 2014.

Source: Coal-fired Power Plants Atmosperic Pollutants Emission Standards, Hebei Provincial Administration of Quality and Technical Supervision and Hebei Provincial Environmental Protection Bureau, July 2015.

Table 4-6: Atmospheric Pollutant Emission Standards in Shanxi

Atmospheric Pollutant Emission Standards in Shanxi	NOx (mg/m^3)	SOx (mg/m^3)
Coal-fired Power Generating Unit (>300 MW)	50	35
Low Calorie Value Coal-fired Power Generating Unit	50	35

Source: Implementation Suggestions on Promoting Super Low Emission for Power Generating Units, by Shanxi Government, August 2014.

Table 4-7: Atmospheric Pollutant Emission Standards in Shandong

Atmospheric Pollutant Emission Standards in Shandong	NOx (mg/m^3)	SOx (mg/m^3)
Existing Coal-fired Power Generating Units	400	300
New Coal-fired Power Generating Units	300	200

Source: Shandong Provincial Administration of Quality and Technical Supervision and Shandong Provincial Environmental Protection Bureau, September 2013

These highly regulated emission controls inevitably increase the costs of operating coal-fired power plants in China which may be of an important consideration for potential new entrants into the market.

Pricing mechanism not reflecting prices of fuel sources

The electricity price in China is set by the Government and is independent of the generation cost. As such, fluctuation in prices of fuel sources may impact the profitability of investors, hence deterring potential operators entering the industry.

4.3.5.2 Product Substitution

All other fuel sources are encouraged to replace coal

As of 2014, coal accounted for 62.9% of total installed capacity in China. The initiatives to tackle climate change and improve atmospheric quality have led to administrative and financial policies that encourage investment in renewable energies, which will in turn result in the reduction of coal in the fuel mix to 55.0% by 2020. In light of the China's prospect economic development and growing electricity demand, the available fuel sources such as coal, LNG, nuclear, and renewable energy are expected to be more evenly distributed in terms of installed capacity in order to offer unique advantages to complement each other for energy security and continuous power supply.

4.4 COMPETITIVE LANDSCAPE

4.4.1 Key Players Profiles

China's power generation is dominated by 5 major power generation groups, namely China Datang Corporation, China Huaneng Group, China Huadian Corporation, China Guodian Corporation, and China Investment Power Corporation. These 5 major power generation groups collectively own 46.7% of the total installed power generation capacity in China as of 2014. These five generation groups are independent of power T&D. The Chinese State Government is the biggest stakeholder of all these five companies.

Table 4-8: Top Five Power Generation Groups Based on Effective Capacity (MW), by Fuel Type, 2014

Company	Hydro power	Thermal (coal & natural gas)	Nuclear	Wind	Total
China HuaNeng Group	20,000	118,340	0	13,138	**151,490**
China Datang Corporation	19,084	90,006	0	11,399	**120,489**
China HuaDian Corporation	23,290	89,590	0	8,000	**120,880**
China GuoDian Corporation	12,850	92,390	0	19,760	**125,000**
CIPC (China Investment Power Corporation)	20,699	59,000	2,100	6,524	**88,323**

*Source: Guodian Group, Datang Group, China Investment Power Corporation (**"CIPC"**), Huaneng Group, Huadian Group, the State-owned Assets Supervision and Administration Commission of the State Council, Frost & Sullivan, 2015*

Major Power Generation Company Profiles

Huaneng Group

Huaneng Groups is a SOE formed in 1985. It comprises Huaneng International Electricity Company (a public company listed on Hongkong stock exchange), Huaneng International Electricity Development, Huaneng New Energy Holding, Huaneng Nuclear Power Development Corporation, and others. Its core business is in power generation and sales, but owns interests in the development, investment, construction, production, sales, and operation of financial sector, coal, transportation, and environmentally related products.

By the end of 2014, Huaneng Group owns 151.5 GW total installed capacity in China and overseas. To meet the State Government initiatives in restructuring the energy fuel mix, Huaneng has actively invested in diverse energy sources: solar PV power generation, distributed power generation, hydropower generation, and shale gas development, etc. In 2013, in the projects that are newly approved, begin construction and entering commissioning stage, low carbon clean energies accounts for 47.8%, 48.2%, and 75.2%.

Datang Group

Datang Group is a SOE formed in 1985. It started business in the 11 western provinces and have expanded into 30 provinces in China, and Laos, Cambodia, and Myanmar. It has developed businesses in coal production, new energies, transportation, information technology, environment protection businesses, technical consulting and power generation related businesses, amongst others.

It owns four public companies, namely Datang International Power Corporation, Datang Huayin Power Co., Ltd, Guangxi Guiguan Power Corporation, and Datang Group New Energy Holding Company. By the end of 2014, its total installed power generation capacity reached 120.0 GW.

Huadian Group

Huadian Group is a SOE formed in 1985. Its core business is power and heat generation and supply, power generation related primary energy development, and related technical services.

It controls coal production assets with a total capacity of 65.0 million tonnes per annum. It reached total installed power generation capacity of 123.0 GW by the end of 2014. It has controlling stakes in 7 public companies: Huadian International, Huadian Energy, Qianyuan Power, Huadian Heavy Industry, Huadian Fuxin, Jinshan Holdings, and Guodian Nanjing Automation. It owns the world's first ultra-supercritical air-cooled power units with 1,000.0 MW capacity. It was the first in China introducing NOx removal units with 600.0 MW.

Guodian Group

Guodian Group was formed in 2002. The core business of Guodian is in development, investment, construction, operation and management of power generation. It has developed businesses in coal production, new energies, transportation, information technology, environment protection businesses, technical consulting, etc. It also has EPC capability both in China and overseas.

It comprises Guodian Power Development Corporation, Longyuan Power Group, Guodian Northeast Power Corporation, and others. By the end of 2014, its total installed power generation capacity reached 125.0 GW in China, while its coal production reached 68.0 million tonnes. In addition, its wind power generation capacity was 20.0 GW in 2014, which is ranked the number 1 in the world[103].

CPIC

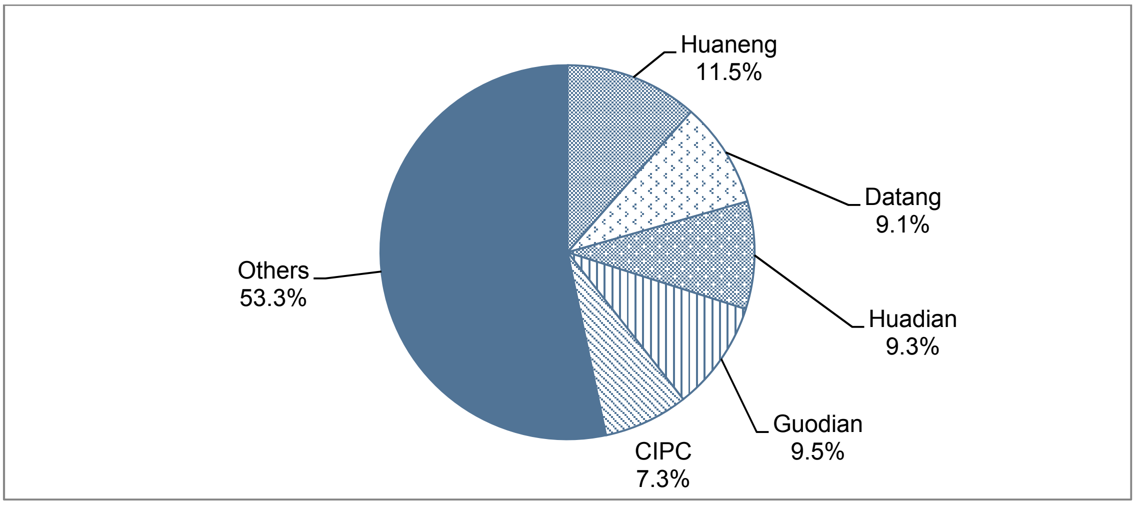
CPIC is a SOE formed in 2002. It owns assets in power generation, coal, aluminium, rail, and ports. It is the only power generation company in China that has all hydropower, thermal power,

[103] Extracted from Guodian Group's website: http://www.cgdc.com.cn/gsjj/index.jhtml

nuclear power and renewable energy power generation assets. CPIC also has a deep global reach, with investments in Turkey, Tanzania, Japan, Vietnam, and Malta, etc. CPIC has the highest solar PV power generation in China in 2014. Renewable energy generation capacity was about 35.0% of its fuel mix, highest among the five largest power generation groups.

4.4.2 Market Share and Ranking

Chart 4-15: Market Share of Major Participants in the Power Generation Industry, China, 2014



Source: CEA, 2014, Frost & Sullivan

Banpu Power, through its subsidiary, Banpu Investment China Limited, entered the Chinese electricity market in 2006. Leveraging Banpu PCL's investment in coal mines, two of its three power generation plants are located in Hebei and one in Shandong. Meanwhile, Banpu Power is constructing the Shanxi Luguang Power Plant in Shanxi and is expected to achieve commercial operation in 2017. The total installed equity capacity of Banpu Power in China is 243.0 MW and 813.0 tph of steam. By supplying both steam and power, Banpu Power's CHP plants achieve higher efficiency than power only plants. In addition, Luguang Power Generation Co., Ltd, in which Banpu Power has 30.0% stake, has started the construction of Gaohe Power Plant. Gaohe plant is planned to be constructed in two stages with first stage capacity of 2 units of 660.0 MW, and second stage 1,880.0 MW, reaching total plant capacity 3,200.0 MW. The first stage is planned to commence operation in 2017. Vertically integrated, Banpu PCL owns stakes in coal mines at Gaohe Coal Mine (45.0%) and Hebei Coal Mine (40.0%).

4.4.2.1 Hebei

As of 2013, the total installed capacity for coal-fired power plants in Hebei province stood at 41,870.0 MW. Frost & Sullivan notes that apart from Matou Power Plant owned by the State Grid Company, all other coal-fired power generation operators in Hebei are IPPs. It is estimated that the total effective capacity of the 8 largest companies to be at 25,188.0 MW, which is approximately 60.2% of the market share within the installed capacity of coal-fired power plants. The largest company operating in coal-fired power generation Hebei province is the Hebei Province Construction & Investment Co with an effective capacity of 6,828.0 MW, followed by Datang Group (6,640.0 MW) and Huaneng Group (2,800.0 MW).

Table 4-9: Effective Capacity of Major Participants in Coal-fired Power Generation, Hebei, 2013

Company		No. of Plants	Effective Capacity (MW)
HPCIC	Hebei Province Construction & Investment Co	16	6,828.0
Datang	Datang Group sole investment	10	6,640.0
Huaneng	Huaneng Group	3	2,800.0
Guohua	Beijing Guohua Power Co	1	2,400.0
Guodian	Guodian Group	6	1,750.0
CPIC	China Power Investment Corporation	3	1,700.0
Huadian	Huadian Group	4	1,600.0
Huarun Power	Huarun Power Holding Co	4	1,470.0
Total Effective Capacity by the Top 8 Players (MW)			**25,188.0**
Total Installed Capacity (2013) (MW)			**41,870.0**
Capacity by Other Players (MW)			**16,682.0**

Notes: Information for 2014 is not publicly available as of the publication of this report.
Source: Wood & McKenzie 2014; Frost & Sullivan

4.4.2.2 Shanxi

Shanxi province has the total installed capacity of coal-fired power generation of 50,845.0 MW as of the end of 2013. The coal-fired power generation industry in Shanxi is fragmented and comprised the large national power generation groups, local power generation groups and power generation groups belonging to the Provincial Government. The largest company in the province based on effective capacity is the Guodian Group with an effective capacity of 6,372.0 MW, followed by Shanxi International Electricity Group (5,820.0 MW) and Datang Group (5,437.0 MW). Banpu Power, with an effective installed capacity of 273.0 MW in coal-fired power generation, is estimated to hold a market share of approximately 0.5% in the coal-fired power generation industry in Shanxi province.

Table 4-10: Effective Capacity of Major Participants in Coal-fired Power Generation, Shanxi, 2013

Company		No. of Plants	Effective Capacity (MW)
Guodian	Guodian Group	7	6,372.0
SIEG	Shanxi International Electric Group	7	5,820.0

Company		No. of Plants	Effective Capacity (MW)
Datang	Datang Group	8	5,437.0
CPIC	China Power Investment Corporation	8	3,820.0
SLPC	Shanxi Local Power Co	2	1,880.0
WHEC	Wuxiang Hexin Electric Co	1	1,200.0
Huaneng	Huaneng Group	2	960.0
Luneng	Luneng Group	2	720.0
PCIC	Pingshuo Coal Industry Co	1	700.0
SDIC	State Development & Investment Corp	1	270.0
Total Effective Capacity by the Top 10 Players (MW)			**27,179.0**
Total Installed Capacity (2013) (MW)			**50,845.0**
Capacity by Other Players (MW)			**23,666.0**

Notes: Information for 2014 is not publicly available as of the publication of this report.
Source: Wood & McKenzie 2014; Frost & Sullivan

4.4.2.3 Shandong

The total installed capacity of coal-fired power generation in Shandong stood at 70,524.0 MW in 2013. The effective capacity of the 8 largest players in the market constituted 55.6% of the total installed capacity. Huaneng Group is the largest player in the province with an effective capacity of 12,855.0 MW, followed by Huadian Group (12,086.0 MW) and Guodian Group (4,630.0 MW).

Table 4-11: Effective Capacity of Major Participants in Coal-fired Power Generation, Shandong, 2013

Company		No. of Plants	Effective Capacity (MW)
Huaneng	Huaneng Group	17	12,855.0
Huadian	Huadian Group	11	12,086.0
Guodian	Guodian Group	10	4,630.0
SPITC	Shandong Province International Trust Investment Co	3	3,510.0
Datang	Datang Group	2	1,980.0
Luneng	Luneng Group	3	1,975.0
SEPGC	Shandong Electric Power Group Co	2	1,510.0
REDGC	Rizhao Economic Development General Co	1	200.0
Total Effective Capacity by the Top 8 Players (MW)			**39,201.0**
Total Installed Capacity (2013) (MW)			**70,524.0**
Capacity by Other Players (MW)			**31,323.0**

Notes: Information for 2014 is not publicly available as of the publication of this report.

Source: Wood & McKenzie 2014; Frost & Sullivan

4.4.3 Competitive trends

China has continued to open up its power generation sector since the separation of generation companies and grid companies. Large scale coal power generation meeting certain requirement and renewable energy power generation (including hydropower, wind, solar, tide and bio-thermal) are listed under Catalogue of Industries for Guiding Foreign Investment.

Coal-fired Power Generation

The coal-fired segment of the power generation industry in China is expected to undergo consolidation, with companies that are able to invest in advanced technologies and able to adhere to the stringent emission requirement expected to gain market share. The capacity of new coal power plants that have been approved since 2012 has all been above 500.0 MW. The Department of Environment has implemented strict standards in evaluating the environment impact of new projects. The factors considered include the coal quality, the locality of the coal plant (e.g. if it is adjacent to a number of other coal plants, in which circumstances, the new plant might potentially aggravate further air quality in that location), the technologies associated with generation efficiency and emission, amongst others.

Though supply of coal has become more easily available than the 2011 to 2012 period when coal-fired power plants were unable to secure enough coal supply for continuous operation, companies that vertically integrate with upstream resources are more likely to succeed in terms of fuel supply reliability. As such, small players that have less resources in capital or fuel supply are expected to find it challenging to secure approval for new power generation project.

Renewable Energy Generation

While coal-fired power generation is expected to favour existing participants, renewable energy generation is expected to witness growing liberation of the market with increasing number of new participants focusing solely on renewable generation. For instance, Guodian Group has reduced its asset under management for solar PV power generation from over 1,000.0 MW in 2014 to less than 250.0 MW in June 2015 via its divestment strategy to divest solar PV power generation assets to private sector participants that solely focus on solar PV power generation. This allows the large SOE to focus on their core businesses, such as large coal power, hydropower, or nuclear power, and give way to private sectors to invest in renewable energy projects which is comparatively cheaper and have shorter life cycle.

4.5 RELEVANT LAWS AND REGULATION

Chinese power generation industry has gone through a series of significant changes from a central planning mechanism to a gradual decentralisation that Provincial Governments are given authorities to determine the electricity supply development within their jurisdiction. First Electricity Law in China was passed in December 1995, at the No.17 meeting of the No 8.

Standing Committee of National People's Congress. It was revised in 2009. The Electricity Law is the foundation on which the development and supportive policies are devised.

The major reform happened in 2002, when the State Council issued 'Electric Systematic Reform Plan, in which State Electricity Regulatory Commission (**"SERC"**) is formed and is given monitoring powers and authorities over electricity generation, T&D sectors. This marked the modernisation of new electricity industry regulatory framework. SERC was removed in 2013 and replaced with NEA by the State Council. Two departments within NEA: Market Supervision Division and Electricity Safety and Security Supervision Division have taken over the functions of SERC, in planning, supply and demand monitoring and coordination, pricing mechanism designing, ensuring compliance, and others.

Prior to this, Chinese power supply industry consisted of National Electric Company and IPPs. National Electric Company owned T&D assets and power generation assets. The State Council decided to separate the power generation assets that were under the management of the National Electric Company to form the five national power generation groups, namely China Datang Corporation, China Huaneng Group, China Huadian Corporation, China Guodian Corporation, and China Investment Power Corporation. The T&D assets were allocated into two grid companies: the State Grid Company and China Southern Power Grid Company.

Electricity Act

The governing legislation for electricity industry in China is the Electricity Act provides for the regulation of the electricity supply industry in China. It was first established in 1995, and most recently modified in April 2015. It serves as the foundation, to ensure and promote the development of electricity supply, to protect the lawful interests of investors, operators, and consumers, ensure the secured electricity supply.

The Electricity Act mandates the following:

- Pricing mechanism under the Chapter 5 of the Act. The electricity price shall be based on the principle of uniform policy, unified pricing and be regulated at different levels.
- Issuance of license to power generating companies and T&D providers under Chapter 4 of the Act.
- Investment in the power industry shall implement the principle of "whoever invests, benefits."
- The planning for electric power development shall be drawn up on the basis of the requirements of national economy and social development and shall be put into the plan of national economy and social development.
- Power construction projects shall conform to the electric power development planning as well as the State's industrial policies on the power industry. No power equipment and technology declared obsolete by formal decree of the State shall be used for power construction projects.

In the most recent modification that passed in April 2015, the following aspects are changed:

- Clause 25, 'electricity suppliers can only start operation after it has been granted 'Power Supply Business Permit' from Administration Bureau of Industry and Commerce' is removed.

National Action Plan for Energy Strategy ("NAPES") 2014-2020

NAPES 2014-2020 was issued in September 2014. It creates a roadmap for China's energy use and development from 2014 to 2020.

- The goal to cap its annual primary energy consumption at 4.8 billion tonnes of standard coal equivalent, win an immediate capping target of 4.2 billion tonnes coal equivalent by 2020. Fuel diversification is key strategy to achieve this goal.
- A target of raising the percentage of the total energy mix supplied by clean energy to 15 percent by 2020.
- By 2020, to have 10 percent of energy supplied from LNG while lowering the overall share of coal to 62 percent from the current level of 66 percent.

CHP plants

The advantages of CHP of its higher efficiency have long been recognised in China, with the use of CHP has been dated back since the 1950s'. The Action Plan for Atmospheric Pollution Prevention, issued by the State Council in September 2013, requested to replace distributed coal-fired boilers with concentrated CHP units in chemical, paper, printing, leather and pharmaceutical industry clusters. A distributed coal-fired boiler refers to the common industry practice whereby one boiler supplies electricity to one off-taker. Under the policy, the Government encourages large CHP units to be constructed to supply to a number of off-takers within an industry cluster. It is also forbidden to build new coal-fired power plants apart from CHP in Beijing, Tianjin and Hebei as well as Yangtze and Pearl River delta areas.

Other published official documents that adopt CHP as a favourable power generation solution include:

- China 21the Century Agenda, passed in UN in 1992, which was ratified by the Government of China;
- People's Republic of China Energy Saving Act, passed in 2007;
- People's Republic of China Atmospheric Pollution Prevention Law, passed in 2000;
- Regulation about Developing CHP, issued by NDRC, Ministry of Environment Protection, in 2000
- CHP and Comprehensive Gangue Utilisation Power Plant Projects, issued by NDRC and Ministry of Construction in 2011.

Meanwhile, in the 12th Five-year Plan for Atmospheric Pollution Prevention in Key Areas, select cities in Hebei, Shandong and Shanxi provinces were listed as key areas in tackling the atmospheric pollution. For instance, Taiyuan city in Shanxi province, Jinan, Qingdao, Zibo, Weifang, and Rizhao cities in Shandong province, as well as Shijiazhuang, Tangshan, Baoding, and Langfang cities in Hebei province are listed as 'Under Critical Control Area'. More stringent requirements applied to cities under this category include the halt in approving new coal-fired power plants unless they belong to the two categories:

- Replacement of small and inefficient coal-fired power plants with large coal-fired power plants;
- CHP.

Even though there has not been any fiscal support or beneficial taxation regime to encourage the uptake of the CHP, power plants with CHP technologies are favoured by the Government in obtaining Government approvals, as CHP plants typically are able to achieve higher efficiency than power only plants.

Key regulating authorities

China's electricity generation sector has different stakeholders, but the NDRC has the overarching authority to monitor and manage the development of the sector.

NDRC

NDRC is a division under the State Council of China. It was formed in 2003, from the heritage of National Planning Committee. In 2008, NDRC relinquished its authorities on industries to the Ministry of Industry and Information Technology. NDRC has 28 departments and divisions among which that are relevant to power generation industry are Department of Climate Change, Department of Pricing, and National Development Agency. The functions of NDRC are broad.

It is responsible for the following:

- National economic and social development strategies, making medium-long term and annual planning;
- Research and analyse domestic and international economic trends, develop national economic development, pricing level balancing, and optimise critical economic structure;
- Monitoring macro-economic and social development trends;
- Collect and analyse financial and treasury data and information. Participate in treasury policy, monetary policy, and land policy designing. Design and implement pricing policies;
- Planning large development projects and productivity planning. Design national fixed asset investment scale, structure, target, and implementation;
- Promote sustainable development strategy, and make climate change planning and implementation.

NEA (Market Supervision Division and Electricity Safety and Security Supervision Division)

NEA was created in 2008 under 'Decision to Reform the State Council Structures and Organisations'. NEA is under administrative authority of NDRC. Its chief function includes:

- Research and develop energy strategies.
- Research and develop annual energy development target.
- Develop energy industry development policies.
- Analyse the impact of taxation policy, financial policy, pricing policy, trade policy, foreign investment policy, consumption policy on energy supply and demand balance.

- Develop suggestions on energy industry system reform.
- Implement and promote the national strategy on renewable energy development.
- Guide provincial energy development, and coordinate provincial energy production development and supply and demand balance.
- Responsible for oil reserve planning and implementation.

Provincial Development and Reform Committee ("PDRCs")

PDRCs were established at different times in the mid-2000s' replacing the previously Provincial Planning Committee. Each PDRC is an organisation under the management of each Provincial Government. It monitors and implements the plans initiated by the NDRC at provincial level, while draft new plans that correspond to the specific needs of the province.

Core divisions at PDRC that are relevant to the power generation industry are Provincial Energy Agency (**"PEA")** and Price Control Administration.

PEA

Select provinces have their individual PEA which is a division under the PDRC and responsible for tracking, gathering, and reporting the energy supply, demand, and early warning in their own province, while executing the plans initiated by the NEA.

Each PEA has different organisation structure and focus that suit the energy characteristics. For instance, Shaanxi Province is rich in coal resources and natural gas, so its PEA has separate divisions to organise and plan the development of coal, coal power generation and LNG resources research and development.

Provincial Energy Regulatory Office, NEA

While some provinces have independent provincial energy agencies, some provinces have offices under the administrative authority of NEA, namely Provincial Energy Regulatory Office. They carry the similar functions as PDRCs, but under direct guidance of NEA. This is due to the various steps during the national and provincial organisational restructuring that has been on-going since the early 2000s'.

4.6 OUTLOOK AND PROSPECTS

Gradual Market Deregulation

China's electricity sector is experiencing reforms and transformations. 'Suggestions on Further Deepening the Regulatory Reform in Electricity Sector', issued by NDRC in February 2015 is the first policy following the 'Electricity Industry System Reform' issued in 2002. It is a milestone document signalling the major change in the following areas:

- Retain the T&D assets as state-owned assets. The Government set the prices for this part of the services.
- Deregulate the power generation and power retailing markets.

Separating the retailing function from grid companies and introducing private and non-private sectors to participate in the electricity retailing is said to be the first step of the deregulation. This is likely to be followed by an experimental market mechanism that allows the generators and other market participants to determine the on-grid-tariff that is currently set by the Government.

Continuous Growing and Diversify Generation Capacity, and Emission Reduction

Electricity demand in China is still growing. China's current electricity consumption is about 4,000 Kwh per capita which is only a third of that in the US or Canada. While China endeavours to develop its economy and improve citizens' living standards, electricity demand is expected to continue to grow. Frost & Sullivan forecasts the total installed capacity in China will grow from 1.5 TW in 2015 to 2.0 TW in 2020 at a CAGR of 6.2%.

Reduced dependence on coal has been of great priority for the Government of China. To achieve this Government has issued financial subsidies, administrative annual planning orders for each province, and strategic guidance to increase investment in other fuel sources, mostly in wind energy, solar energy and LNG. According to the Government initiatives, it is envisaged that coal-fired power generation capacity will account for about 55.0% of the total installed capacity by 2020, representing a drop of almost 8.0% from its current level of 62.9% as of 2014.

China has been executing aggressive strategies to improve the efficiency emission standards at coal-fired power plants. This includes shutting down small coal power plants, enforcing pollution control facilities at coal power plants, requiring new plants to be CHP plants and developing large scale coal-fired power plants with high efficiency and low emission.

Moving forward, the Government is expected to prefer CHP plants in terms of coal-fired power generation as the plants are able to achieve higher efficiency than power only plants. Select cities in Hebei, Shandong and Shanxi provinces have been listed as 'Under Critical Control Area' in terms of atmospheric pollution, which lead to the halt in approval for new coal-fired power plants unless they are CHP plants or large coal-fired power plants replacing small inefficient plants.

Developing and Strengthening Grid Networks

Meanwhile, China endeavours to expand its grid network to reach the previously off-grid areas in order to eliminate off-grid population. China has been constructing Super High Voltage transmission lines to enable 'West-east-power-transmission' projects which transmit power generation from the western provinces to with higher power resources to the eastern provinces with higher population density but low power resources.

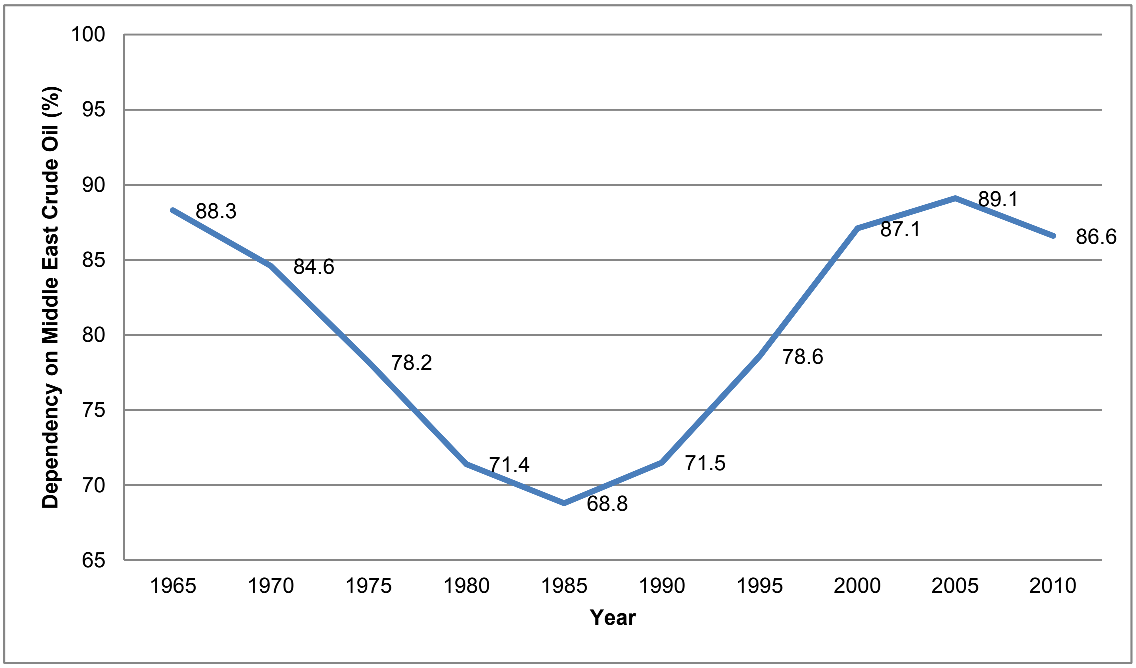
5 COUNTRY OVERVIEW OF SOLAR POWER GENERATION INDUSTRY

5.1 OVERVIEW OF RENEWABLES AND SOLAR POWER GENERATION IN JAPAN

5.1.1 Background of Solar Power Generation Industry

Japan is highly dependent on imports for its primary energy supply. Chart 5.1 indicates Japan's dependency on Middle East Crude Oil, as compared to Japan's total crude oil import between 1965 and 2010. The Middle East's share was more than 80.0% between 1965 - 1975 and 1998 - 2010. According to the Ministry of Trade, Economy and Industry (**"METI"**), Japan's crude oil import from the Middle East remained at above 80.0% in 2014[104]. This high level of dependency on Middle Eastern fuel imports has made Japan vulnerable, particularly on fuel availability for its power generation sector. Furthermore, the prospect of electricity imports from neighbouring countries is relatively limited due to the geographical limitation of Japan as an island nation.

Chart 5-1: Historical Japan's Dependency Trend on Middle East Crude Oil (%), 1965 – 2010



*Source: the Federation of Electric Power Companies of Japan (**"FEPC"**)*

In order to ensure a stable electricity supply, it is crucial for Japan to establish an optimal combination of conventional and alternative sources of power generation. This will provide energy security as well as environmental friendly and economically efficient energy to the

[104] Preliminary Report on Petroleum Statistics, June 2015, METI

country. Subsequent to the two oil crises in the 1970s, Japan began to diversify its energy sources through an increased use of nuclear energy and renewables, such as solar power. In June 2002, the “Basic Act of Energy Policy” was introduced in order to initiate the energy policy in a comprehensive and consistent manner. This act sets the basic principles regarding energy policy, emphasising energy security, adaptability to the environment, and utilization of market mechanisms. Based on this policy, the first “Basic Energy Plan” was established in October 2003.

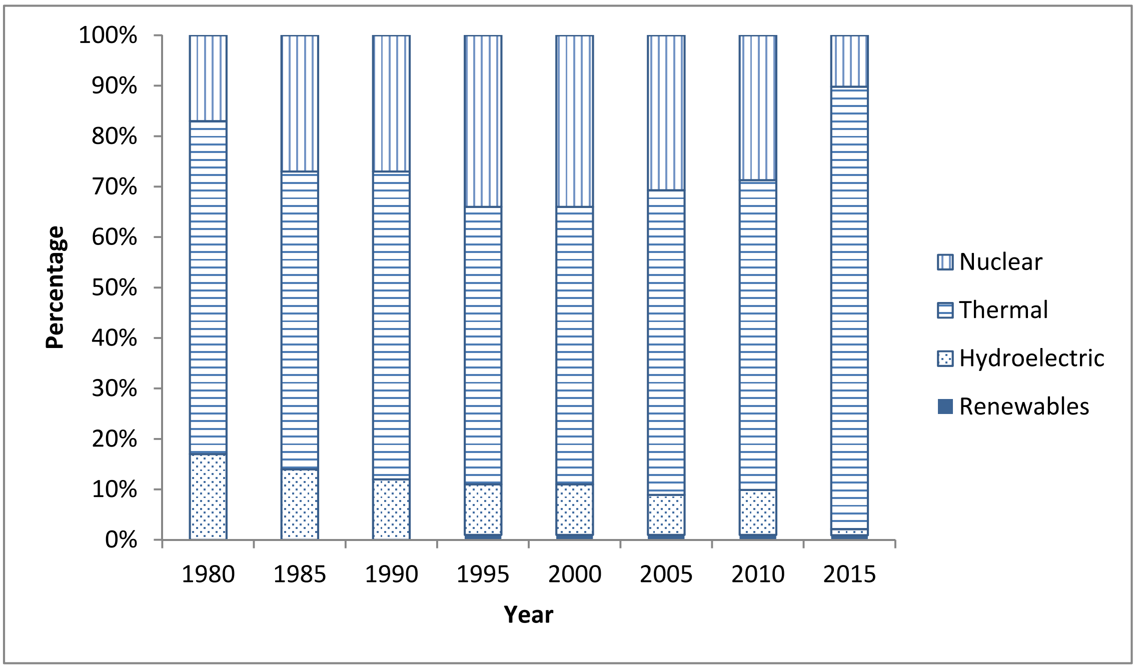
In 2006, a “New National Energy Strategy” **(“NNES”)** was introduced by METI. The NNES regarded energy security as one of their key agenda items in view of a potential oil crisis in the future. NNES’s long term strategy addressed energy efficiency and conservation policies, with a target of 30.0% energy efficiency improvement by 2030. The other focus areas were the introduction of renewable sources and also to increase nuclear power supply by 30.0% to 40.0% of the total national electricity supply.

In June 2010, the Japanese cabinet adopted the third Energy Strategic Plan. The plan aimed to increase the contribution of electricity generated by nuclear power from 288 TWh in 2010 to approximately 430 TWh in 2020. It targeted an energy independence ratio[105] of 70.0% by 2030, as compared to 38.0% in 2010. The plan also established a target to increase the power supply from renewable energy to 13.0% in 2030, from 6.0% in 2007, and to establish at least 14 nuclear plants by 2030.

The Great Sendai Earthquake of 2011, however, had a negative impact on Japan’s nuclear sector. The accident at Tokyo Electric Power Company **(“TEPCO”)**’s Fukushima Daiichi Nuclear Power Plant compelled Japan to review its dependency on nuclear power generation. The fourth Strategic Energy Plan was subsequently introduced in April 2014, which outlined the key risks and challenges in Japan’s energy structure and established a more comprehensive and systematic energy policy for the long term. An energy related technological development roadmap was formulated to address the challenges in the power generation sector, such as the utilisation of cost efficient renewable energy (solar power, wind power, ocean energy and biomass), safety improvements to nuclear plants, and advancement in T&D networks.

[105] “The Energy Independence Ratio is the percentage of Japan’s primary energy supply, which consists of either energy produced domestically or imported fossil fuels, which is produced by Japanese companies.” Applied Energy: An Introduction, Mohammad Omar Abdullah, Page 136, Version Date: 20120612

Chart 5-2: Historical Trend of Power Generation Volume by Source (%) in Japan, 1980 – 2010



Notes:

(1) Total of 10 electric power companies and power purchased

(2) Oil includes LPG and other gases.

(3) Figures may not add up to the totals due to rounding

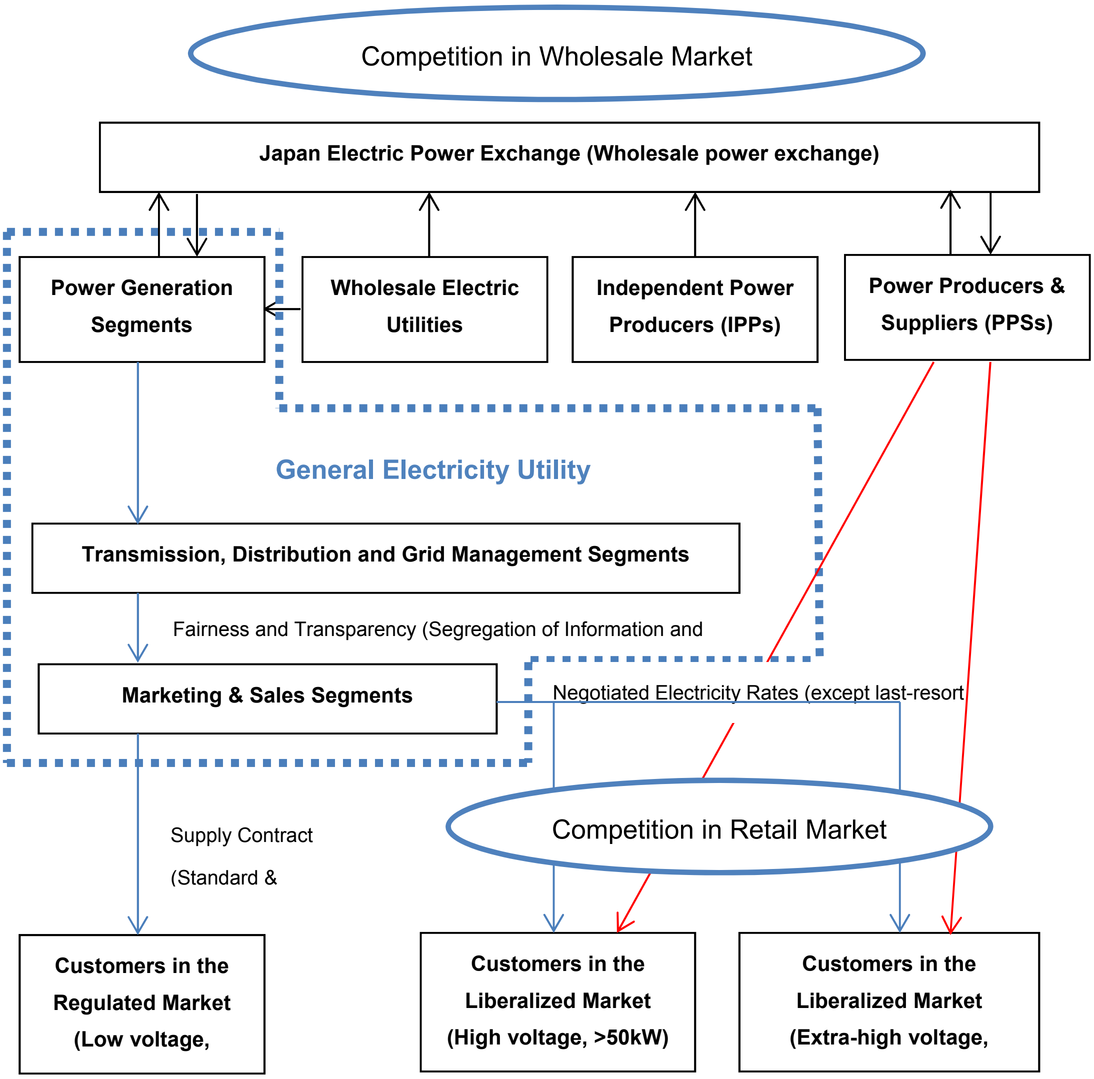
Source: FEPC

The fourth Strategic Energy Plan also emphasised the importance of building a multi-layered and diversified flexible energy supply-demand structure, to ensure stability and to enable flexible responses to changes in energy supply volumes. Meanwhile, other alternative energy sources play a critical part in providing a reliable and sustainable power supply to mitigate potential shortages of fossil fuel supplies.

5.1.2 Industry structure and value chain

Ten privately-owned electric power companies are in charge of regional power supply services, referred to as General Electricity Utilities. They are responsible for electricity supply, from power generation to the distribution to end users. The electric power companies must obtain a license from the Japanese Government by providing supply conditions, such as electricity rates.

Figure 5-1: Electricity Supply Industry Structure in Japan

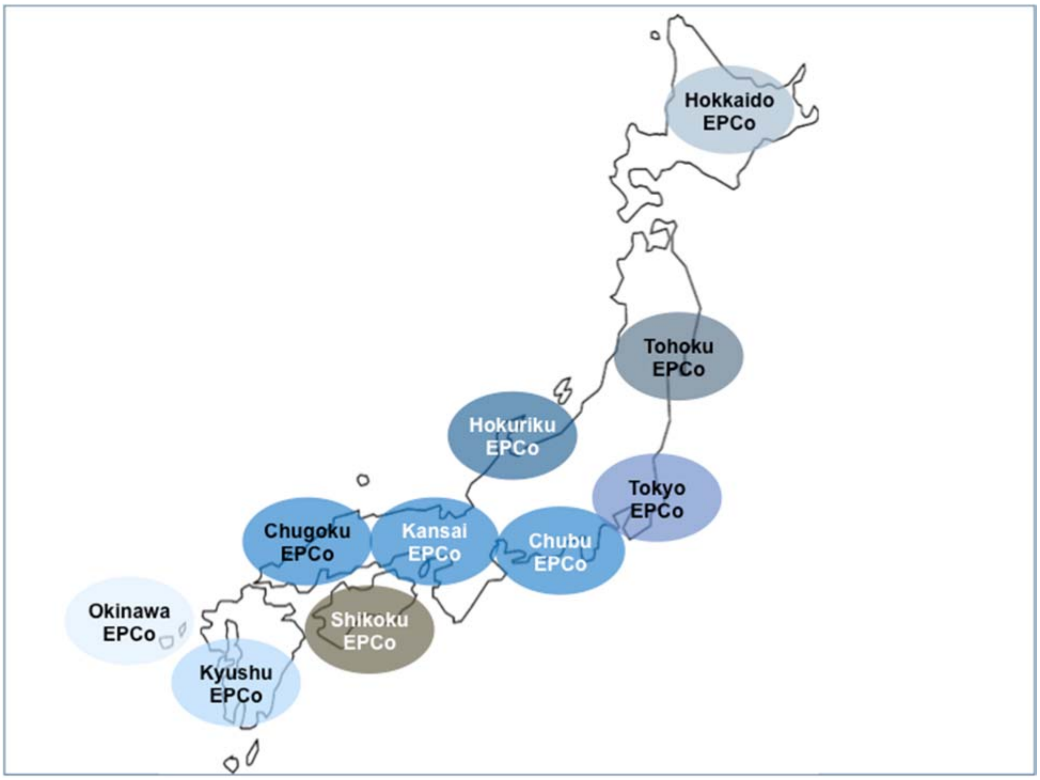


Source: FEPC

Over the years, the Japanese electricity market has been almost completely monopolized by the General Electricity Utilities, which operate in their respective regions of the country. Because of the lack of regulatory structure and defined serviceable regions, competition across regional boundaries is minimal, and the generation and delivery of electricity has generally been bundled under each of the General Electricity Utilities[106].

[106] Electricity System Reform in Japan, January 2014, Anderson Mori & Tomotsune

Figure 5-2: Distribution of General Electricity Utility Companies in Japan



Source: FEPC

Japan Electric Power Exchange **("JEPX")** was founded in November 2013, to encourage the buying and selling of electricity by electric power companies and power generation firms. 21 industry members are responsible for the operation and fund contribution to JEPX. Transaction participants include electric power companies and power producers and suppliers.

Table 5-1: List of Japan Electric Power Exchange Partners

No.	Company
1	eREX Co., Ltd.
2	ENNET Corporation
3	Osaka Gas Co., Ltd.
4	The Kansai Electric Power Co., Inc.
5	Kyushu Electric Power Co., Inc.
6	SUMMIT ENERGY CORPORATION
7	JFE Holdings, Inc.
8	Shikoku Electric Power Co., Inc.
9	NIPPON STEEL & SUMIKIN ENGINEERING
10	JX Nippon Oil & Energy Corporation

No.	Company
11	Diamond Power Corporation
12	The Chugoku Electric Power Co., Inc.
13	Chubu Electric Power Co., Inc.
14	J-POWER
15	TOKYO GAS Co., Ltd.
16	The Tokyo Electric Power Co., Inc.
17	Tohoku Electric Power Co., Inc.
18	NIHON TECHNO Co., Ltd.
19	Hokuriku Electric Power Co.
20	Hokkaido Electric Power Co., Inc.
21	Marubeni Corporation

Source: JEPX

Although the electricity retail market was partially liberalized in 1995, the PPSs contribute a relatively low market share of 3.5% of the liberalised sector in 2012. A major reason is their limited supply which mainly comes from excess electricity generated by small-scale generators in the industrial sector. There are about 206 PPSs[107], of which approximately 30.0% were established after the Great Sendai Earthquake in 2011. Tokyo had the majority of PPSs (39.8%), followed by Fukuoka (7.3%). In a nutshell, PPSs operations are found in 36 prefectures.

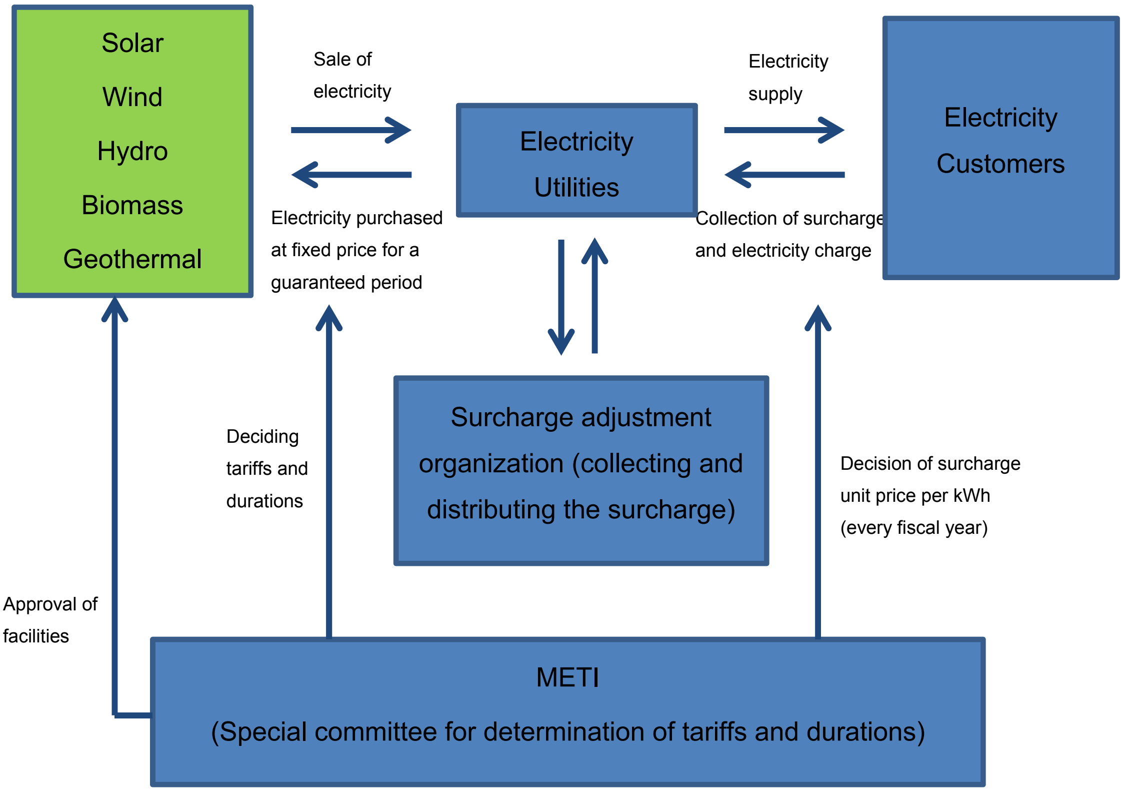
The renewable energy sector in Japan has a slightly different setup from the Electricity Supply Industry Structure as depicted in Figure 5:1. Renewable power generation is based on a FiT scheme, under which the renewable energy producer is able to request electric utility to sign a contract to purchase electricity at a fixed price, for a period guaranteed by the Government.

Before the FiT scheme was introduced in July 2012, solar power was the only type of renewable power being addressed under the excess electricity purchasing scheme. Subsequent to the implementation of the FiT scheme, electric utilities are obligated to purchase electricity generated from all types of renewable energy (solar, wind, biomass, geothermal, small and medium scale hydraulic) over a fixed period (10 - 20 years) at pre-determined prices. The price and the period is recommended by Procurement Price Calculation Committee, and finalised by METI after consultation with the relevant ministers including the Minister of Agriculture, Forestry and Fisheries; the Minister of Land, Infrastructure, Transport and Tourism; the Minister of the Environment; and the Minister of State for Consumer Affairs.

[107] Teikoku Databank (25 April 2014)

Instead of targeting "excess power purchasing", which only covered the surplus electricity generated by solar PV panels, the FiT scheme allows for a "total purchasing program" for all types of renewables, making the scheme more impactful in promoting renewables. From 2012 to 2014, the total power generated by renewable energy has increased by 58.0%, from 44,670 GWh to 70,596 GWh.

Figure 5-3: FiT Scheme for Renewable Energy



Source: Agency for National Resources and Energy, METI

The gap between the purchase price and generation cost will be transferred to the electricity consumers in Japan. A surcharge will be added to consumers' monthly electricity bills, proportional to their electricity usage. Hence, costs to purchase the electricity generated by renewables will be transferred to the population in the form of surcharge, which is determined by METI on a yearly basis.

As identified in Table 5-2, the tariff decreased from 2014 to 2015, mainly because of the drastic reductions in power generation costs. METI has targeted a halving of the solar energy prices over the course of the next 3 to 5 years.

Table 5-2: Tariffs and Durations (Solar PV), FY2014 and FY2015

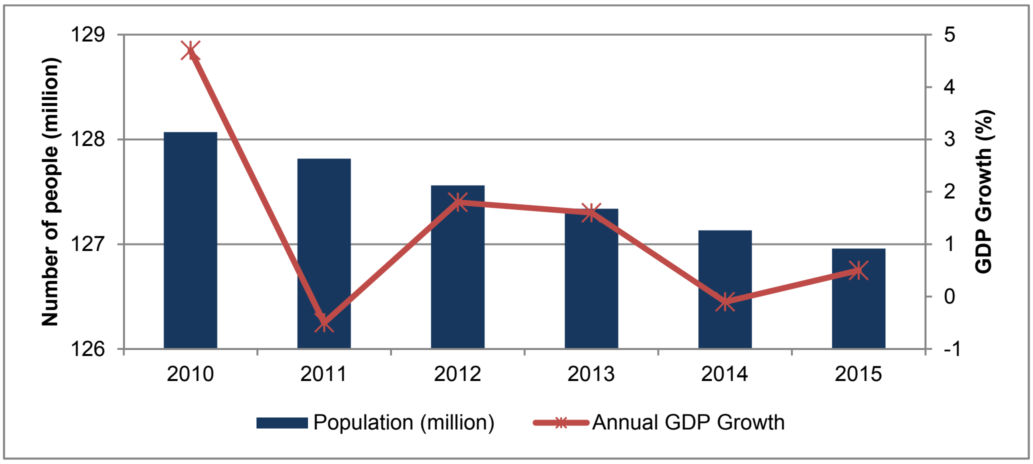
Procurement category	Tariff (per kWh), tax exclusive 2014	Tariff (per kWh), tax exclusive 2015	Duration
Non-residential 10 kW or more	32 yen	29 yen (Apr 1 to Jun 30) 27 yen (from July 1)	20 years
Residential Less than 10 kW *(When generators are not required to install output control equipment)*	37 yen	33 yen	10 years
Residential Less than 10 kW *(When generators are required to install output control equipment)*		35 yen	10 years

Source: Agency for National Resources and Energy, METI

5.1.3 Demand Conditions

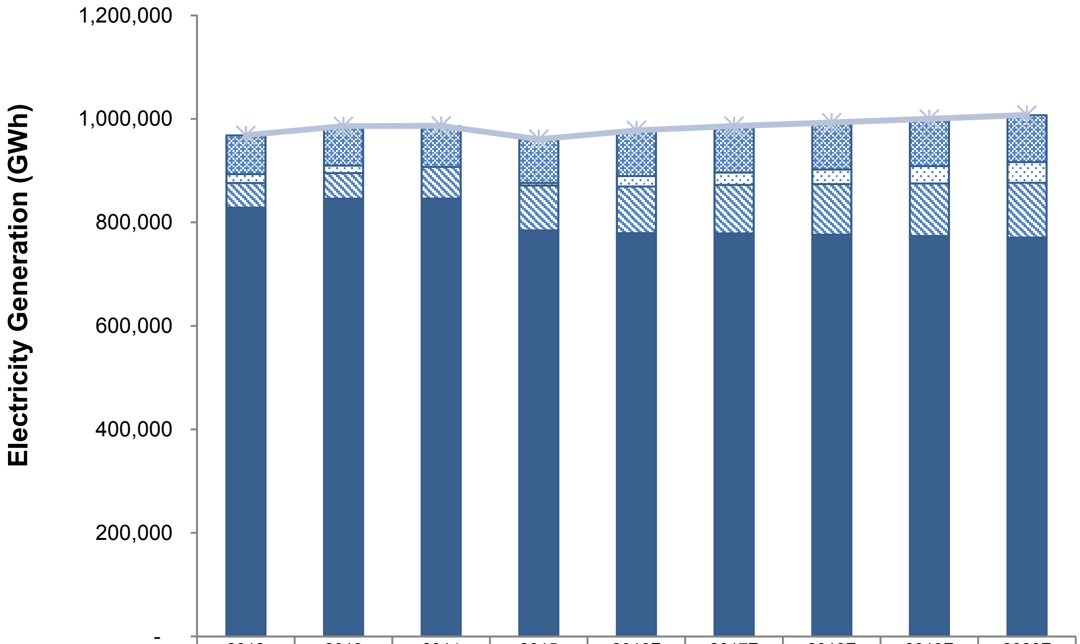
The decline in Japan's population, from 128.1 million in 2010 to 127.0 million in 2015, and its declining economic growth, 4.7% in 2010 to 0.5% in 2015, has had a negative impact on the energy sector. As a result of these macroeconomic factors, Japan posted a decline in total power generation between 2013 and 2014. However, from 2016 to 2020, electricity generation in Japan will experience steady growth due to economic recovery and preparation works for the upcoming 2020 Summer Olympics in Tokyo.

Chart 5-3: Historical Japan's Population and GDP Growth, 2010-2015



Source: the World Bank

Chart 5-4: Historical and Projected Electricity Generation (GWh) in Japan, 2012 – 2020F

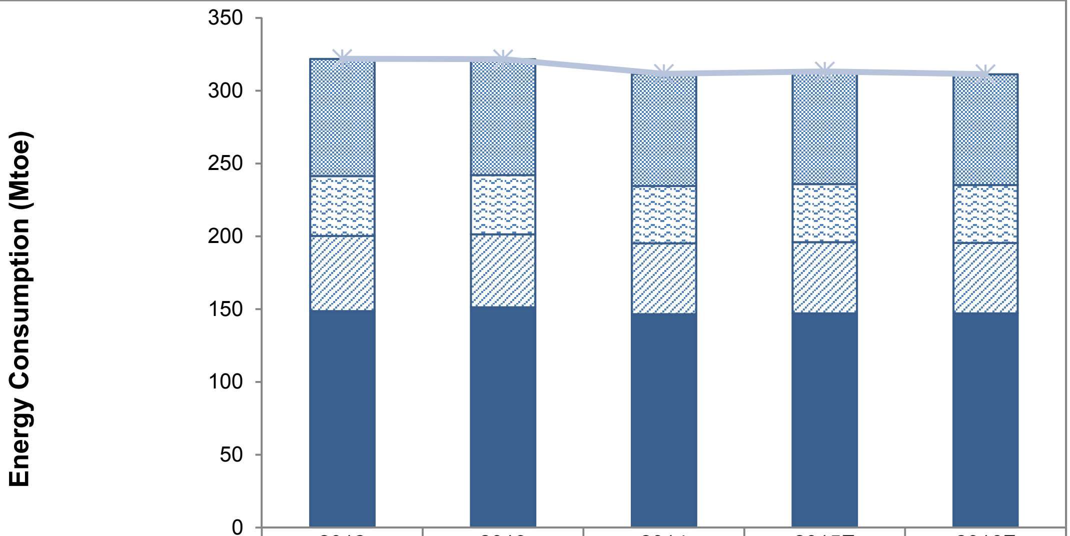


	2012	2013	2014	2015	2016F	2017F	2018F	2019F	2020F
Hydropower	74,731	76,217	79,024	84,240	87,950	89,623	90,323	90,790	90,805
Nuclear Power	17,230	13,947	-	5,000	20,000	23,764	28,237	33,552	39,867
Renewables	47,637	49,768	60,908	86,550	90,082	93,757	97,583	101,565	105,709
Fossil Fuels	828,834	846,096	846,580	785,073	779,737	779,064	776,685	774,069	771,104
Total	968,432	986,028	986,512	960,863	977,769	986,209	992,828	999,975	1,007,485

*Sources: Japan Renewable Energy Foundation (**"JREF"**), IEA, Japan for Sustainability, the Institute of Energy Economics (**"IEE"**), Japan*

Total energy consumption fell marginally until 2015, consistent with Japan's economic situation and also the energy efficiency and conservation programs initiated by the Agency for Natural Resources and Energy, such as the Summer Energy Conservation Measures in 2014. However, energy consumption by power generation sector in the form of electricity is going to increase marginally from 84.6 Mtoe in 2012 to 84.9 Mtoe in 2016 as shown in Chart 5.6, which is recovering after Fukushima incident. Total electricity generation in Japan is likely to increase from 960,863 GWh in 2015 to 1,007,485 GWh in 2020 at a CAGR of 1.0%.

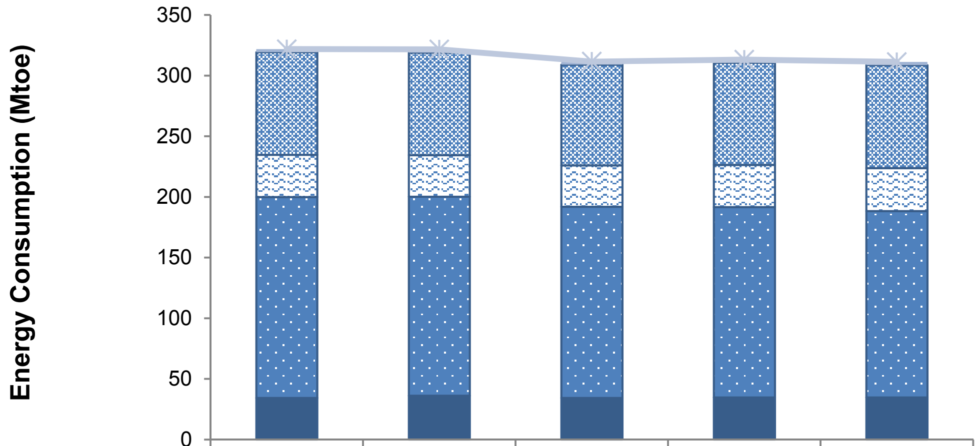
Chart 5-5: Historical and Projected Energy Consumption (Mtoe) by Sectors in Japan, 2012–2016F



	2012	2013	2014	2015E	2016F
Transport	80.4	79.5	77	77.3	76
Commercial Buildings	41.1	40.7	39.4	39.9	39.8
Residential Buildings	51.6	50.1	48.6	48.9	48.4
Industry	148.7	151.3	146.6	147.1	147.1
Total	321.8	321.6	311.6	313.2	311.3

Source: IEE

Chart 5-6: Historical and Projected Energy Consumption (Mtoe) by Products in Japan, 2012 – 2016F



	2012	2013	2014	2015E	2016F
Others	2.5	2.6	2.5	2.5	2.6
Electricity	84.6	84.5	83	84.3	84.9
City and natural gas	34.7	34.3	34.1	34.7	35.4
Petroleum	165.7	164	157.7	157	153.7
Coal and coal products	34.3	36.2	34.3	34.7	34.7
Total	321.8	321.6	311.6	313.2	311.3

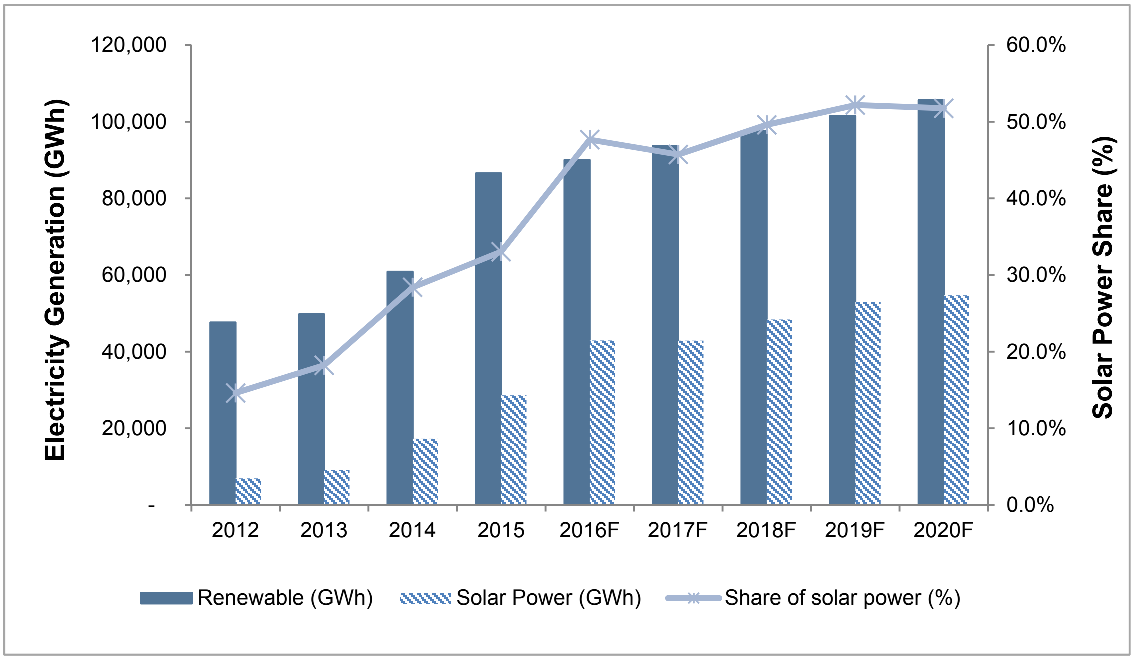
Source: IEE

Renewable power generation is expected to grow at 4.1% CAGR, from 90.1 TWh in 2016 to 105.7 TWh in 2020, while solar power generation is expected to grow at 6.2% CAGR from 42.9 TWh to 54.7 TWh, during the same period. This is equivalent to 51.8% of the total renewable power generation by 2020, compared to about 14.6% in 2012.

Shorter installation time and the smaller land area requirements of solar farms makes solar power an attractive alternative source of power generation compared to other renewable energy sources, such as wind generation plants, which require significantly larger operation space, longer development time and higher capital investments[108]. Besides, rapid expansion of solar power globally has resulted in widespread deployment of the technology which eventually led to substantial falls in solar PV costs, and hence improved the return on investment in solar energy.

[108] Strategic Energy Plan, April 2014, Agency for Natural Resources and Energy

Chart 5-7: Historical and Projected Electricity Generated by Solar Power (GWh) in Japan, 2012 – 2020F

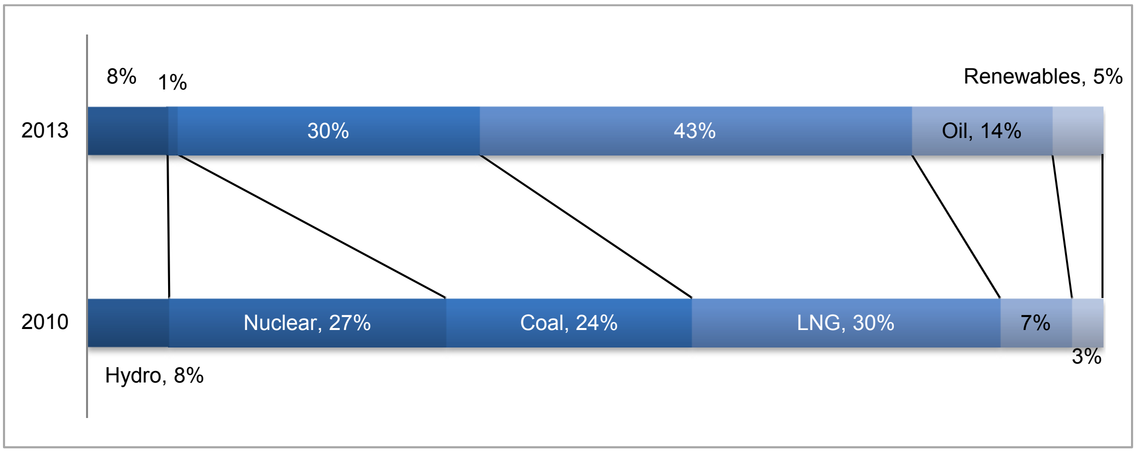


Source: JREF, Japan for Sustainability, EIA

5.1.4 Supply Conditions

The Great Sendai Earthquake in 2011 had significant impacts on the generation mix of Japan's power generation. In line with the Japanese Government's aim to reduce the reliance on fossil fuel based power generation, the contribution of thermal power generation to the total installed capacity is expected to decline from 155.0 GW or 56.0% in 2015 to 111.0 GW or 40.0% by 2020. During the same period, the contribution of renewable energy is expected to grow from 35.0 GW or 12.0% to 79.0 GW or 28.0% of the installed capacity. The contributions of hydropower and nuclear power generation capacity are expected to remain stable at 18.0% and 15.0% respectively during 2015 to 2020.

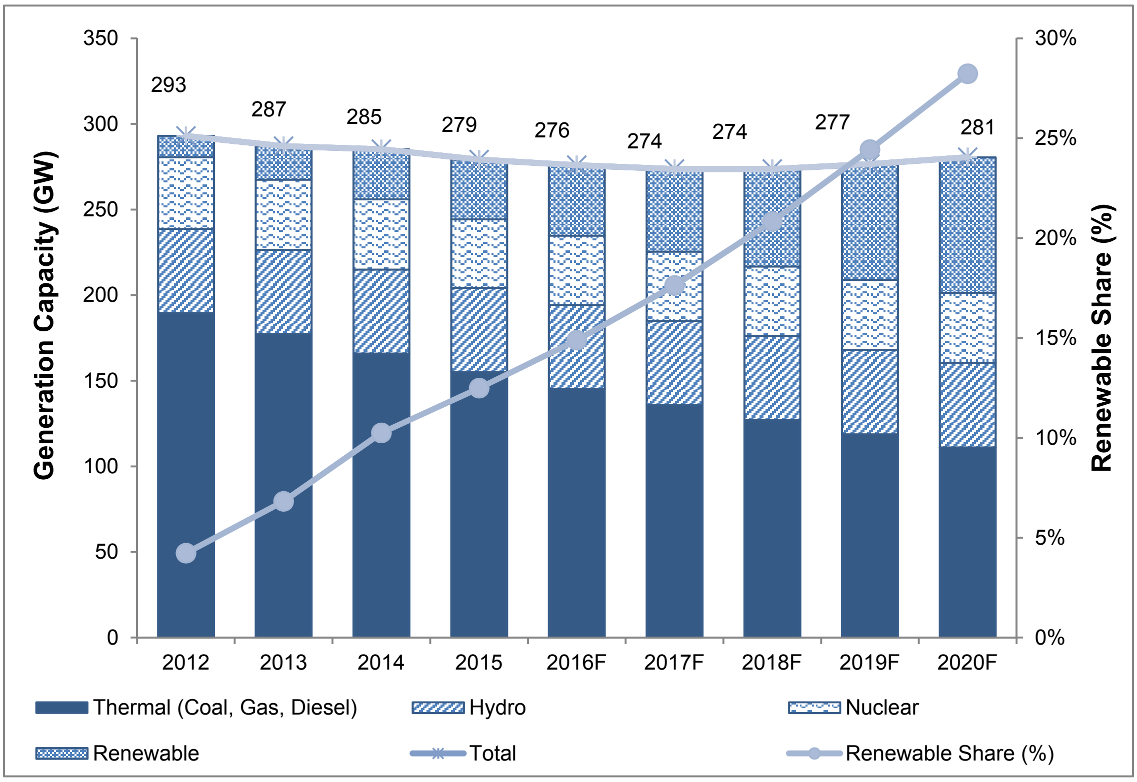
Chart 5-8: Historical Power Generation Mix in Japan (2010 and 2013)



Source: EIA

The share of the nuclear power generation in the base load has drastically declined from 27.0% in 2010 to 1.0% in 2013. In the same period, the combined share of gas, coal and oil in the generation mix increased from 61.0% to 87.0%. Simultaneously, there was also a marginal increase in renewables' share from 3.0% to 5.0%.

Chart 5-9: Historical and Projected Generation Capacity Growth Trend (GW) in Japan, 2012 – 2020

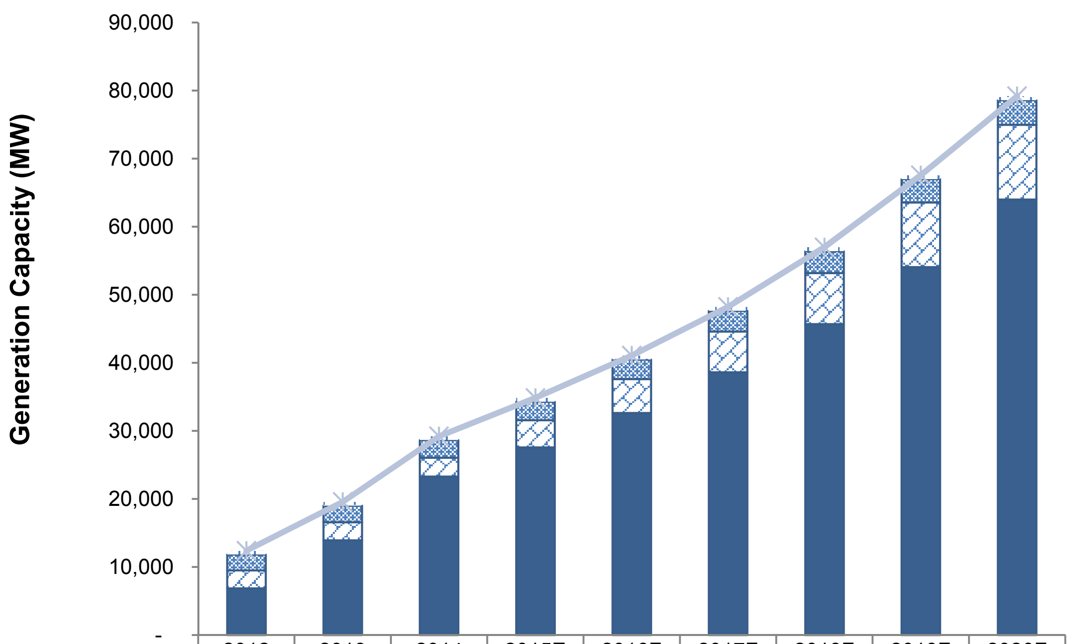


*Source: FEPC, JREF, Japan Wind Power Association (**"JWPA"**), EIA*

From 2015 to 2020, the total generation capacity in Japan is likely to remain stagnant despite the anticipated increase in power demand during that period of time. Declining energy requirements are mainly due to Japan's investment in energy efficiency programs, such as the Summer Energy Conservation Measures and the Top Runner Program.

Nonetheless, generation capacity for renewable sources is expected to grow from 34.9 GW in 2015 to 79.2 GW in 2020. During the same period solar power generation capacity is expected to increase from 27.6 GW or 79.0% of the total renewable capacity to 64.0 GW or 81.0% of the total renewable capacity.

Chart 5-10: Historical and Projected Share of Solar Power and Renewables Generation Capacity (MW) in Japan, 2012–2020F



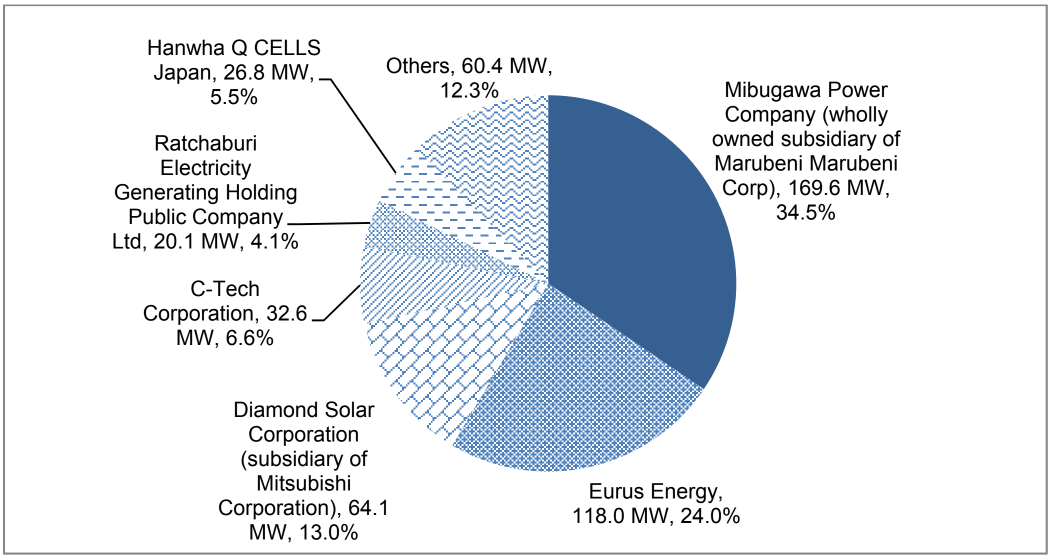
	2012	2013	2014	2015E	2016F	2017F	2018F	2019F	2020F
Geothermal	541	541	547	554	560	567	573	580	587
Biomass	2,344	2,436	2,576	2,724	2,880	3,045	3,220	3,405	3,600
Wind	2,618	2,665	2,788	4,000	5,000	6,000	7,500	9,500	11,000
Solar	6,885	13,928	23,300	27,574	32,631	38,616	45,699	54,081	64,000
Total	12,388	19,570	29,211	34,851	41,071	48,228	56,992	67,566	79,187

Sources: JWPA, IEA, Agency of Natural Resources and Energy, Institute for Sustainable Energy Policies, METI, EIA Geothermal Report

5.1.5 Competitive Landscape

In 2014, IPPs accounted for 2.1% (492.0 MW) of the total 23,300.0 MW solar power capacity in Japan. The IPP solar market in Japan is served by few large solar power plants and about 10 to 15 small scale solar power producers, which collectively own a total installed capacity of less than 30.0 MW. Mibugawa Power Company ("**Mibugawa**") is the largest player with about 170.0 MW of installed capacity, which accounts for a 34.5% share of the IPP solar power installed capacity in 2014, followed by Eurus Energy with 118.0 MW of capacity or 24.0% of the IPP Solar Power installed capacity.

Chart 5-11: Market Share among IPPs by Solar Power Installed Capacity (MW) in Japan, 2014



Source: Company Annual Reports

5.1.6 Relevant Laws and Regulation

In April 2014, the "Fourth Basic Energy Plan"[109] was approved by Japan's Cabinet. The new basic energy plan takes into account Japan's medium to long term energy supply and demand structure for the next two decades. The Plan provides support to renewable energy, such as Solar PV and wind power generation, which are identified as the key low-carbon energy sources in Japan. Furthermore, the Ministerial Council on Renewable Energy was established to support renewable energy developments.

The Fourth Basic Energy Plan is positioned as a key guideline to define the future direction on renewable energy. Its six key aims are:

1) To realize a multi-layered supply structure consisting of various energy sources;
2) To promote a more resilient energy supply structure;

[109] IEA

3) The participation of various entities in the energy supply structure through promotion of structural reform;
4) To realize energy supply and demand structure led by the demand side by offering a variety of options;
5) To improve the self-sufficiency rate with development and the introduction of Japan-made energy to minimize impacts of circumstantial changes in other countries; and
6) To contribute to addressing global warming by reducing greenhouse gas emissions across the world.

Under the Plan, community-level efforts on PV power generation will be supported, since it is relatively easier to install PV system on a small or medium scale.

The METI is taking a number of initiatives for supporting the dissemination of PV systems, which include:

1) A subsidy for the installation of residential PV systems;
2) A FiT program for renewable energy power generation facilities; and
3) A subsidy for introducing renewable energy power generation systems as part of restoration measures.

The Ministry of Land, Infrastructure, Transport and Tourism **("MLIT")** has developed a new environmental action plan and published the "Environmental Load Reduction Program on Government Facilities 2014". Under this program, MLIT intends to promote the implementation of renewables, including Solar PV systems in green Government buildings for central ministries and agencies, and their related facilities in local areas. For the private sector, MLIT invited proposals for projects which aim to reduce carbon emissions in houses and buildings. A subsidy program is in place to contribute a fixed amount or a part of the system's maintenance cost.

Meanwhile, the Ministry of Agriculture, Forestry and Fisheries **("MAFF")** implements a subsidy program to install PV systems at facilities for agriculture, forestry and fisheries, in order to promote the introduction of renewable energy into these industries.

The Ministry of Education, Culture, Sports, Science and Technology **("MEXT")** introduced the "Super eco school demonstration project" in 2012. A total of 63 schools were approved in 2014 under the Eco School Pilot Model Project, to receive a subsidy for the installation of PV systems. For public schools, MEXT provides a 50% subsidy to install Solar PV systems and storage batteries as part of the realization of zero-carbon energy at public school facilities.

In Japan's renewable energy business, one of the methods for making an equity investment is to establish a limited liability company, which is also termed as Godo Kaisha ("**GK**"). Typically, GKs will act as the asset holder of the renewable energy generation facility. In the case when there is capital investment in renewable energy assets from a foreign investor, the foreign investor will need to participate under the bilateral contract of known as Tokumei Kumiai ("**TK**"), regulated under the Japanese Commercial Code, Article 535 as a TK investor and shall remain as an anonymous partner within the GK. Under the ruling, the TK investors are eligible to negotiate the profits or losses to be assumed from the operation of the TK operator, which is typically a Japanese entity operating the renewable energy assets. Simultaneously, TK investors are also subjected to taxes in accordance to the share of profit generated by the renewable energy assets that they have pre-agreed with the TK operator.

5.1.7 Prospects and Outlook

Japan will continue moving towards a balanced combination of power sources. Renewable energy will constitute a sustainable share of power generation, along with fossil fuels and nuclear power, in the nation's continued efforts in ensuring energy security, energy conservation, and energy cost efficiency.

Energy consumption is likely to remain stagnant for the next few years. The continued market penetration of energy efficient home appliances and the decline in average family size will reduce energy consumption in the residential sector. Energy conservation efforts, economic recovery, and the upcoming 2020 Tokyo Olympics Games are likely to remain as the factors impacting the energy consumption trend in Japan.

The solar power generation market in Japan has undergone positive developments since the introduction of the new FiT program in 2012, which allowed large scale solar power plants of over 500.0 kW to be eligible. Simultaneously, the rapid growth in solar power generation is also likely to encourage the growth of the adjacent Solar PV panel and component manufacturing sectors. Government incentives will motivate the development of solar power plants and attract increasing number of investors. From 2015 to 2020, Japan's solar power generation capacity is expected to increase by 36,426.0 MW.

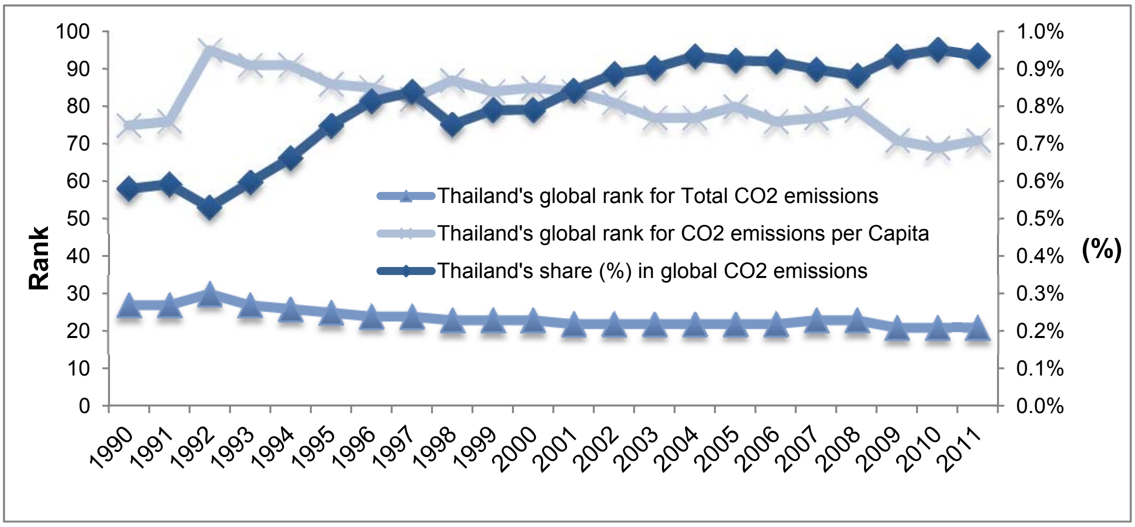
5.2 OVERVIEW OF RENEWABLES AND SOLAR POWER GENERATION IN THAILAND

5.2.1 Background of Solar Power Generation Industry

In the energy sector, the Government of Thailand has been undertaking actions based on guiding principles to achieve the target of the formation of sustainable energy security, promotion of alternative energy, monitoring of energy prices, energy saving and the protection of the environment. The NEPC has a mission to lead the country through the global economic challenge and towards a sustainable growth. To complement this, the Renewable Energy Policy was designed and launched in 2008.

Increased level of carbon emission from the use of conventional energy has led to climate change, which in turn led to several catastrophic events in Thailand, most notably the flood in 2011. The 2011 severe flood, which paralysed large parts of the country, had caused massive economic losses amounting to 1,425.0 billion baht[110], triggering the implementation of the renewable energy plan in Thailand. Thailand carbon emissions have increased in the last two decades and account for almost 1.0% of world emissions, ranking 21st in the world top emitters and 7th in APAC[111]. The emission level is expected to further increase based on key factors such as economic and population growth. As such, the country's National Economic and Social Development Plans 2012 – 2016 has set targets to reduce the impacts of climate change, increase energy efficiency and to reduce CO_2 emissions by 2016 through the promotion of renewable energy.

Chart 5-12: Thailand's CO_2 Emissions Characteristics



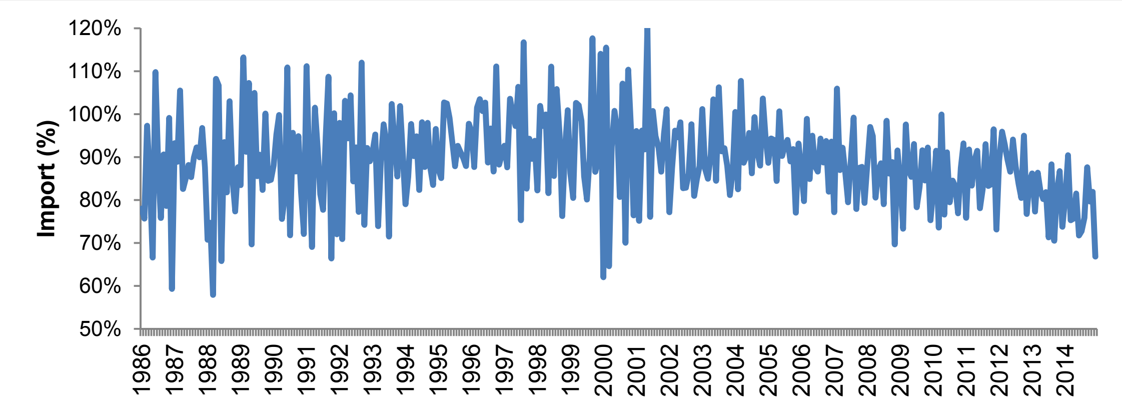
Source: Millennium Development Goals, UN

Furthermore, Thailand has been relying heavily on imported fuels. From January 1986 to December 2009, Thailand's crude oil import share on a monthly basis was around 80.0%. The

110 "The World Bank Supports Thailand's Post-Floods Recovery Effort". World Bank. 13 December 2011
111 Millennium Development Goals, UN

energy consumption in Thailand accounted for a value of about 1.5 trillion Baht in 2012 and is estimated to increase to 2.1 trillion Baht by 2017[112]. Hence, the dependency on imported energy will inevitably increase accordingly. Being heavily reliant on imported oil, the Government of Thailand, via various Government policies, is targeting to significantly increase the production and consumption of renewable energy in recent years. This is shown in the lower average crude oil import share of 68% in the past five years (January 2010 to December 2014).

Chart 5-13: Thailand's Share of Crude Oil Imports in Refinery Throughput



Source: EPPO, Ministry of Energy

Driven by the factors above, the Government of Thailand, through its Renewable Energy Policy, is taking the necessary initiatives to develop and promote Thailand towards CO_2 emission reduction across all the sectors by 2050 and thereby become a low-carbon society without reducing its developmental capability and competitiveness[113]. In terms of sources of alternative energy, Thailand has an abundance of agricultural products that can be used for energy generation in the form of biomass, biogas, biodiesel, ethanol and by-products of processed food industry. On top of that, Thailand also has large potential for solar power generation with average radiation of 18 - 19 MJ/m2 /day[114] due to its proximity to the equator.

In conjunction with the Renewable Energy Policy, the Government of Thailand has assigned the Ministry of Energy to launch an investment program in the alternative and renewable energy sector. The policy was initiated in 2006 and the first 15-year REDP was approved in 2008, followed by a 10-Year AEDP 2012-2021 published in 2012. The REDP and AEDP were formulated by the NEPC of Ministry of Energy to promote the use of alternative energy to reduce imported fossil-fuels, strengthen energy security, promote alternative energy consumption at the community levels, support domestic manufacturing of alternative energy technology for domestic requirement, as well as to conduct research and development for developing integrated renewable energy industry.

With the commitment to become a low-carbon society, the AEDP 2012-2021 targets solar PV installation capacity of 2,000.0 MW by 2021. In 2013, the NEPC revised AEDP 2012 - 2021 to

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[112] EPPO, Ministry of Energy
[113] Thailand Climate Policy, 2012. Ministry of Natural Resources and Environment
[114] Department of Alternative Energy Development and Efficiency (**"DEDE"**), Ministry of Energy

increase Thailand's target installed solar PV installed capacity by 1,000.0 MW to a total of 3,000.0 MW. Targets for other alternative energy installed capacities were also revised under this initiative.

Industry Structure and Value Chain

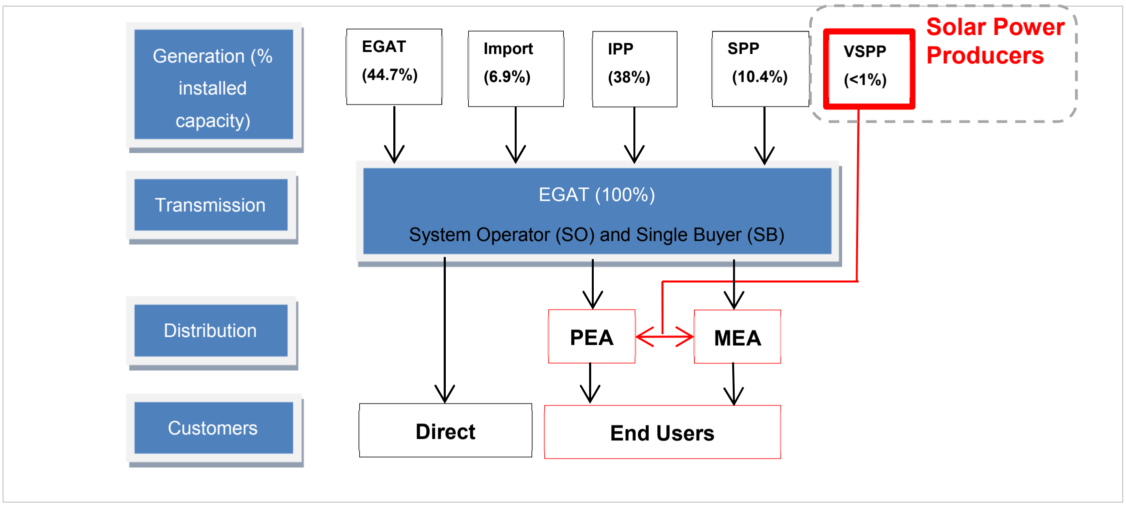
Thailand's electricity sector has transformed from a Government monopoly to a semi-unbundled "Enhanced Single Buyer" ("**ESB**") model over the past 20 years. Under the Ministry of Energy and Ministry of Finance, EGAT was established in 2006 as an enterprise to execute electricity generation, acquiring electricity (from IPP, SPP and import from neighbouring countries) as well as transmission to the distribution authorities namely MEA, PEA, direct customers by law and neighbouring countries.

Based on Thailand's ESB model as shown in Figure 5-1, solar power producers fall under the VSPP category (with installed capacity of less than 10.0 MW), which accounts for less than 1.0% of the total installed capacity in 2014. The electricity generated by solar power producers is sold to PEA/MEA while it is noted that EGAT does not buy electricity directly from VSPPs. The qualified VSPPs are categorized as follows:

1. Renewable energy: wind, PV, mini hydro, sea or ocean waves, geothermal energy and biogas.
2. Non-commercial fuel: agricultural waste, by-products of agricultural waste, municipal waste, dendrothermal (wood from fuel tree plantation).
3. Transportation-processed fuel: waste energy (waste steam), loss energy (heat from the engine exhaust) and by-product energy (mechanic).

PEA and MEA buy electricity from VSPPs under the "Purchase of Power from VSPP (for the Generation Using Renewable Energy)" regulation set by these distribution utilities and subsequently distribute electricity to end consumers in their respective regions.

Figure 5-4: Thailand Solar Industry Structure, 2014

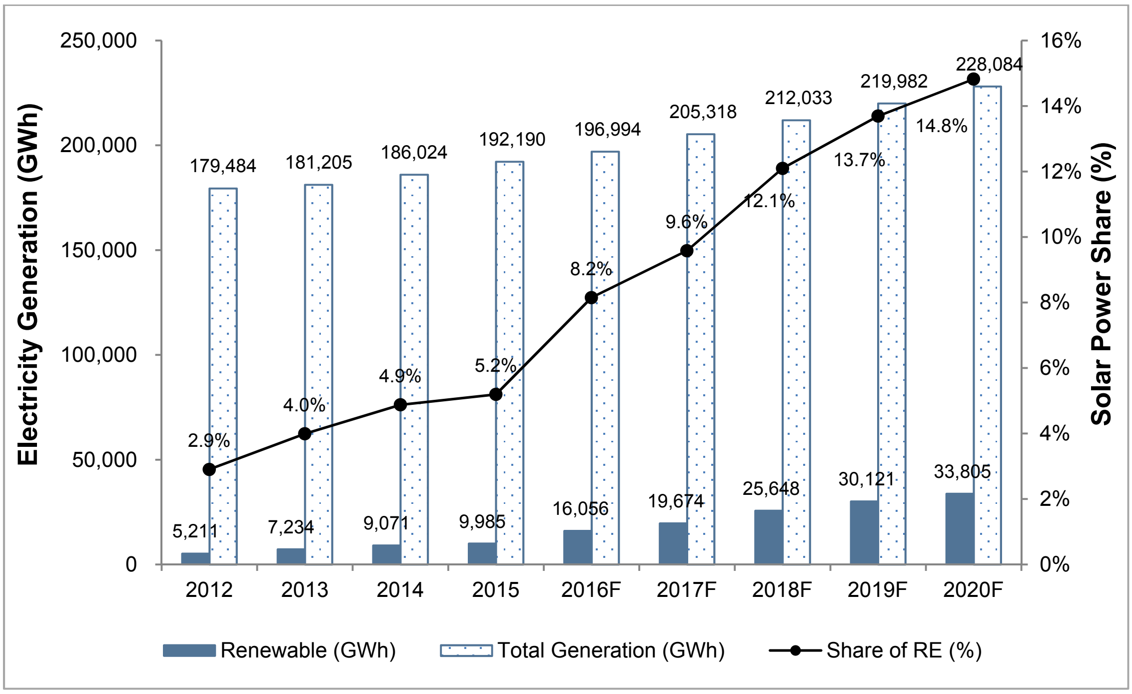


Notes:
SPP (>10 MW and <90 MW)
VSPP (<10 MW)
Source: Modified from Annual Report 2014, EGAT, Frost & Sullivan

5.2.2 Demand Conditions

Thailand generated 2.9% or 5,211 GWh of electricity from renewable sources in 2012 and it grew to 5.2% or 9,985 GWh in 2015 at a CAGR of 24.2%. According to PDP 2015, there will be a strong improvement in the share of renewable energy as a source of electricity generation, from 8.2% or 16,056 GWh in 2016 to 14.8% or 33,805 GWh in 2020 at a CAGR of 20.5%. With a favourable FiT introduced in 2014, large addition of electricity generation from renewable energy sources by VSPP is expected. Besides, the growth in generation of electricity is expected to be further driven by the projected increase in population (67.9 million in 2012 to an estimated 69.3 million in 2021), GDP growth of 3.8% and urbanisation rate of 3.0% growth yearly in 2015.

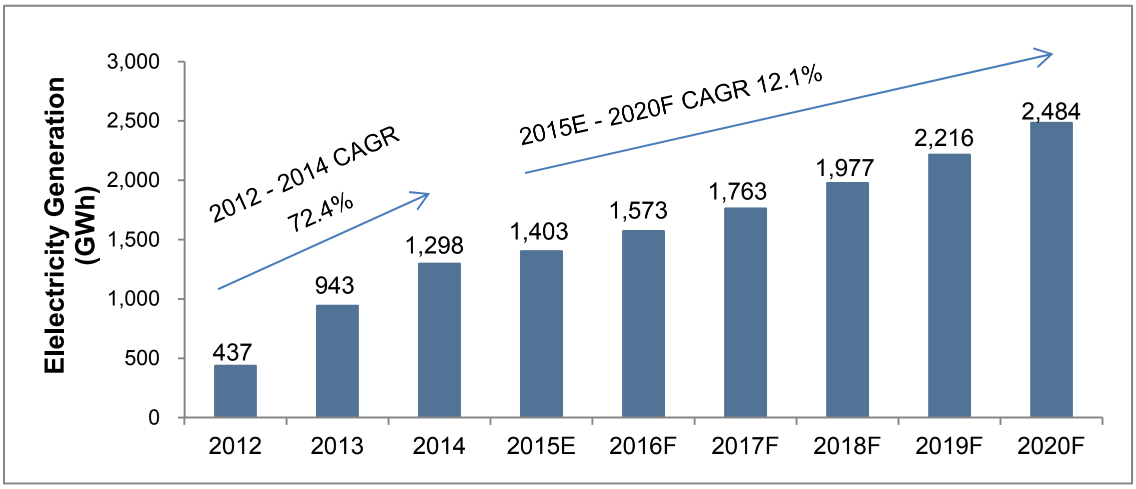
Chart 5-14: Historical and Projected Share of Electricity Generation (GWh) from Renewable Sources in Thailand, 2012–2020F



Source: EPPO Statistic Database, Frost & Sullivan

The solar PV power generation in Thailand generated 437 GWh of electricity in 2012 and it grew to 1,298 GWh in 2014 at a CAGR of 72.4%. The Ministry of Energy has forecasted that electricity generated by solar PV power generation will further grow from 1,403 GWh in 2015 to 2,484 GWh in 2020 at a CAGR of 12.1%.

Chart 5-15: Historical and Projected Electricity Generation (GWh) by Solar PV Power Generation in Thailand, 2012–2020F



Source: DEDE, Ministry of Energy

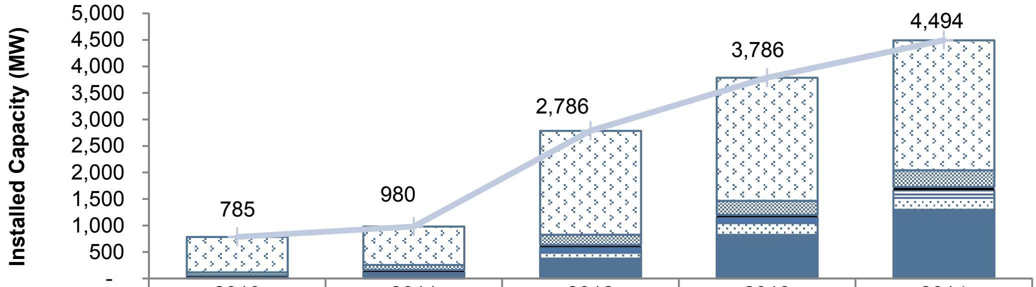
5.2.3 Supply Conditions

The overall installed capacity of renewable energy in Thailand increased from 785.0 MW in 2010 to 4,494.0 MW in 2014 at a CAGR of 54.7%. Biomass and solar PV power generation accounted for a majority 82.4% of the 3,709.0 MW of additional capacity during this period with 1,786.0 MW and 1,272.0 MW respectively.

The installed capacity of solar PV power plants increased from 377.0 MW in 2012 to 1,299.0 MW in 2014 at a CAGR of 85.6%. The Ministry of Energy through AEDP has forecasted that the installed capacity from solar PV power generation will be at 3,000.0 MW by 2021 and 6,000.0 MW by 2036[115]. The 2014 solar PV power generation capacity stood at 43.3% from the target capacity of 3,000.0 MW in 2021. In line with the AEDP, Frost & Sullivan expects that the installed capacity of solar power plants to grow from 1,500.0 MW in 2015 to 2,673.0 MW in 2020 at a CAGR of 12.2%.

[115] Source: PDP and AEDP 2015

Chart 5-16: Historical Installed Capacity (MW) of Renewable Energy in Thailand, 2010 – 2014



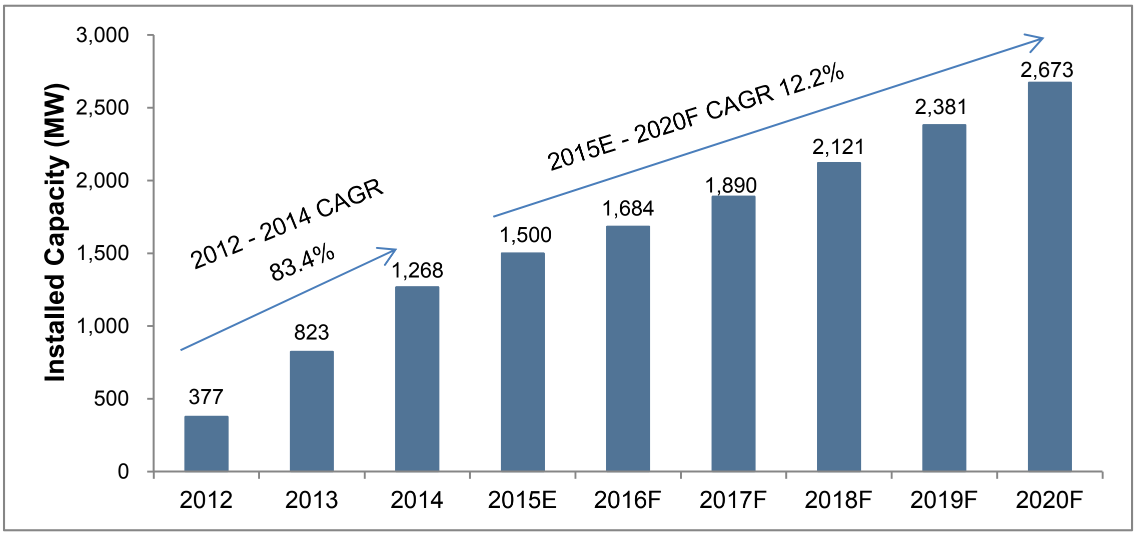
	2010	2011	2012	2013	2014
Biomass	666	725	1,960	2,321	2,452
Biogass	61	94	193	263	312
MSW	30	37	43	47	66
Mini Hydro	1	13	102	109	142
Wind	0	0	112	223	225
Solar	26	111	377	823	1,299
Total	785	980	2,786	3,786	4,494

Source: Ministry of Energy

The growth in solar PV generation capacities starting from 2012 were achieved by six strategies as outlined by the Ministry of Energy in AEDP 2012 - 2021 (Rev. 2013), which include:

1. Promoting collaboration within community scale for the production and consumption of renewable energy
2. Adjustment of the incentive scheme for private investment – Shifting from Energy Adder rates to FIT
3. Laws and regulation-implementation to benefit renewable energy, i.e. AEDP 2012 and revised to 2013 – 2021
4. Upgrade of the infrastructure including transmission line, distribution line and development towards Smart Grid System
5. Public relations and awareness for the people
6. Research and development for developing integrated renewable energy industry.

Chart 5-17: Historical and Projected Installed Capacity by Solar Power in Thailand, 2012 –2020F



Source: DEDE, Ministry of Energy and Frost & Sullivan

5.2.4 Competitive Landscape

Electricity from solar VSPPs are sold to the distribution authorities, namely the PEA and MEA. As of 2014, the solar PV power generation in Thailand is highly fragmented as there are 288 VSPPs operating in the industry[116]. The top 5 solar power producers are home-grown companies, with the largest company by effective capacity being the SPCG Public Company Limited (178.7 MW), followed by Bangchak Petroleum PCL (118.0 MW), the EGCO (94.5 MW), Thai Solar Energy Public Company Limited (48.0 MW), and Gunkul Engineering Public Company Limited (26.4 MW). EGAT currently does not own any solar power plants except for an equity stake of 45.0% in RATCH, which owns 24.0 MW of installed capacity in solar power generation as of 2014. There are two international players amongst the 10 largest solar power producers by installed capacity, namely CLP Holding (21.0 MW) from Hong Kong and Sonnedix Solar (17.0 MW) from the US. The top 10 players constitute for 550.4 MW or 42.4% of total installed capacity in 2014, while the remaining 748.1 MW or 57.6% are owned by other players and non-corporation VSPP companies, which mostly operate as rooftop solar PV power generation.

Table 5-2: List of the Top 10 Thailand Solar Power Producers by Installed Capacity, 2014

Company		No. of Plants	Effective Capacity (MW)
SPCG	SPCG Public Company Limited	36	178.7
BCP	Bangchak Petroleum PCL	8	118.0
EGCO	Electricity Generating Public	7	94.5

[116] Source: ERC, retrieved from http://www.erc.or.th/ERCSPP/

Company		No. of Plants	Effective Capacity (MW)
	Company Limited		
TSE	Thai Solar Energy Public Company Limited	10	48.0
GUNKUL	Gunkul Engineering Public Company Limited	10	26.4
RATCH	Ratchaburi Electricity Generating Holding Public Company Limited	11	24.0
CLP	CLP Holding Co, Ltd	1	21.0
Sonnedix	Sonnedix Solar (Thailand) Co., Ltd	2	17.0
IFEC	Inter Far East Engineering Public Company Limited	7	11.5
PPP	Premier Products Public Company Limited	3	11.3
Total Effective Capacity by the Top 10 Players (MW)			**550.4**
Total Installed Capacity (2014) (MW)			**1,298.5**
Capacity by Other Players and Non-Corporation VSPP Companies (MW)			**748.1**

Notes:
1. EGAT owned a 45.0% stake in RATCH.
2. Superblock Public Company Limited has been excluded as information on its capacity is not publicly available.

Source: Companies Annual Reports, Frost & Sullivan

5.2.5 Relevant Laws and Regulation

The policies for Renewable Energy in Thailand are addressed in PDP 2010-2030 (revised in 2012 and 2015), AEDP 2012–2021 (revised in 2013) and the EEDP 2011-2030. PDP is established as an umbrella to AEDP and EEDP and thus create a more comprehensive approach for integrated energy industry.

PDP 2010 - 2030 (revised in 2015)

PDP 2010-2030 (revised 2012) is prepared by EGAT as a master investment plan for power sector development where it overlays the electricity supply and the demand side in Thailand. PDP 2015-2036, approved in May 2015, is executed based on three strategies: energy security, revision on the electricity price and reduction of CO_2 emissions by promoting renewable energy. The key takeaways regarding support for renewable energy consumption by 2036 include:

1. A target of total installed capacity set to reach 70,410.0 MW, out of which 57,400.0 MW covers biomass, clean coal, nuclear and imported in order to reduce reliance on natural gas source.
2. An upgrade of transmission system and implementation of smart grid technologies to support renewable energy generation.
3. Aim to reduce carbon emissions by promoting electricity from renewable energy – from 133,539 kiloton by 2030 (in PDP 2010) to 104,075 kiloton by 2036 (in PDP 2015).

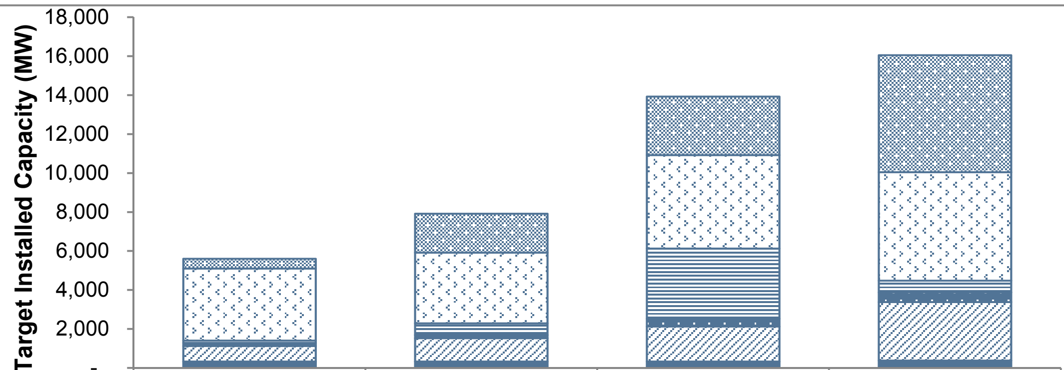
AEDP 2012 - 2021 (revised in 2013 and 2015 - Draft)

AEDP was developed by DEDE under the Ministry of Energy to conform to PDP. In 2008, the 15-year REDP 2008 - 2022 was introduced, as the first policy in alternative and renewable energy. In 2012, NEPC approved a 10-year AEDP 2012-2021 to replace REDP. In commitment to a low-carbon society, 15-year AEDP 2012-2021 targets for solar PV installation capacity of 2,000 MW. In 2013, the NEPC revised AEDP 2012 to increase Thailand's capacity in renewable energy overall. Additional solar PV capacity of 1,000 MW was added to a total of 3,000 MW. As of August 2015, a revision of AEDP 2012 is currently being drafted and reviewed by NEPC. Under the revised draft, the total renewable energy target capacity has increased approximately 1.2 times higher than in the previous AEDP. The key takeaways of the draft AEDP 2015–2036 relating to support for renewable energy by 2036 include:

1. Priority on power generation from waste, biomass and biogas, to benefit both farmers and community.
2. Additional installed capacity of renewable energy generation.
3. Promotion of electricity generation from solar and wind if the investment cost will be able to compete with electricity generation using natural gas.
4. Community energy production will be encouraged to reduce fossil fuel consumption.
5. Renewable consumption will increase from 8.0% to 20.0% in 2036.
6. Competitive bidding to be employed in the selection process for FIT application.

Based on REDP 2008, solar capacity was targeted to reach 500.0 MW by 2022 and later was revised to reach a capacity of 3,000.0 MW by 2021. The draft AEDP 2015 sets solar power at an installed capacity of 6,000.0 MW by 2036. The chronology of the targets for renewable energy is summarized in Chart 5-7.

Chart 5-18: Thailand Renewable Energy Target Installed Capacity (AEDP 2008 – 2036)



	REDP 2008 - 2022	AEDP 2012 - 2021	AEDP 2013 - 2021	AEDP 2015 -2036 (DRAFT)
Solar	500	2,000	3,000	6,000
Biomass	3,700	3,630	4,800	5,570
Biogas	120	600	3,600	600
Waste	160	160	400	500
Wind	800	1,200	1,800	3,002
Small Hydro	324	324	324	376
Total	5,604	7,914	13,924	16,048

Source: DEDE, Ministry of Energy

EEDP 2011-2030 (rev. 2015 – Draft)

EEDP 2010-2030 was developed by EPPO under the Ministry of Energy to conform to PDP. It targets to reduce energy intensity by 25.0% compare to 2005, or equivalent to reduction of final energy consumption by 20.0% in 2030, or about 30,000 thousand tonnes of ktoe. EEDP (rev. 2015) currently being drafted and reviewed targets to reduce energy intensity by 30.0% in 2036. In term of economic sectors energy savings are set to be: industrial (22.0%), commercial and Governmental (34.0%), residential (8.0%) and transport (46.0%) by 2036. It also aims to reduce CO_2 emission of 7.0% by 2036 in transport sector as pledged to United Nations Framework Convention on Climate Change (**"UNFCC"**).

PDP 2015, AEDP 2015 and EEDP 2015 assume GDP growth of 3.8% and population growth of 0.03% for the forecasting. Another important policy to shape renewable energy development in Thailand is Climate Change Master Plan ("**CCMP**") 2012-2050. The CCMP was developed by the Office of Climate Change Coordination and the Office of Natural Resources and Environmental Policy and Planning, both under the Ministry of Environment.

Renewable Energy Support: FIT to replace Adder Tariff

Adder scheme was introduced in 2007 for solar energy to support the development of solar power generation to meet the target of 20.0% of total energy consumption by 2022 (REDP). It is also known as the "premium-price FiT", whereby utility companies pay power producers a base tariff, wholesale fuel prices as well as an additional price component differentiated by technology, installed capacity and geography for every unit of electricity produced. For instance, some southernmost provinces which experienced political unrest command higher additional component compared to the rest. The Adder Tariff for solar PV power generation started at a lucrative 8 Baht/kWh for solar power generation for a support period of 10 years. This led to speculators applying for the Adder Scheme without any real intention to develop the power plants. In two and a half years since the Adder scheme was introduced, there were a total of 1,620.0 MW worth of contracts for Solar PV power generation being signed but only 6.8 MW being materialised[117]. This led to the Government of Thailand to reduce the Adder Tariff for Solar PV generation to 6.5 Baht/kWh in 2010.

In 2014, NEPC replaced Adder with FiT, in which a fixed amount per kWh is paid during the life of the PPA for a support period of 25 years. The support of 25 years fixed payment is also more attractive in terms of project feasibility as the financial certainty is more than twice as long as the 10 years support period under the Adder Scheme. The FiT rate also favours smaller projects, for instance, the FiT rate for rooftop solar is 6.85 Bath/kWh for plants with less than 10.0 kW in capacity, 6.40 Bath/kWh for plants between 10.0 kW and 250.0 kW in capacity, and 6.01 Bath/kWh for plants between 250.0 kW and 1.0 MW in capacity. This is in line with the Government direction to promote renewable energy in the communities. It also corresponds with the guidelines for AEDP 2015-2036, which would focus on waste energy, biomass and biogas as a priority. The NEPC has also announced that applications for VSPP PPAs should take place using a new Competitive Bidding Method by 2014. The distributing authorities will no longer issue PPA to power producers generating less than 10.0 MW (VSPPs) and instead issue PPA based on the ERC's FiT subsidy program.

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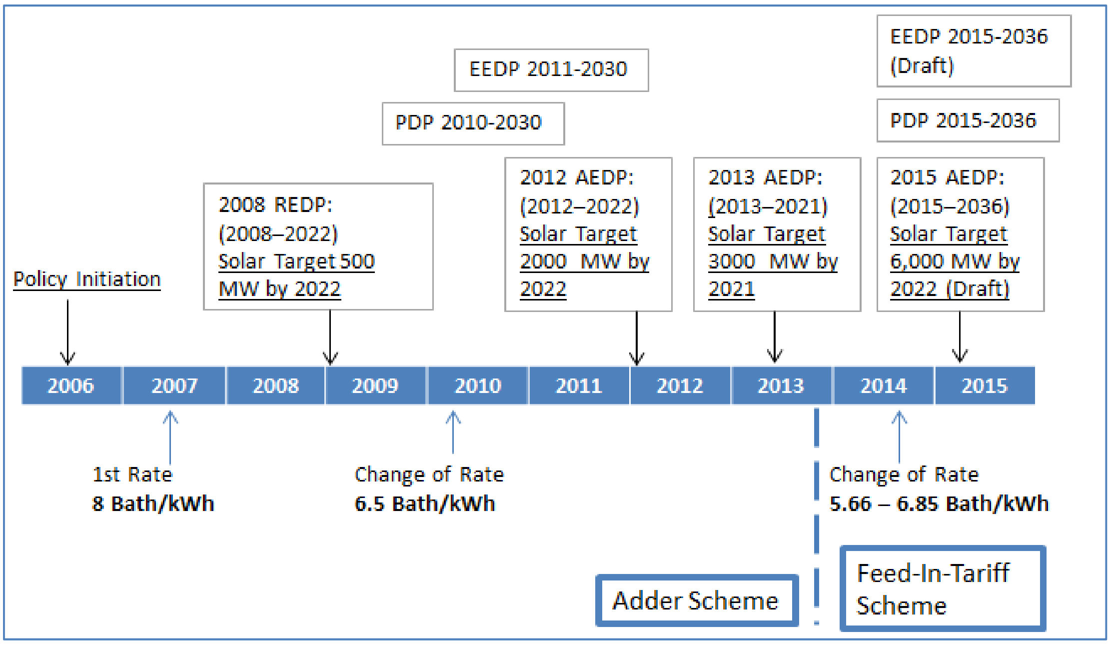
[117] Publication by WRI-ADB Workshop on Feed-in Tariffs titled "Thailand's Renewable Energy Policy: FiTs and Opportunities for International Support"

The PPA under the FiT regime is monitored by ERC under applicable rules and regulations. Other regulations that apply on renewable energy or solar include regulations by EGAT/PEA/MEA stipulated since 2007 for purchase of power from SPPs and VSPPs.

The evolution of Thailand solar power policies and other renewable energy supports developed are illustrated in Figure 5-5.

Figure 5-5: Evolution of Thailand's Solar Policy and Support Schemes



Source: DEDE, Ministry of Energy

5.2.6 Prospects and Outlook

Solar power generation market in Thailand has undergone positive development since the introduction of the new FiT tariff and the revised Renewable Energy Policies beginning 2013. The year 2013 represented a turning point for Thailand's solar PV policy and its future plans for lower carbon emissions. It was also a starting point for the private sector and the Government to continuously improve solar PV adoption through policy setting and regulatory enforcements. The Government also launched a FiT tariff to replace the Adder tariff for solar PV and to stimulate the rooftop solar market. The Ministry of Energy has also designed a Solar PV Roadmap Initiative to provide a platform for the promotion of solar energy in Thailand.

Frost & Sullivan estimates that electricity consumption in Thailand will register a higher growth at a CAGR of 4.8% between 2015 and 2020 from 177,598 GWh in 2015 to 224,492 GWh in 2020 and is subjected to the variations with different economic and climatic outlook during the forecast period. According to PDP 2015, there will be a strong improvement in the share of renewable energy as source of electricity generation, from 6.5% or 12,405 GWh in 2015 to 14.8% or 33,805 GWh in 2020 with a CAGR of 22.2%.

In 2014, installed capacity of solar power plants for electricity generation stood at 1,298.5 MW or 43.3% of the target capacity of 3,000.0 MW in 2021. Electricity generation from solar PV power generation in Thailand is forecasted to grow at a CAGR of 12.1% from 1,403 GWh in 2015 to 2,484 GWh in 2020. Correspondingly, the power generation industry is expected to grow simultaneously and supplemented by renewable energy generation to meet the expected targets outlined in PDP 2015 - 2036. Frost & Sullivan expects the installed capacity of solar power plants to grow at a CAGR of 12.2% from 1,500.0 MW in 2015 to 2,673.0 MW in 2020 at a CAGR of 12.2%, which is in line with AEDP's target of 3,000.0 MW by 2021. This target will further support Thailand's goal of 25% of renewable energy capacity as stipulated in AEDP by 2021. Meanwhile, the growth of solar power generation beyond 2021 is also expected to be healthy as the revised AEDP 2015 (draft) has outlined the target of installed capacity of solar power plant to reach 6,000.0 MW by 2036 with the strategies to continue promoting renewable energy.

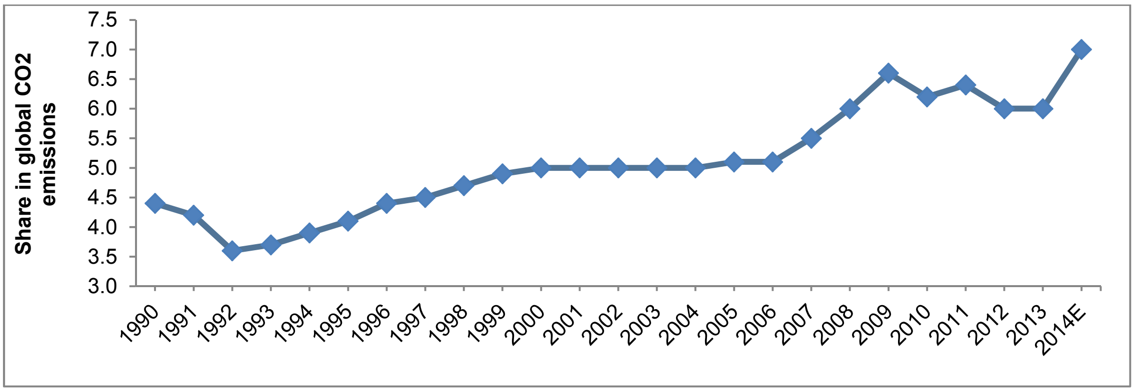
5.3 OVERVIEW OF RENEWABLES AND SOLAR POWER GENERATION IN INDIA

5.3.1 Background of Solar Power Generation Industry

India's economy has been growing rapidly at an average annual GDP growth rate of approximately 6.4% from 2008 to 2014, making it the seventh largest economy in the world. According to the IMF's projection[118], India's GDP is expected to grow averaging at 7.6% from 2015 to 2020, surpassing China as the world fastest growing economy. At the same time, India's population has grown at CAGR of 1.4% from 1.2 billion in 2008 to 1.3 billion in 2014 and is projected to reach 1.3 billion by 2018[119]. At its current population growth trend, the UN predicts India to surpass China to become the world's most populous country by 2028.

With rapid economic growth in terms of GDP coupled with the coal dependent power generation infrastructure, India's share of global CO_2 emissions has increased from 4.2% in 1990 to 6.4% in 2011. Thermal power generation contributed to 43.0% of India's approximately 2.0 billion tonnes of CO_2 emissions followed by coal fuelled manufacturing contribution to CO_2 emissions at 17.0%[120] in 2013. As of 2014, India remains the third largest CO_2 emitter in the world since 2008 after China and USA[121].

Chart 5-19: India's Global Share (%) of CO_2 Emission, 1990-2014E



Source: UN and International Global Biosphere Program

As of 2014, the total installed capacity and total electricity generated in India was 233,930.0 MW and 1,104,039 GWh[122] respectively. Electricity generation in India is predominantly thermal, with coal contributing the lion's share of 75.6% while gas and diesel only account for 3.8% in 2014. This is followed by hydro (11.7%), renewables (5.6%) and nuclear (3.3%).

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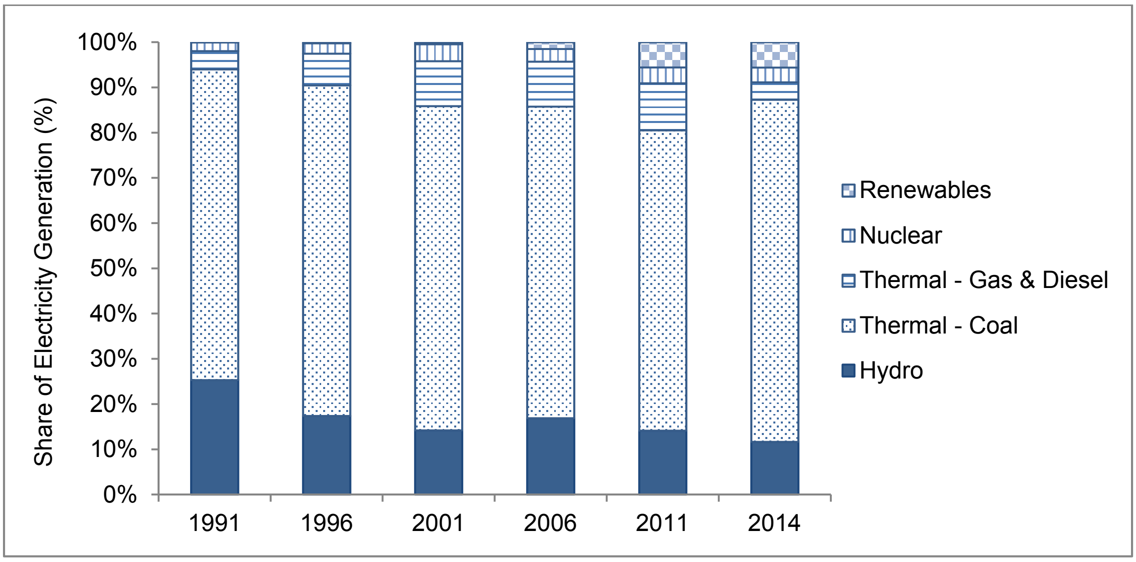
118 IMF, World Economic Outlook (WEO), April 2015
119 IMF, World Economic Outlook Database July 2014
120 IEA, 2014
121 International Global Biosphere Program (2014)
122 CEA, Growth of Electricity Sector in India 1947-2015

Chart 5-20 : Share of Electricity Generation by Source (%) in India, 1991–2014



Source: Central Electricity Authority, Frost & Sullivan Analysis

The dependence on conventional power generation sources exposes India to energy security concerns. While costs of generation from conventional sources have remained competitive in the past decade up to 2014, it is likely to increase over time and use of conventional sources of fuel, such as coal has detrimental environmental impact. To reduce carbon emissions, the Government of India formulated the National Action Plan on Climate Change ("**NAPCC**") in June 2008 to mandate renewable energy purchases to account for 5.0% of total consumption for 2009 and 2010 with an incremental of 1.0% for the subsequent decade up to 2020. The NAPCC essentially envisages renewables, particularly solar, to account for 15.0% of the total generation mix, equivalent to about 35,700.0 MW by 2020.

Furthermore, increasingly limited availability of these sources prompted the Government of India to develop a stable and indigenous alternative for power generation. Given that India has vast commercially-viable renewable energy potential estimated at 895.0 GW of which 750.0 GW are of solar power potential[123], the Government of India is banking on the significant potential of renewables not just to boost energy security but also to jumpstart its economy with the launch of the Jawaharlal Nehru National Solar Mission ("**JNNSM**") in January 2010.

The objectives of JNNSM go beyond securing renewables generation – it strategically aims to develop domestic knowhow through research and development and secure domestic production of critical raw materials and components which ultimately reduce costs and improve scalability of solar power deployment. In essence, the JNNSM is formulated with the intent to make India a global leader in solar power technology which involves three major phases of development towards a target of 20,000.0 MW grid-connected solar power installations by 2022. In June 2015, the target was scaled upwards to achieve 60,000.0 MW grid-connected power installations by 2022[124].

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[123] India RE-Invest Conference 2015, Investor Guide

[124] Known as the Solar Scale-up Plan, it envisage for total installed capacity for solar power to reach 100.0GW by 2022, inclusive of 40GW off-grid rooftop solar power.

Table 5-3: Development Phases of JNNSM, 2008-2022

Phase	Year	Capacity Target (MW)	Installed Capacity (MW)
1	2009 - 2013	1,000.0 - 2,000.0	1,686.0 (by 2013)
2	2014 - 2016	4,000.0 - 10,000.0	2,632.0 (by 2014)
3	2017 - 2022	20,000.0	-

Source: JSNNM (2008)

As of 2014, India's total installed power capacity stood at 271,722.0 MW. As renewables account for 13.2% or 35,777.0 MW of total installed capacity, it is currently on track to meet the NAPPC's target of 15%. Wind power command the lion's share of renewables with 65.5% or 23,444.0 MW in 2014, followed by Waste-to-Energy at 4,534.0 MW (12.7%), Small Hydro at 4,055.0 MW (11.3%) and Solar at 3,744.0 MW (10.5%).

Industry Structure and Value Chain

The Ministry of New and Renewable Energy ("**MNRE**") is the nodal agency at the central level for promoting grid-connected and off-grid renewable energy in the country. The formulation of JNNSM by the MNRE in 2008, which advances the creation of solar parks, has led to the establishment of State Renewable Agencies. Over the years, these nodal agencies at the state level have developed considerable knowledge and experience in planning and implementation of RE programmes. The subsequent formulation of the Strategic Plan for New and Renewable Energy Sector 2011 - 2017 by the MNRE further positioned renewable energy as the main strategic thrust towards energy security.

The Indian Renewable Energy Development Agency Ltd ("**IREDA**") and Solar Energy Corporation of India ("**SECI**") are two major schemes under the purview of MNRE. IREDA provides financial support for electricity generation projects from renewable energy while SECI assist with the development, and implementation of JNNSM.

Table 5-4: Key Players in the Indian Renewable Energy & Solar Industry

Role	Key Players
Policymakers	Ministry of New and Renewable Energy (MNRE)
	Ministry of Power (MOP)
	Indian Renewable Energy Development Agency (IREDA)
	State Renewable Development Agencies (SNA)
Regulators	Central Electricity Authority (CEA)
	Central Electricity Regulatory Commission (CERC)
	State Electricity Regulatory Commission (SERC)
Implementation Agency	Solar Energy Corporation of India (SECI)
	National Thermal Power Corporation Vidyut Vyapar Nigam (NVVN)
Financiers	World Bank
	ADB
R&D	National Institute of Solar Energy (NISE)

Role	Key Players
	National Centre for Photovoltaic Research and Education (NCPRE)
Association	Association of Renewable Energy Agencies of States (AREAS)
	Solar Energy Society of India (SESI)
	Indian Solar Manufacturers Association (ISMA

Source: Council on Energy, Environment and Water India, National Resources Defense Council & Frost & Sullivan

The Ministry of Power ("**MOP**") oversees the policy of the electric power sector, working in parallel with MNRE for solar generation capacity. Both National Thermal Power Corporation which is the appointed company under MOP and Vidyut Viyapar Nigam Ltd ("**NVVN**") being a SOE are responsible for facilitating power trading - to achieve optimum power generation. NVVN will sign PPA with the power utilities for the purchase of solar power from the project developers and Power Sale Agreement with the distribution companies or other utilities.

The Central Electricity Agency ("**CEA**") assists the Government with the formulation of National Electricity Policy ("**NEP**"), short and long-term implementation plans as well as technical support provision for grid-connectivity. The State or Central Electricity Regulatory Commission ("**SERC**" and "**CERC**") are the Government or state advisories in promoting competition and investment in order to increase electricity supply, besides assist in the formulation of NEP and National Tariff Policy ("**NTP**").

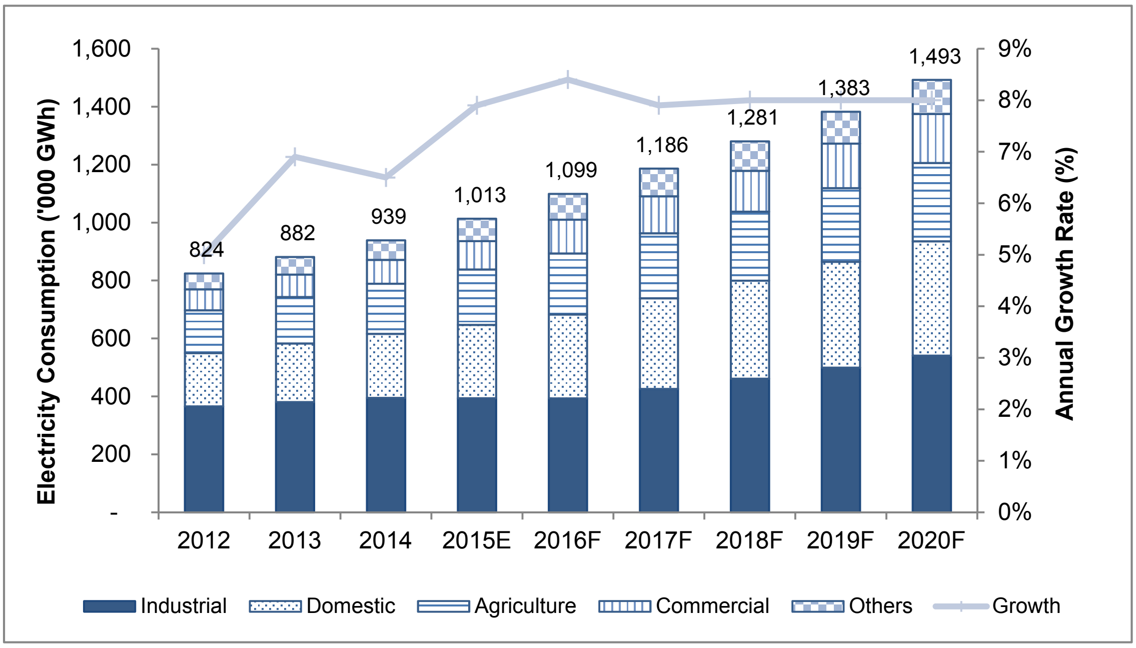
5.3.2 Demand Conditions

Total electricity consumption in India was estimated at 938,823 GWh in 2014, which represents a CAGR of 6.7% from 2012, when electricity consumption was recorded at 824,301 GWh. Frost & Sullivan expects the electricity consumption will increase further at a CAGR of 8.1% from 2015 to 2020 when the electricity consumption is estimated to reach 1,492,747 GWh in 2020.

The peak demand in India increased from 135.5 GW in 2012 to 148.2 GW in 2014, registering a CAGR of 4.6%, according to the Central Electricity Authority of India. The rise in peak demand was driven by population and economic growth in the country. The peak demand is forecasted by the CEA to continue to grow at a CAGR of 9.7% to reach 283.5 GW by 2021[125].

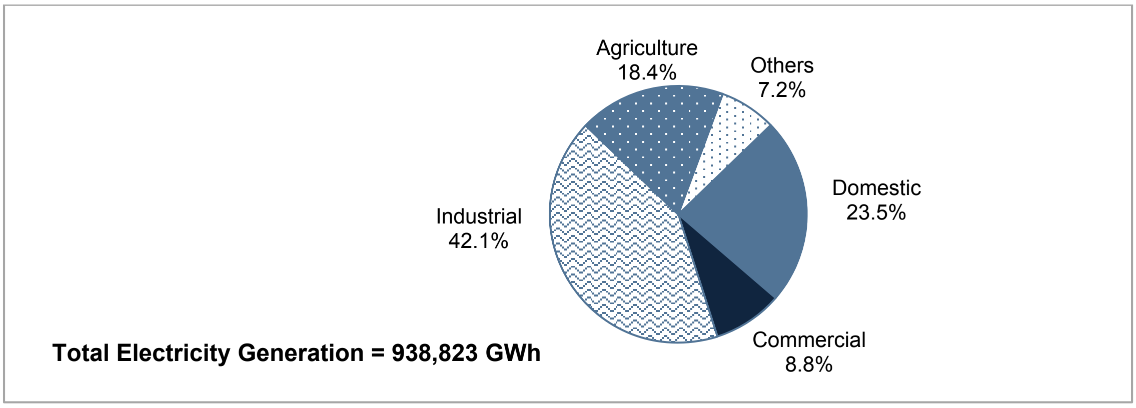
[125] CEA, Perspective Transmission Plan for Twenty Years (2014 - 2034)

Chart 5-21: Electricity Consumption (Thousands GWh) By Segment and Annual Growth Rate (%) in India, 2012 - 2020F



Source: CEA, Frost & Sullivan Analysis

Chart 5-22: Share of Electricity Consumption (%) by Segments in India, 2014



Note: Others include Traction, Public Lighting, Public Water Works, Sewage Pumping, etc.
Source: CEA

In 2014, the industrial sector accounts for the majority of the power demand in India with 42.1% of market share, followed by domestic (23.5%), agriculture (18.4%) and commercial (8.8%). Other sectors, including railways and public amenities consumption, accounted for the remaining 7.2%. With the Government of India's focus on the manufacturing industry over the next 10 years, the industrial sector is likely to continue to account for the majority of power demand. Demand from the residential sector is also set to increase with the development of rural electrification programmes and the increasingly affluent population.

Growing manufacturing sector

The manufacturing sector accounts for approximately 12.9% of India's GDP in 2013[126]. The Government of India plans to invest in the sector in order to raise the share of manufacturing to 25.0% by 2020. To achieve this goal, the Government is planning to develop four 'industrial corridors' to set up new industrial cities[127], which include:

- The Delhi-Mumbai Industrial Corridor;
- The Amritsar-Kolkata Industrial Corridor;
- The Bengaluru-Mumbai Industrial Corridor; and
- The Chennai-Bengaluru Industrial Corridor.

These industrial corridors are in various stages of development but are expected to be a major driver for demand of electricity in India over the next five to six years. The continuous increasing size of India's service sector is also likely to drive demand.

Increasing urbanisation

Although the number of cities or towns in India has increased by over 50.0% in the last 10 years, the urbanisation rate in the country still remained relatively low at 32.0% as of 2014[128]. The urbanisation rate is likely to continue to increase, as domestic migration from rural areas to cities in search of better opportunities is expected to continue. India is forecasted to reach an urbanisation rate of 50.0% by 2050. More importantly, spatial expansion of cities is likely to create the formation of three mega cities (large cities with minimum 8.0 million population and GDP of US$250 billion), four mega regions (minimum 15.0 million population) and eight mega corridors (combination of mega regions of 60km or more apart with minimum population of 25.0 million) by 2025[129].

As such, India is expected to invest heavily in infrastructure and connectivity. Private investments in infrastructure projects are also expected to rise as the Government focuses on creating conducive environment to nurture more PPPs. The IMF forecasts that India's GDP will grow at an average of 7.6% annually from 2015 to 2020. Thus, Frost & Sullivan believes that increased industrial activities, such as infrastructure projects and robust economic growth are likely to be the main driver for the growth in electricity consumption in India.

Rural electrification

The Government is determined to advance rural electrification with the laying of transmission lines in rural areas and seeking to make electricity available to an increased number of consumers which drives the demand for electricity. According to the CEA, 96.7% of villages throughout the country have access to electricity as of May 2015[130].

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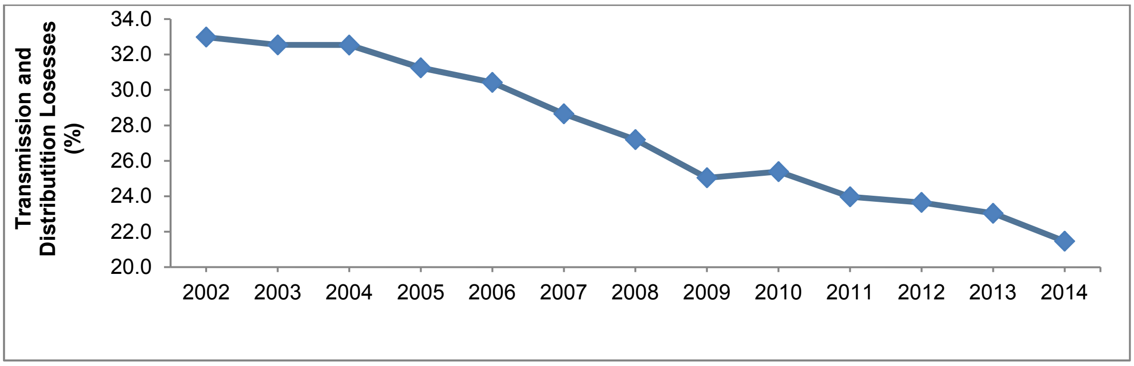
[126] Planning commission, Government of India - December 2014.
[127] Department of Industrial Policy & Promotion Ministry of Commerce & Industry, GOI
[128] UN' World Urbanisation Prospects 2014
[129] Frost & Sullivan Market Insights on Mega Trends Underlying India's Emerging Dominance
[130] CEA defines electrification as at least 10% of the total number of households in the village is electrified along with supply of electricity to public services such as schools, community centers and health centers.

5.3.3 Supply Conditions

The strategic shift and determination towards renewables by the Government of India is in part due to the inherent challenges facing the country's power generation industry. Despite years of ambitious capacity addition initiatives, India has yet able to provide universal and reliable access to electricity for its population. In reality, the available capacity[131] of thermal installed capacity has gradually declined from nearly 80.0% in 2008[132] to about 60.0% by July 2015[133]. Fuel shortages and high T&D losses are major reasons causing India to suffer from frequent deficits in electricity supply. In 2014, peak electricity demand in India was 148.2 GW while available capacity stood at 141.2 GW, resulting in a shortage in electricity supply with a supply–demand gap of approximately 7.0 GW[134].

Chart 5-23: Trend in India's T&D Losses (%), 2000-2014



Source: CEA

In response to these impediments, the Government of India aggressively leveraging on renewables to decentralise its electricity supply[135]. Deployment of renewables particularly solar technology to date has been successful in extending electricity and energy reach to its population through multiple applications of on-site off-grid installation (for homes and street lightings[136]) and utility-scale grid-connected solar and wind farming[137].

Thus, the Government of India aims to reduce the reliance on fossil fuel based power generation by augmenting renewables to improve energy security. India has augmented about 48.4 GW of additional total power generation capacity between 2012 and 2014. Based on the target capacity increase under India's 12th and 13th Five-Year Plan (ending in 2017 and 2022 respectively), the total installed capacity is projected to increase at a CAGR of 6.3% from 283.8 GW in 2015 to 385.0 GW by 2020. During this period, nuclear and renewable sources will contribute the largest growth in new installed capacity at a CAGR of 20.8% and 11.0% respectively.

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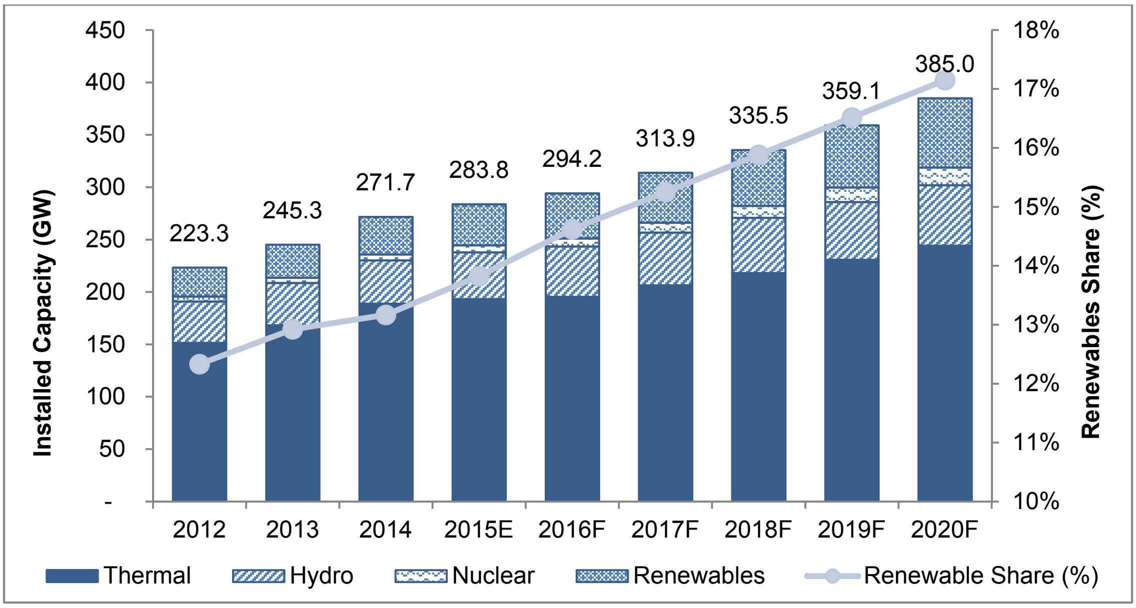
[131] Based on the plant load factor which is the ratio of actual output to its potential output over time
[132] CEA, Growth of Electricity Sector in India 1947-2015
[133] CEA, Executive Summary July 2015
[134] CEA, Growth of Electricity Sector in India 1947-2015
[135] Ministry of New and Renewable Energy, Strategic Plan for New and Renewable Energy Sector 2011-2017
[136] Under Remote Village Electrification programme
[137] Under the JNNSM policy.

Installed capacity of thermal power and its share of the total installed capacity is expected to decline from 192.0 GW or 68.6% in 2015 to 244.3 GW or 63.5% by 2020. During the same period, installed capacity and share of renewable energy is expected to grow from 39.2 GW or 12.9% to 66.0 GW or 17.2% of the installed capacity. Meanwhile, there will be additional capacity of 10.4 GW for nuclear and 13.0 GW hydropower during 2015 to 2020, which will boost its share of total installed capacity to 3.9% and 15.3% respectively.

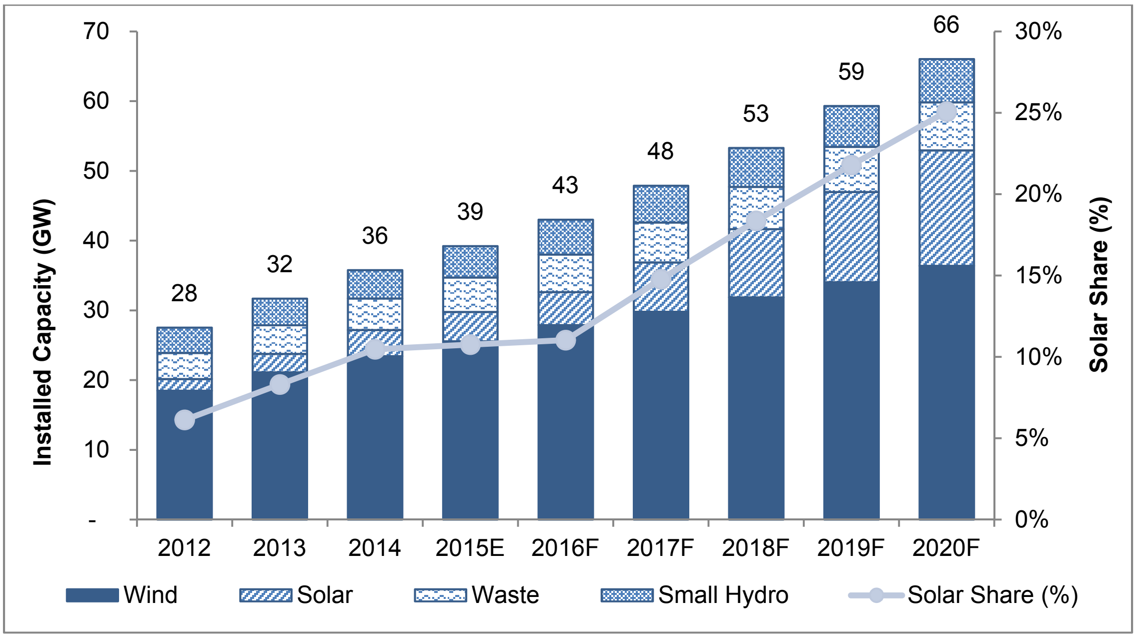
Between 2015 and 2020, solar power alone will increase tenfold from 1.7 GW to 16.6 GW, contributing the largest growth in new installed capacity of renewables. This will result in increasing share of solar power among renewables, from 6.1% in 2015 to 25.1% by 2020. The additional capacity has also been driven by the innovative renewable energy policies or schemes at state or central levels on the optimal utilization of renewable energy sources and tariff regulations. This also includes the launched of the first model of Solar Parks in Gujarat and Rajasthan in 2010 - 2012.

Chart 5-24: Installed Capacity (GW) by Source and Share of Renewables (%) in India, 2012 – 2020F



Note: Thermal includes coal, gas and diesel.
Source: CEA, Frost & Sullivan Analysis

Chart 5-25: Installed Capacity (GW) and Share of Solar Power (%) and Renewables in India, 2012–2020F



Source: CEA, Frost & Sullivan Analysis

Development of Solar Parks and Ultra Mega Solar Power Projects

In September 2014, the MNRE released a draft scheme for the development of 25 Solar Parks and Ultra Mega Solar Power Projects across the country targeting 20,000.0 MW by 2022. SECI would be MNRE's agency for handling this scheme. The scheme is modelled after the success of Charanka Solar Park in Gujarat in 2010 - 2012. Under the scheme, developers would be invited after all statuary approvals are completed.

The parks will be readily equipped with transmission lines and additional infrastructure, such as access roads, water and communication facilities required for operations. States and private companies have the flexibility to choose their agency for implementing, developing and maintaining the solar parks. In 2014, the MNRE has also announced a plan for five Ultra Mega Solar Projects to be built in the wastelands of Rajasthan (7.0 MW), Gujarat (4.0 MW) and Ladakh region (7.0 MW).

Table 5-5: Proposed Solar Parks in Phase II and III of JNNSM

No.	Region	Cumulative Capacity (MW)
1	Gujarat	700.0
2	Andra Pradesh	2,500.0
3	Uttar Pradesh	600.0
4	Meghalaya	20.0
5	Rajasthan	2,680.0
6	Madhya Pradesh	1,500.0

No.	Region	Cumulative Capacity (MW)
7	Karnataka	2,000.0
8	Tamil Nadu	500.0
9	Punjab	1,000.0
10	Telangana	1,000.0
11	Kerala	200.0
12	Uttarakhand	39.0
	Total	12,739.0

Source: JSNNM Guidelines and MNRE

Development of Solar Cities

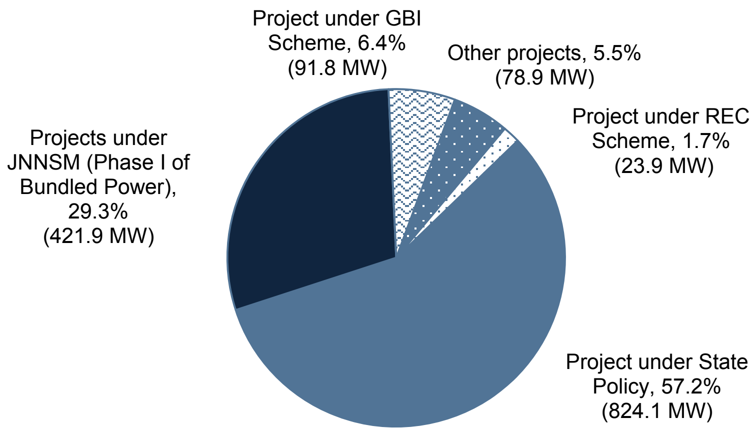
Besides Solar Parks, MNRE would also focus on the addition of the Solar Cities programme as outlined by Phase II of JNNSM. This programme will assist Urban Local Government aiming at a minimum of 10.0% reduction in the demand of conventional energy at the end of five years between 2014 and 2019, which can be achieved through a combination of energy efficiency and supply addition from renewable energy sources. A total of 60 cities with population varies between 5 to 25 million) were proposed to be supported for the development in 2012. 46 cities have been sanctioned, of which the master plans of 39 cities have been finalised by end of 2014.

5.3.4 Competitive Landscape

The installed capacity of solar operators released by MNRE is based on project and states for 2013, which correspond with the predetermined target of Phase I of the JNNSM. As of March 2013, 1,440.6 MW of solar power were installed across the 19 states. Project-wise, 824.1 MW were installed under state policy, 421.9 MW under JNNSM (Phase I), 91.8 MW under the Generation-Based Incentives ("**GBI**") scheme and 23.9 MW under Rural Electrification Corporation ("**REC**") scheme, while 78.9 MW of other projects.

The top five states with the highest installed capacity of solar power were Gujarat with 824.1 MW, followed by Rajasthan (442.3 MW), Andhra Pradesh (23.2 MW), Tamil Nadu (17.1 MW) and Uttar Pradesh (12.4 MW).

Chart 5-26: Installed Capacity of Solar Power by Projects, March 2013



Source: Ministry of New and Renewable Energy

The following table presents the market share of India's top 10 private solar power producers in 2013 which mostly operates in Gujarat and Rajasthan. The cumulative installed capacity of the 10 largest private solar producers is 387.5 MW, which contribute to approximately 26.9% of total installed capacity for solar power in India. The remaining 73.1% were shared between 200 states and private companies with varying capacity ranging from less than 1.0 MW to 20.0 MW.

As for 2013, Azure Power is the largest solar power producer in India in 2013, with installed capacity of 57.2 MW or a market share of 3.9%.

Table 5-6: Top 10 Private Solar Producers in India, March 2013

No.	Company	State	Scheme	Installed Capacity (MW)	Market Share (%)
1	Azure Power	Gujarat, Punjab, Rajasthan	State, JNNSM	57.2	3.9
2	Reliance Power	Rajasthan, New Delhi	Open access, GBI	46.0	3.2
3	Adani Power	Gujarat	State	40.1	2.8
4	Solarfield Energy Two	Gujarat, Rajasthan	State, JNNSM	40.1	2.8
5	Welspun Energy	Andra Pradesh, Gujarat, Rajasthan	State, JNNSM	40.0	2.8
6	Lanco Solar	Gujarat, Rajasthan	State, RPSSGP	36.0	2.5
7	Green Infra Solar Energy Ltd	Gujarat, Rajasthan	State, JNNSM	35.0	2.4
8	Mahindra Group	Rajasthan	JNNSM	35.0	2.4
9	Alex Astral Power	Gujarat, Rajasthan	State, JNNSM	30.1	2.1

No.	Company	State	Scheme	Installed Capacity (MW)	Market Share (%)
	Private Limited				
10	Tata Power	Gujarat, Maharashtra	State	28.0	1.9

Source: CEA, Frost & Sullivan Analysis

5.3.5 Relevant Laws and Regulation

Relevant Acts and regulations that govern the renewable energy particularly solar power generation industry in India are presented in the table below:

Act	Details
National Renewable Energy Act (NREA) 2015	The draft published in August 2015 serves to promote the production of energy from renewable energy sources, in order to reduce dependence on fossil fuels, ensure energy security and reduce local and global pollutants, keeping in view economic, financial, social and environmental considerations.
National Electricity Policy (NEP) 2005	The Policy aims to provide the guidelines for development of power sector by 2012 in term of access to electricity, availability of power, reliability of supply, financial turnaround and commercial viability of electric sector as well as protection of consumer interest. SERC is authorized to fully utilize renewable energy for supply of electricity and explore for new and sustainable development of technologies. Under this policy, SERC prescribes the percentage for purchase of power from renewable sources, and the needs for increase in share of electricity from renewable source.
National Tariff Policy (NTP) 2006	The Policy authorizes CERC or SERC to prescribe a minimum percentage of Renewable Purchase Obligation (**"RPO"**) to be made applicable for tariff setting, taking into account the availability of such renewable resources at each state.
Renewable Purchase Obligation (RPO)	At central level, CERC sets targets for distribution companies to purchase certain percentage of their total power requirement from renewable energy producers. The NTP envisages the RPO to be at 3.0% of renewable energy from the total energy demand by 2022. At the states level, SERC specifies its own target RPO which varies between 2.0% and 14.0% of their total power requirement.
Renewable Energy Certificate (REC)	REC is being initiated to promote the use of renewable energy at the states with limited renewable energy resources while required to meet the RPO. SERC prescribes a certain volume of renewable energy to be purchased largely by industrial consumers.

Source: CEA, Frost & Sullivan Analysis

5.3.6 Prospects and Outlook

The Government of India has been ambitious in its target for renewables particularly solar as it aims grid-connected installed capacity of solar power to reach 60.0 GW by 2022. The Government of India has rolled out accommodative policies and incentives to nurture investment in renewables. In 2015, the Government of India has extended tax exemptions for up to 10 years for all the power projects which commence operations by 31 March 2017 from the recent deadline of 31 March 2015. This may have a positive impact on some of the IPP projects, which have been stalled due to financing issues and high capital upfront associated with renewables.

In addition, the existing policy allows 100.0% FDI activities in power generation projects including renewable energy without prior approval either from the Government of India or the Reserve Bank of India. All of these initiatives, along with tax incentives and generation based incentive scheme, are expected to continue to sustain international investors' interest in the power generation sector particularly of renewables and solar. These measures along with a vibrant renewable energy ecosystem make India a favourable renewable energy investment destination.

5.4 Overview of Renewables and Solar Power Generation in China

5.4.1 Background of Solar Power Generation Industry

In 2005, China introduced the Renewable Energy Law, which has become the framework for development of the renewable energy industry in the country. The law offers a range of financial incentives, including a national fund to encourage renewable energy development, discounts in loans, and preferential taxation for renewable energy projects. It also required power grid operators to purchase electricity from registered renewable energy producers. The combination of financial investments and policy incentives has encouraged the growth in both wind and solar PV power generation. Solar PV power generation in China is usually segmented into distributed solar PV power generation and concentration solar PV power generation, according to the plant's adjacency to the load centre. Distributed solar PV power generation refers to solar PV power generation that is located on or in the vicinity of premises owned by the electricity users. The electricity generated is often consumed by the users directly, with excessive power being exported to the grid and used as balancing power to compensate for fluctuations in grid frequency caused by imbalanced generation and consumption in the distribution network. On the other hand, concentration of solar PV power generation refers to large solar PV power generating facilities (often greater than 10.0 MW installed capacity) that are located on a specially allocated land and all the electricity generated is exported to the transmission network.

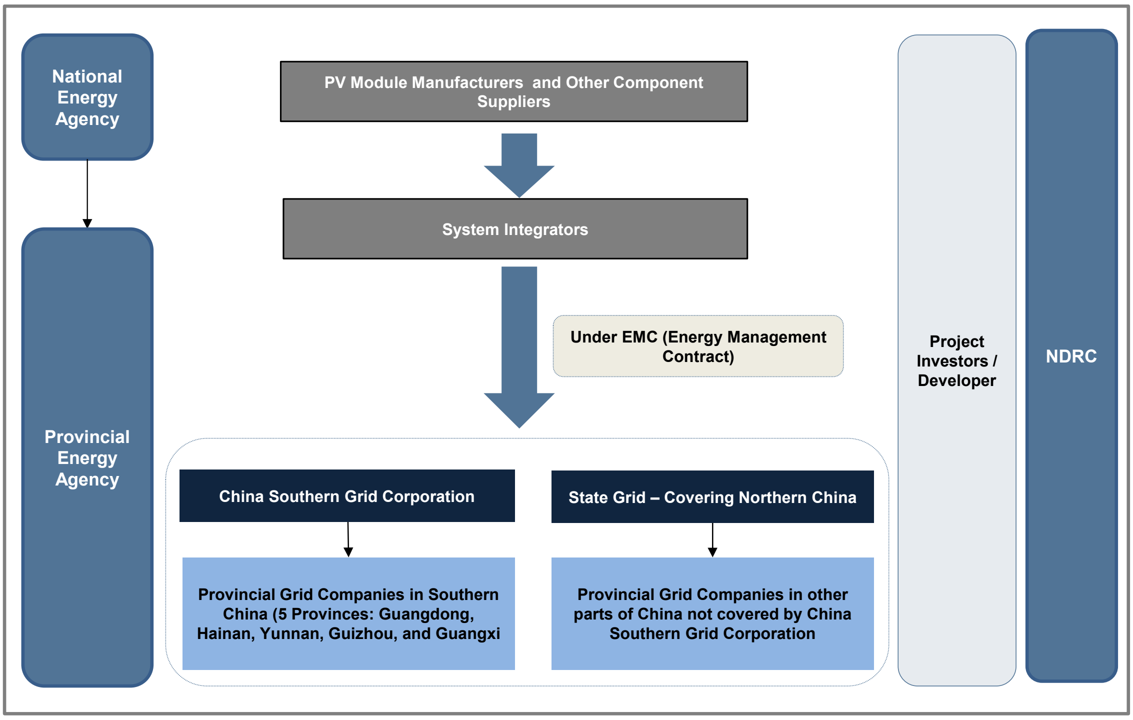
2005 and 2012, China developed a large manufacturing base for solar and wind energy equipment. In 2014, China's solar PV panel manufacturing output accounted for about 35.0% of the global output[138]. The strong capabilities in the manufacturing of solar PV panels as well as other critical components for solar PV power generation including inverters, power conditioning systems, transformers, switchgear, monitoring systems, etc. provided a sound foundation for solar PV power generation development in China.

Industry structure and value chain

All solar PV power generation projects need to be registered with the NEA and approvals are required at national and provincial levels. T&D company in the province, where the project is located, has an obligation to collaborate with the developer to develop a feasible grid-connection plan. Upon project completion, the project developers enter into an Energy Management Contract with the grid companies to sell the generated electricity to the grid. During the operational stage, the electricity generation and export data need to be reported to provincial authorities.

[138] Frost & Sullivan, 2015

Figure 5-6: Industry Structure of Solar Power Generation Industry in China



Source: Frost & Sullivan

5.4.2 Demand Conditions

China is a large country with an estimated population of more than 3 million without grid-connected electricity in 2013. The "Solution for 3-year Action Plan on Resolving Power Supply for the Grid-disconnected (2013 - 2015)" issued by the NEA in September 2013 set the target to supply power to the off-grid population. This propelled solar PV power generation to be one of the technologies that could feasibly achieve the target due to its efficiency and reliability. For instance, Zaduo County in Tibet adopted a 10.0 MW installed PV system together with an energy storage system ("**ESS**") and micro-grid to supply power to 10 counties with total population of 58,000[139] that were off-grid.

PV technology has also been experimented with in large central Government-initiated projects to test the technological viability and requirements for a large scale rollout. For instance, a project, known as the Zhangbei Wind (500.0 MW)/solar PV (100.0 MW)/ESS (16.0 MW) project, is led by China Huadian Group, owned by the State Grid company, and funded by the Central Government. It is trying to achieve a smooth output and peak shaving[140] as well as frequency adjustment on the grid by utilising the three technologies.

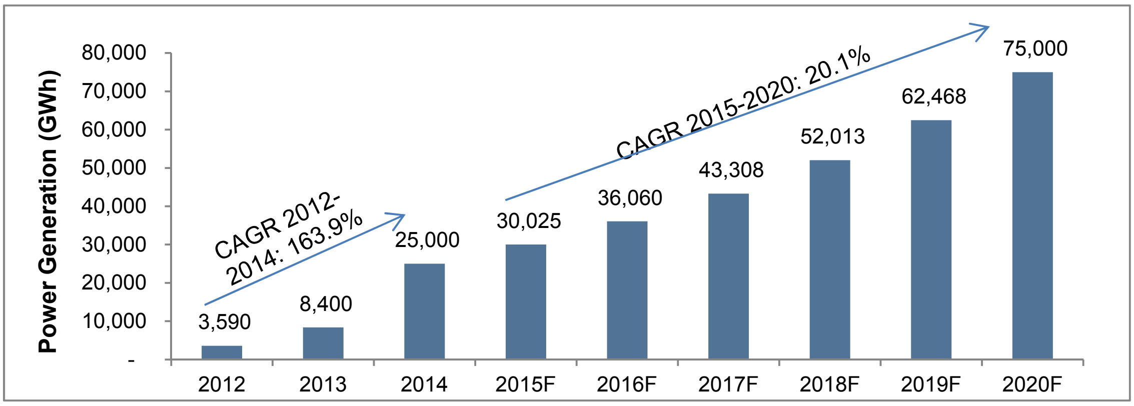
Furthermore, solar resources are abundant in the western provinces of China, such as Xinjiang, Gansu and Sichuan and these provinces are encouraged to develop the solar PV generation to be provided to eastern provinces, such as Jiangsu, Zhejiang, Beijing and Tianjiang. The

[139] China Population Statistics
[140] Peak shaving refers to the process of reducing peak demand for electricity by relying on off-grid electricity supply during peak period.

challenge of energy losses, especially in the case of long distance power transmission, has also been mitigated with the usage of super high voltage direct transmission lines[141]. Being able to efficiently transmit electricity generated by solar PV power plants in the western provinces to the eastern provinces improves the feasibility of large concentrated solar PV power projects, thereby resulting in a vast development of the solar PV generation industry in western provinces. For instance, the completion of the super high voltage direct current transmission line (±800 KW) between Hami, Xinjiang Province and Zhengzhou, Henan Province in January 2014 greatly supported the investment of renewable energy power plants, including solar PV power plants in Xinjiang province.

With the supporting factors discussed above, solar power generation in China increased almost 7 folds in 2 years from 3,590 GWh in 2012 to 25,000 GWh in 2014. Solar power generation is expected to continue to grow from 30,025 GWh in 2015 to 75,000 GWh in 2020 with a CAGR of 20.1%.

Chart 5-27: Historical and Projected Solar PV Power Generation, China, 2012 – 2020F



Source: China Statistics 2014, the State Council of China, National Climate Change Strategy (2014 - 2020), the State Council of China, 2014, Frost & Sullivan.

5.4.3 Supply Conditions

The policy that stimulated the development of solar PV installation in China was the 12th Five-year Plan of Solar Energy Development published by the NEA in 2012. This policy set the target of constructing a total of 10.0 GW solar PV concentrated power generation and 10.0 GW distributed solar PV power generation capacity each during the 12th 5-year planning period (from 2011 to 2015). To achieve this, both the National Government and Provincial Governments issued various initiatives and subsidies for both investors and operators of solar PV power plants. In September 2013, the NDRC issued the “Circulate on Leveraging Pricing Mechanism to Foster the Healthy Development of PV Power Generation”. It is stipulated that the whole nation is segmented into three regions based on the availability of solar resources with different standard on-grid-tariff are given to these three regions. The prices of electricity

[141] Referring to transmitting electricity power through direct current line that is over ±500 KVA instead of the more common alternating current systems. The key advantage of high voltage direct current transmission is the reduction of energy loss during transmission, which is paramount over long distance electricity power transmission.

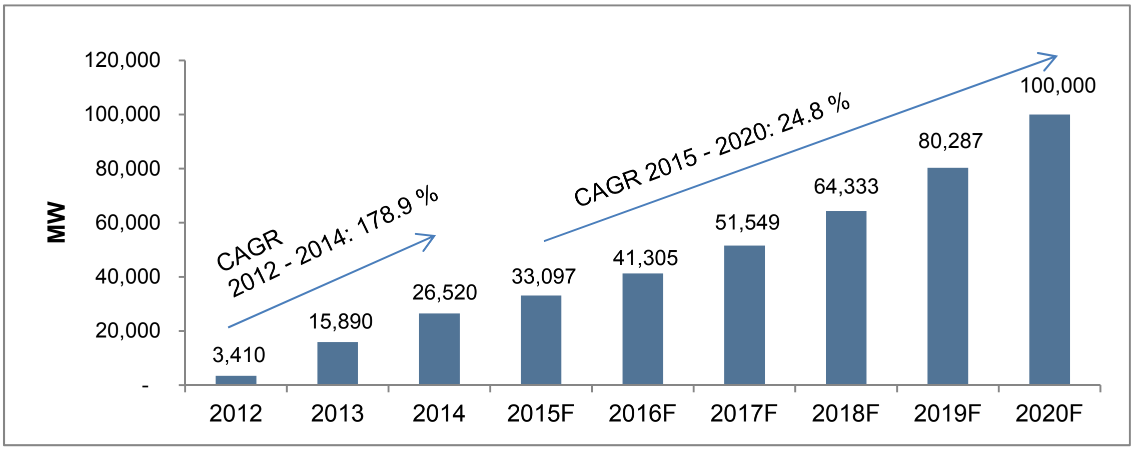
sold by producers to grid companies need to comply with the 'standard pricing mechanism[142]' to set the 'on-grid-tariff', factoring other subsidies.

On the other hand, the State Council's initiatives coined as the "Suggestions on Promoting the Healthy Development of PV Industry" and "The Temporary Administrative Measurements on PV Power Station Projects" issued in 2013 provided clarification on target setting, timeframes and procedures for the development of solar PV power generation projects and grid-connection requirements for provincial energy agencies and provincial grid companies. According to the Temporary Administrative Measurements on PV Power Station Projects, it is a requirement for state companies to revert within 60 days with feedback on new solar PV power plant grid-connection applications. In addition to the guided annual solar PV power plant target set by the state Government, provincial energy agencies are also encouraged to adopt bidding process for suitable solar PV power plant development projects under the guidance of the NEA.

In November 2013, the NEA issued a policy entitled 'Temporary Measurements in Managing the Distributed PV Power Generation Projects'. The policy greatly simplifies the approval procedure nationwide and removes requirements for supporting documents that include location selection, land pre-approval, soil and water conservation, environment impact evaluation, energy saving assessment, social risk assessment, etc. In a separate document issued by the NEA in September 2014 entitled 'Notice on Further Implementing/Executing the Policies regarding Distributed PV Power Generation Projects', the importance of distributed power generation is accentuated. In the notice, all administrative levels must expedite and simplify the Registration System for distributed solar PV power generation projects.

These policies and financial incentives have greatly encouraged the interests and participation of various parties in the solar PV power generation industry in China, thereby supporting the growth of the industry, leading to the installed capacity of solar PV power generation in China to experience exponential growth from 3,410.0 MW in 2012 to 26,520.0 MW in 2014 at a CAGR of 178.9%. The installed capacity of solar power generation in China is forecasted to further grow at a CAGR of 24.8% from 33,097.0 MW in 2015 to 100,000.0 MW in 2020.

Chart 5-28: Historical and Projected Installed Capacity of Solar PV Power Generation in China, 2012 - 2020F

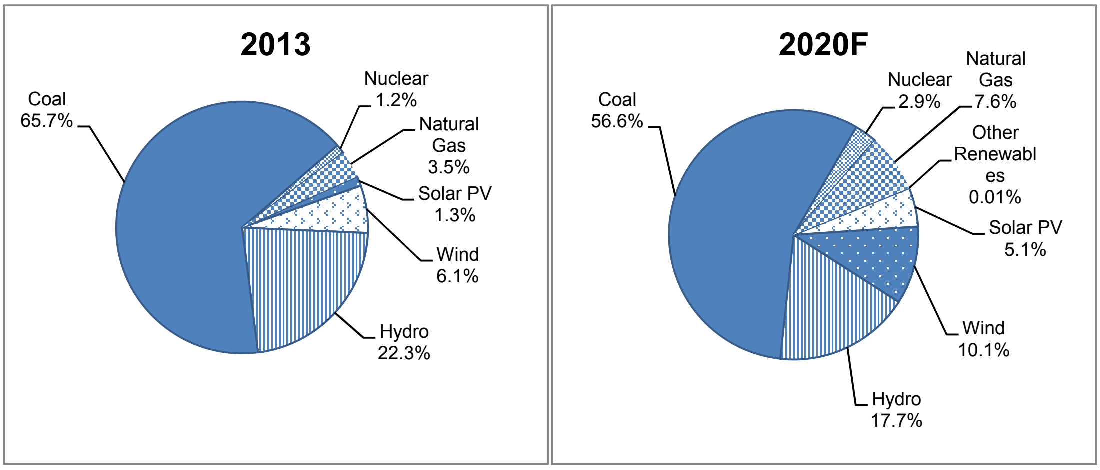


142 Standard Pricing Mechanism is a pricing mechanism of on-grid-tariff that is payable to the power generators.

Source: China National Statistics, 2014, Strategic Energy Development Plan 2014 - 2020 by Office of the State Council, November 2014, Frost & Sullivan

According to the Strategic Energy Development Plan 2014-2020 issued by the Office of the State Council in November 2014, renewable energy sources, such as wind and solar power as well as clean energy power generation for natural gas are the types of energy sources that are expected to experience the fastest growth from 2015 to 2020. In terms of China's fuel mix, coal and hydropower generation are expected to decline from 65.7% and 22.3% in 2013 to 56.6% and 17.7% in 2020 respectively. In comparison, solar PV generation is expected to grow from 1.3% of the fuel mix in 2013 to 5.1% in 2020.

Chart 5-29: Historical and Projected Installed Power Generation Capacity by Fuel Type, China, 2013 and 2020F



Note: Other renewables include geothermal, tidal and biomass and biogas
Source: Strategic Energy Development Plan 2014 - 2020 by Office of the State Council, November 2014, China Electricity Council, Frost & Sullivan

5.4.4 Competitive Landscape

As of 2014, the total installed capacity of solar PV power generation stood at 26,520.0 MW. The types of solar PV power plant operators in China include:

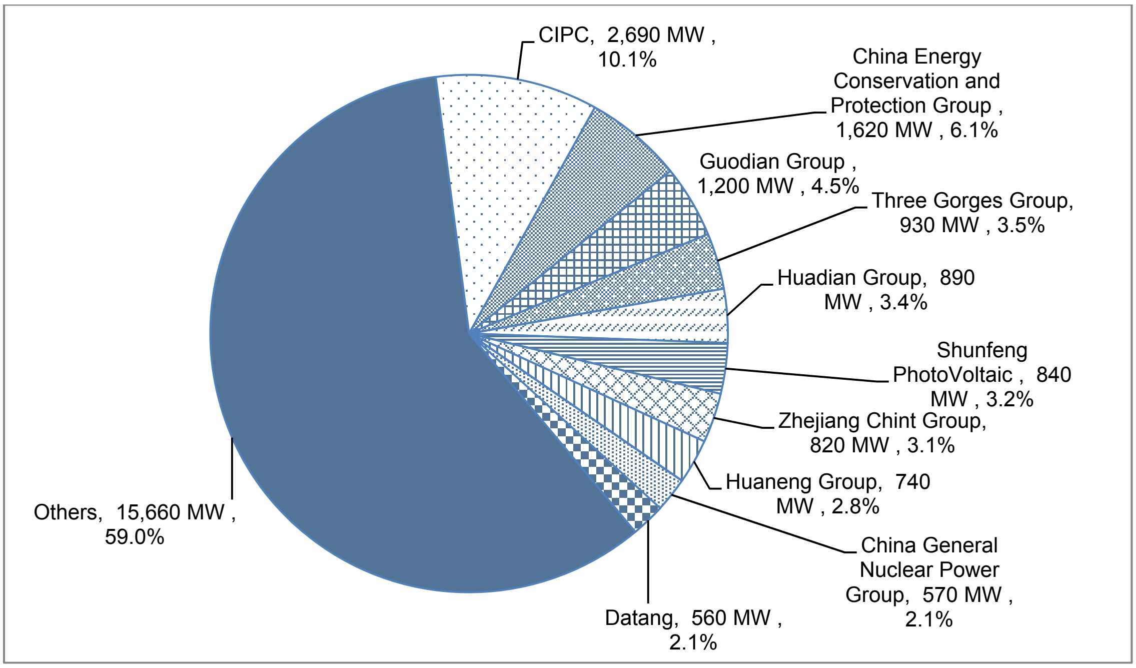
- Large IPPs that have traditionally been in thermal power generation
- Specialised solar PV plant investors and operators
- Solar PV module manufacturers
- Small independent solar PV plant operators.
- Provincial grid companies (In isolated cases. Grid companies are often the project owners in the solar PV and micro-grid combined power supply projects located in remote off-grid regions)

In terms of installed capacity in solar PV power generation, CIPC, with an effective capacity of 2,690.0 MW, has the largest effective capacity in China and accounted for 10.1% of the total solar PV power generation installation capacity in China in 2014. This is followed by China Energy Conservation and Protection Group with an effective capacity of 1,620 MW or a 6.1%

market share. Meanwhile, Guodian Group, the third largest solar PV power generation company in China as of the end of 2014, with an effective capacity of 1,200.0 MW or a 4.5% market share, announced in August 2015 that its ownership in solar PV power generation capacity dropped to 211.0 MW[143] in June 2015. This is the result of the company's strategic divestments in renewable energy power generation to focus on its core business of thermal power generation.

Despite the solar PV power generation industry in China being dominated by the large state owned IPPs, constituting 8 companies of the 10 largest participants by installed capacity, there has been an increase in participation from the private sector, usually in the smaller capacity range which can be as low as 1.0 MW. Nonetheless, there has been an increasing trend, whereby private investors with strong financial positions invest in large size solar PV power generation projects. For instance, 80.0 MW out of the total 570.0 MW in the Ge'ermu solar PV power plant is owned by a private solar panel manufacturing company, Yingli Solar.

Chart 5-30: Solar PV Grid-connected Power Generation Projects Market Share, China, 2014



Source: 2014 China PV Power Generation Development Evaluation Report, NEA, Frost & Sullivan

5.4.5 Relevant Laws and Regulation

Under the framework of the Renewable Energy Law that was passed in 2005 (updated in 2011), Chinese National Government agencies have, since 2013, issued a series of regulations and guidelines to expedite the development of solar PV projects. The first national initiative to drive the development of solar PV installation was the Notice on Implementing 'Golden Sun' Demonstration Projects, issued by the MoF, the Ministry of Science & Technology, and the

[143] Semi-annual Report, China Guodian Group, 27 August 2015.

NEA in November 2009, which offers financial subsidies to qualified solar PV power generation projects. By the time the initiative was completed in 2012 it supported a total installation base of 4,539.0 MW (including off-grid solar PV capacity). These policies and regulations cover such areas as pricing, subsidies, approval procedures, standardisation, technical requirements, and annual installation targets. Each province has also issued its own guiding policies to meet individual targets in the national framework. Their implementation procedures suit their own regulatory environment.

Table 5-7: National PV Policy and Regulation, China, 2015

Date	Issuer	Policy Title
2005, update in 2011		**Renewable Energy Law**
November 2009	MoF, Ministry of Science & Technology, NEA	Notice on Implementing 'Golden Sun' Demonstration Projects
March 2012	MoF, NDRC, NEA	The Temporary Measurements on Renewable Energy Price Additional Subsidies Funds
July 2013	MoF	Notice on Electricity Amount Generated Based Subsidy Policy for Distributed PV Power Generation
July 2013	The State Council	The State Council's Suggestions on Promoting the Healthy Development of PV Industry'
August 2013	NEA	The Temporary Administrative Measurements on PV Power Station Projects
August 2013	NDRC	Notice on Using Price as Leverage to Promote the Healthy PV Industry Development
January 2014	NEA	Notice on Newly Added PV Power Generation Capacity Target for 2014
October 2014	NEA	Notice on Orderly Development of PV Power Station Investment
September 2014	NEA	Notice on Further Implementing/Executing the Policies regarding Distributed PV Power Generation Projects
December 2014	NEA	Notice on PV Power Generation Projects Grid-connection in 2014
June 2015	NEA, China National Certification Agency, Ministry of Industry & Information	Guidance on Promoting the Application of Advanced PV Products and Industry Upgrading
April 2015	NEA	Notice on Carrying Out Nationwide Engineering Quality Inspection on PV Power Generation Projects

Source: NEA; Frost & Sullivan, 2015

5.4.6 Prospects and Outlook

Increase of Renewable Energy in Fuel Mix

Since 2013, the Chinese National Government has launched a series of policies and regulations to encourage solar PV power generation projects as a way to tackle climate change challenges, reduce thermal coal's share in the fuel mix and meet the electricity demand in off-grid areas. The NEA has started drafting the 13th Five-year Planning for renewable energy power generation. Under the plan, the share of renewable energy in the installed power generation capacity is expected to increase from the 28.0% in 2012 to 32.9% in 2020[144].

It is planned that the installed capacity of solar PV power generation will increase from 26.5 GW in 2014 to reach 100.0 GW by 2020[145] at a CAGR of 24.8%. Hydropower and wind power generation are the other sectors that are planned to experience strong growth from 2015 to 2020. It is expected that the installed capacity of hydropower and wind energy will reach 350.0 GW and 200.0 GW by 2020, respectively. Meanwhile, geothermal, bioenergy, and tidal energies are all considered as encouraged types of renewable energies, of which geothermal energy's capacity is expected to reach 50.0 million tonnes coal equivalent in 2020.

More Supportive Policies

The issuance of more policies since 2013 specifically for solar PV has clarified the aspects for investors regarding issues, such as grid connection pricing, available subsidies, targets for new annual solar PV power generation capacity etc. However, uncertainties surrounding the permissible solar PV project sizes and grid connection permission remain. There has been no official PPA approved by the national authorities which can be used by investors and grid companies. PPAs are an important base for investors to estimate the return on investment. It serves as a financial guarantee to obtain loans and other financial support. It is expected that further guidelines related to PPAs are to be issued to clarify the confusions. For instance, there has been a suggestion to conduct experiments on PPAs in selected regions to explore the viability of connecting investors in the capital market with the solar PV power generation industry. The suggestion of an experimental PPA could attract more investors in the capital market to support the development of the local solar PV power generation sector as these investors usually prefer the certainties of returns on their investment that a PPA offers.

More Provincial Commitment

Following the issuance of solar PV policies by the central Government, PEAs have also issued policies applicable within their own jurisdictions to support the development of the solar PV industry. For instance, "On Implementation of Financial Subsidies for PV Power Generation Projects", issued by Liaoning Province in 2011, requires the investors to obtain the project approval by the NEA and the grid-connection agreement (similar to PPA) with the local utility. While in Shandong Provincial Government's "Suggestions on Implementing Central Government's No. 24 Document – Promoting the Healthy Development of PV Industry", solar PV power generation project investors are allowed to rent land to develop the project, provided the land ownership and land use classification remain unchanged.

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[144] Based on the announcement in the 'Action Plan of Energy Development Strategy', issued by the State Council in September 2014.
[145] Strategic National Energy Plan (2014 - 2020), Office of The State Council, June 2014.

Future Solar PV Power Generation Industry Structure

Commercial development of solar PV projects in China has been going on for only a few years. In effect, it has sped up only since 2012 when the 12th Five Year Planning for Solar PV Development Target was launched. The governing policies and regulations are still being issued, modified and improved on while the project development goes ahead. For instance, there have been instances where investors who obtained the project development approval from authorities sold the project and project approval to a third party without actually investing or developing the project, and this business behaviour interrupts the solar PV power generation market order. The authority has therefore adopted counter measures in the Notice on Orderly Development of PV Power Station Investment, issued in October 2014.

The cancellation of solar PV investment subsidies in most European countries, that had heavily subsidised the solar PV installation since 2008, and the anti-dumping initiative from the U.S. towards solar PV manufactured in China have led to a severe overcapacity in the Chinese solar PV manufacturing sector. Hence, the solar PV panel manufacturing sector in China is expected to go through a period of consolidation whereby small and low-quality manufacturers are expected to terminate their operations or be acquired by large reputable conglomerates.

It has been noticed that some of the solar PV panel manufacturers, including Hareon Solar, Yingli Solar and Trina Solar, have gone further along the value chain to participate in the solar PV power generation project development and operation. This trend is expected to continue from 2015 to 2020 during which manufacturers may expand their businesses by capitalising on their material cost advantage through PV modules manufacturing, connection with the authorities that are responsible for projects approval, and understanding of the regulatory framework.

Simultaneously, Frost & Sullivan expects that an increasing number of IPPs will take part in the investment and operation of solar PV power generation projects in China. Since solar PV power generation at the commercial scale is considered to be at a nascent stage, there have been no dominant participants in the sector. Companies with strong financial backgrounds and the ability to demonstrate technical capabilities have strong prospects of benefiting from the sector.

Summary of potential and opportunities for solar power generation in China

The Government of China has announced its determination to improve the air quality as well as to fulfil its international commitments to reduce its CO_2 emission per unit of GDP by 40.0% - 50.0% of its level in 2005 by 2020. Hence, Frost & Sullivan opines that solar PV power generation at the commercial scale will be considered one of the strategic measures to achieve these targets. In combination with micro-grids, distributed PV power generation is also considered an effective way to reduce dependence on coal-fired power in a populous urban environment.

With the financial subsidies from the central Government in place, combined with regional supportive mechanisms, an improving regulatory framework, and a nascent market, Frost & Sullivan believes large-scale solar PV power generation is expected to experience rapid growth. In turn, it offers opportunities to solar PV power generation investors, developers, PV equipment suppliers, and system integrators to capitalise on the growth.

6 OVERVIEW OF COAL-FIRED POWER GENERATION INDUSTRY IN INDONESIA

6.1 BACKGROUND OF COAL-FIRED POWER GENERATION INDUSTRY

Indonesia has sizable gas, oil and coal reserves. Coal is one of the fossil fuels most easily sourced in Indonesia, with the country being the largest producer within the SEA region[146]. According to BGR, Indonesia was ranked the fifth (5th) largest coal producer in the world in 2014 with estimated coal reserves of 17,394 million tonnes. According to BGR, Indonesia produced 410.8 million tonnes of coal in 2014.

Table 6-1: Production, Export, and Consumption of Coal (in Million Tonnes), Indonesia, 2011 - 2014

Coal	2011	2012	2013	2014	CAGR (2011-2014)
Production	353	383	421	410.8	7.2%
Export	272	304	349	359	9.7%
Consumption	80	79	72	76	(1.7)%

Source: Ministry of Energy and Mineral Resources, BGR

The abundant availability of coal reserves in Indonesia has enabled power plant developers to source coal at a low cost from the domestic market, resulting in the high adoption of proven technologies such as coal-fired power plants. Therefore Indonesia predominantly uses coal-fired power plants with steam turbines and boilers for base load power consumption.

PLN is a SOE as well as a limited liability company[147], holding a monopoly on the distribution of electricity in Indonesia. PLN has various business units carrying out functions that include generation, transmission, and distribution of electricity in Indonesia.

PLN produces electricity from its own power plants (76.2% of Indonesia's total installed capacity of 52,889.2 MW in 2015), and most of the PLN's power generation facilities are managed by two PLN's subsidiaries, PT Indonesia Power (17.1% of total installed capacity) and PT Pembangkitan Java-Bali ("**PT PJB**") (13.2% of total installed capacity). PLN builds and owns most of the electricity infrastructure in the country. In 2015, PLN's installed capacity was 40,295.2 MW, with 50.6% stemming from coal-fired power plants[148].

In the Government's attempts to modernise the power industry, electricity has also been generated by IPPs, with the first power plant established in 1992. PLN acts as the single buyer that purchases electricity from IPPs. The total installed capacity of IPPs was 8,964.6 MW in 2015, of which coal-fired power plants accounted for 5914.0 MW.

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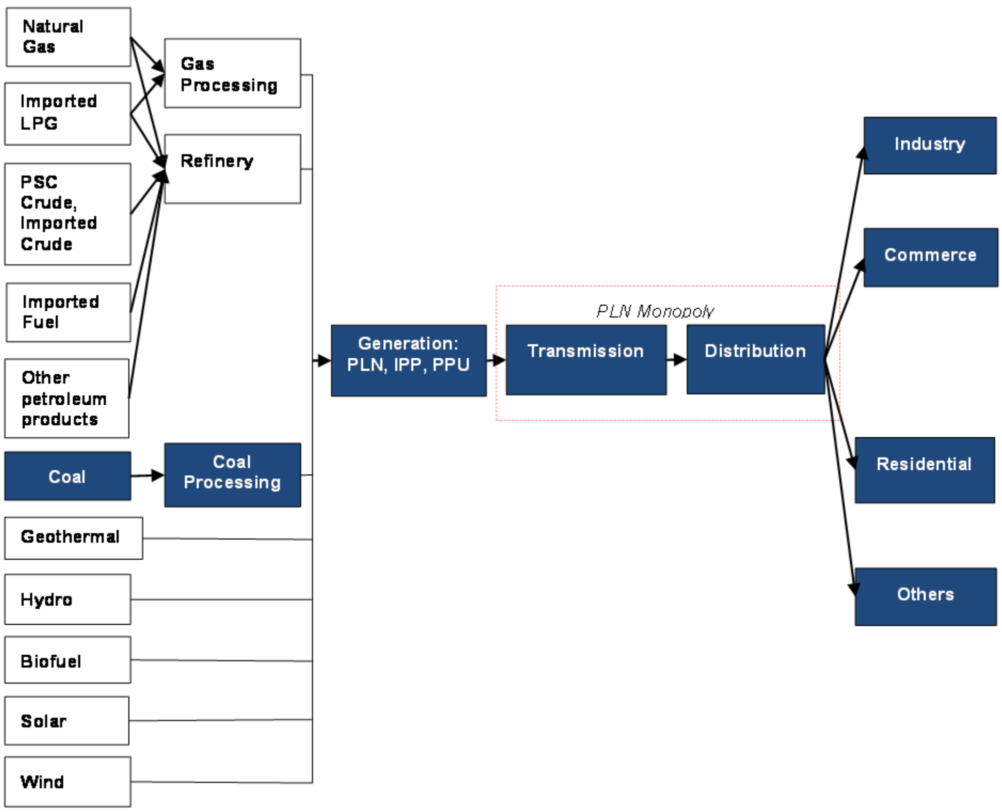
[146] According to BGR, top five coal producers in 2013 were China, the US, India, Indonesia and Australia. Indonesia is the only country located in the SEA region.
[147] PLN was transformed from a public utility into a state-owned limited liability company in 2004.
[148] Source: PLN Annual Report 2015

In addition, electricity is generated by large industries and mines that own private power utilities ("**PPU**"). These companies hold special licenses that allow each company to generate electricity solely for its own use; they may not sell it to the public. However, energy surpluses from PPUs may be sold to PLN.

To meet the growing electricity demand and simultaneously reduce the dependency on oil based fuel, the Government of Indonesia set the acceleration of energy diversification from oil to coal-fired base. According to Presidential Regulation No.71 Year 2006, the Government of Indonesia has assigned PLN to accelerate the development of power plant projects, through the FTP.

FTP 1 was launched in 2006 with an additional target capacity of 10,000.0 MW to be achieved by 2009 - 2010. However, from this phase, only 7,258.0 MW has been achieved by end of 2013 and the target year for completion was missed for several reasons including financing issues, lengthy permits and prolonged land acquisition process. As a continuation of FTP 1, in 2009, FTP 2 was launched with a heightened emphasis on IPP and renewable energy projects and had a target capacity addition of 18,019.0 MW to be achieved by 2016. Coal-fired power plants will account for 10,156.0 MW and out of this, PLN will develop 2,195.0 MW and 7,961.0 MW is earmarked for IPP development. Geothermal, gas and hydropower were other technologies planned under FTP 2. However, targets are unlikely to be achieved under FTP 2 as several projects have been delayed due to licensing issues, land acquisition issues, financing hurdles, and overall construction delays.

Figure 6-1: Value Chain of Power Industry in Indonesia, 2012



Source: Ministry of Energy and Mineral Resources, Republic of Indonesia, Frost & Sullivan

6.2 DEMAND CONDITIONS

Indonesia's strong economic development and the substantial increase in the middle income population segment have catalysed the electricity demand growth in the country. Electricity consumption grew at a CAGR of 6.6% from 147,315 GWh in 2010 to 202,845 GWh in 2015.

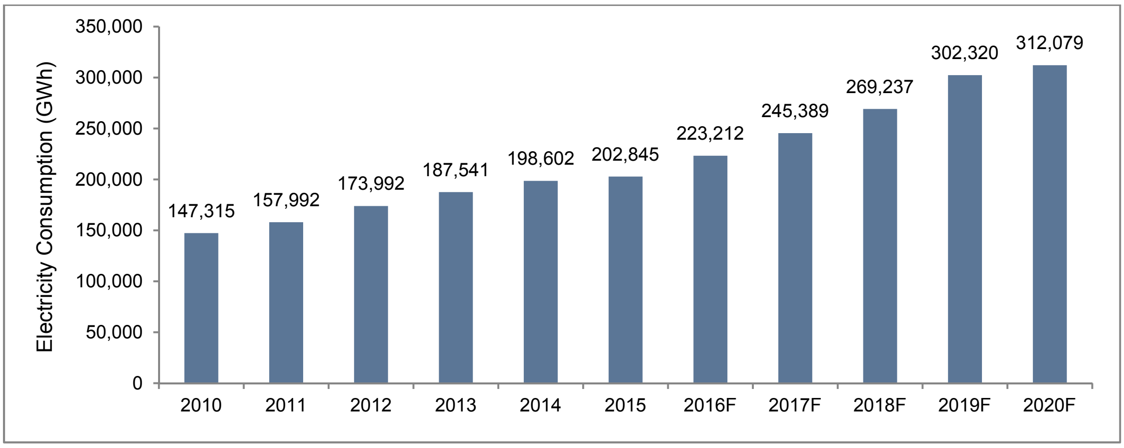
In 2015, the Java-Bali region consumed the most electricity in Indonesia, registering 150,898 GWh or 74.4% of the country's total electricity consumption. Java Island houses the nation's capital, Jakarta as well as Indonesia's economic provinces or regions, such as the Greater Jakarta area, Surabaya and Bandung, which are the country's centres for industries, businesses, trade and services.

The residential sector accounted for 43.7% of total electricity consumption, while the industrial sector, commercial sector and others accounted for 31.6%, 18.2% and 6.5% of total electricity consumption in 2014, respectively.

Table 6-2: Historical Electricity Consumption (GWh) by Sectors in Indonesia, 2012 - 2015

Sectors	Electricity Consumption (GWh)				Consumption CAGR 2012-2015 (%)
	2012	2013	2014	2015	
Industry	60,176	64,381	65,909	64,079	2.1
Commerce	30,989	34,498	36,282	36,978	6.1
Residential	72,133	77,211	84,086	88,682	7.1
Others	10,694	11,451	12,325	13,106	7.0
Total	**173,992**	**187,541**	**198,602**	**202,845**	5.2

Chart 6-1: Historical and Projected Electricity Consumption (GWh) in Indonesia, 2010 – 2020F



Note: Electricity consumption is based on electricity sales data.
*Source: PLN Annual Report 2014, Rencana Usaha Penyediaan Tenaga Listrik ("**RUPTL**") 2016 – 2025 and Frost & Sullivan*

According to RUPTL 2016 - 2025 Indonesia's electricity consumption is anticipated to increase from 203 TWh in 2015 to 312 TWh in 2020 at a CAGR of 9.1%. This higher forecast growth rate is attributed to the growing population, rising income levels and the rapid urbanisation of the country. As the spending power of the population increases and enables improvement in living standards, the uptake of electrical appliances is expected to similarly increase.

According to Statistics Indonesia, the total population of Indonesia was estimated to be 241.0 million of people in 2012 and is projected to reach 271.1 million of people in 2020 at a CAGR of 1.5%. The population of the Java Island region is estimated to be 152.4 million by 2020. The growth in the urban population is viewed as another growth driver for electricity demand, especially in the residential and commercial sectors. According to the Indonesian Statistics Body, Indonesia's urban population is projected to increase to 56.7% in 2020 from less than 50.0% in 2010.

The economic development of Indonesia is also the key driver for rising electricity consumption in the country. The Masterplan for the Acceleration and Expansion of Economic Development of Indonesia ("**MP3EI**") aims to transform Indonesia into one of the 10 major economies in the world by 2025. The MP3EI has identified eight main programmes, namely energy, mining, agriculture, industrial, marine, tourism, telecommunications and the development of strategic areas across six Indonesian Economic Corridors. The development of Indonesian Economic Corridors will drive the demand for power, which is projected to reach 90.0 GW by 2025.

The gap between capacity growth and the pace of electricity demand growth has led to frequent power outages. Such power outages have caused the Government to introduce programmes, such as the FTP to expand the country's power generation capacity. Based on Indonesia's 10-year PDP and Long Term Power System Security announced in 2010, the Government of Indonesia plans to add 55,345.0 MW of installed capacity from 2011 to 2020[149].

6.3 SUPPLY CONDITIONS

The installed capacity in Indonesia has been increasing from 39,099.7 MW in 2011 to 52,889.2 MW in 2015, at a CAGR of 7.8%. The Government of Indonesia has been encouraging investments in the electricity supply industry, particularly for generation and transmission activities.

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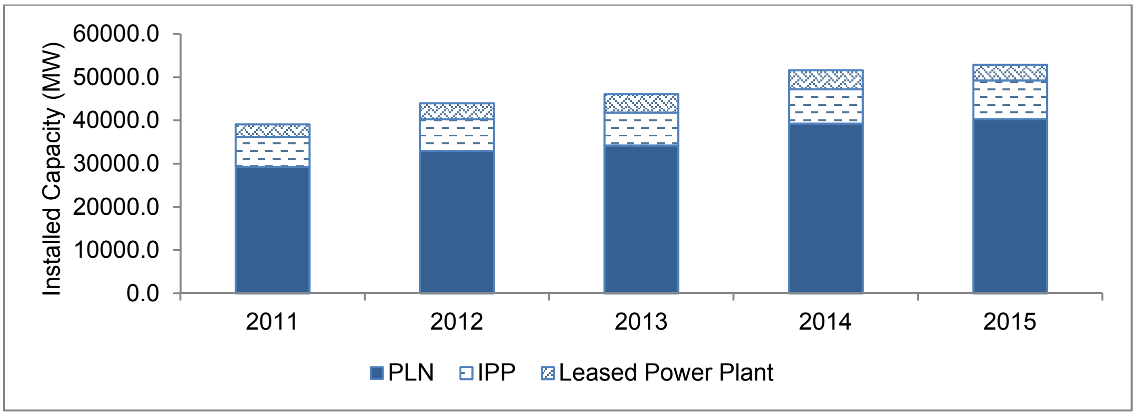
[149] Indonesia 10-year PDP and Long-term Power System Security, PLN

Chart 6-2: Historical Installed Capacity (MW) of Power Plants by Ownership Type, 2011 - 2015



Source: PLN Annual reports

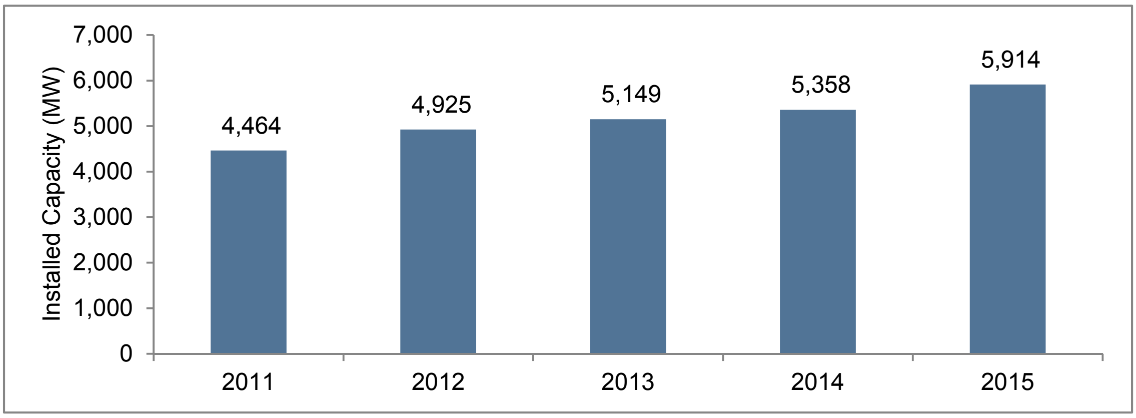
According to Indonesia 10 Year PDP in 2010, the Government of Indonesia aims to add 55,345.0 MW by 2020 to the existing installed capacity. This additional installed capacity will be predominantly coal-fired (35,573.0 MW or 64.3% of the planned additional capacity). The move to expand coal-fired generation capacity is intended as a replacement for oil-fired power plants as well as to optimize the use of indigenous coal for power generation. With this, the Government envisages to reduce the share of electricity from oil-fired power plants from 11.4% in 2014 to 1.0% by 2030.

PLN and its subsidiaries determine that certain PPAs and energy sales contracts with IPPs qualify as leases, on the basis that PLN and its subsidiaries and the IPPs have taken or pay arrangements where PLN and its subsidiaries are taking substantially all of electricity and energy output from the power plants. This type of arrangement is determined to be a finance lease where a significant portion of the risks and rewards of ownership of certain power plants have been transferred to PLN and its subsidiaries on the basis that the lease term is for the major part of the economic life of the assets. There is a bargain purchase option at the end of the lease term[150]. One of the largest leased power plants currently in operation is the 2,640.0 MW coal-fired power plant developed by PT Central Java Power, a 100.0% owned subsidiary of Sumitomo Corporation[151].

[150] PLN Annual report 2014, page 420-421

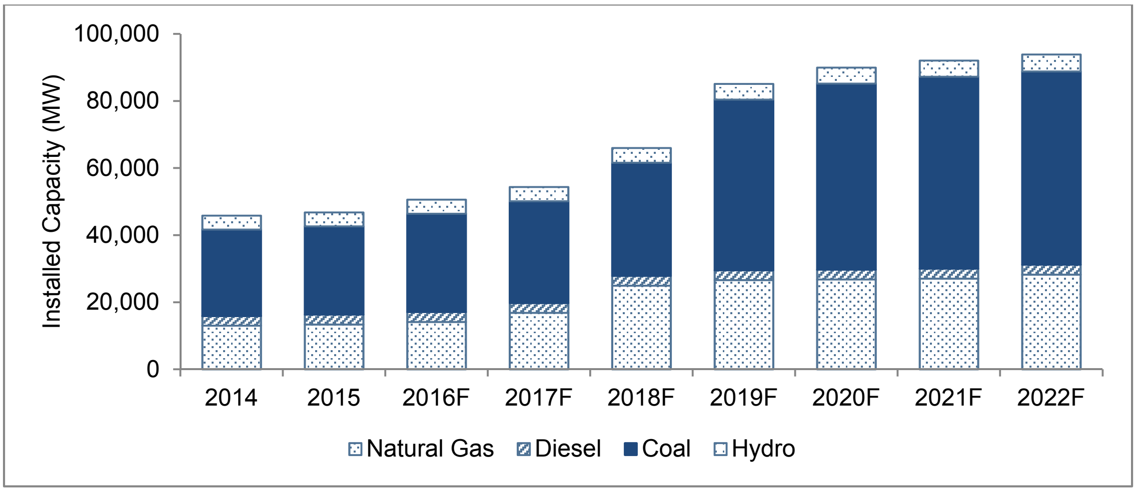
[151] Details of other coal-fired leased power plants not available.

Chart 6-3: Historical Installed Capacity (MW) of Coal-fired Power Plants by IPPs, 2011 - 2015



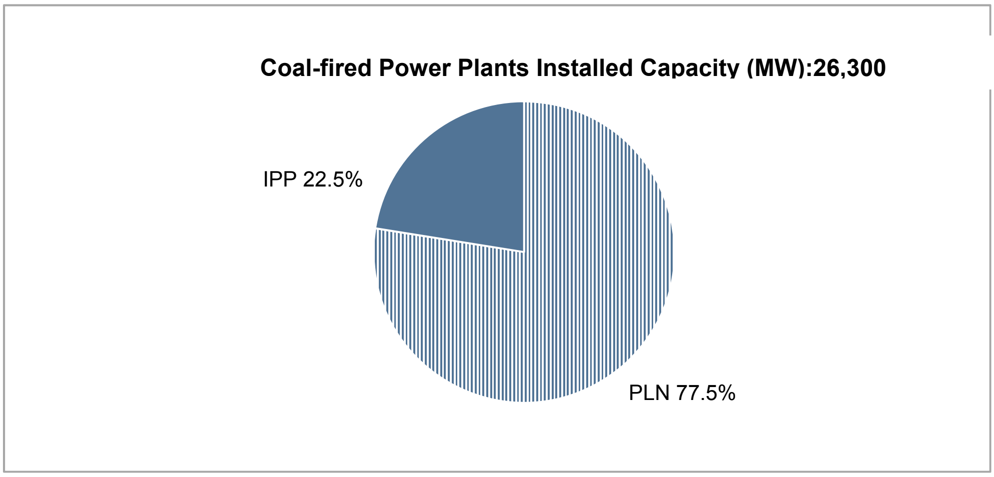
Source: PLN Annual Reports, PLN Statistics and PLN RUPTL 2015 - 2024

Chart 6-4: Historical and Projected Installed Capacity (in MW) of Power Plants by Fuel Type 2014 – 2022F



Note: The above projection excludes geothermal and renewable energy power capacity
Source: PLN's RUPTL 2016 – 2025, Frost & Sullivan

Chart 6-5: Installed Capacity (MW) for Coal-fired Power Plants between IPPs and PLN in Indonesia, 2015



Source: PLN Annual Reports, PLN Statistics and PLN RUPTL 2015-2024

In 2015, the total coal-fired power plants installed capacity was 26,300.0 MW of which IPPs accounted for 22.5% and PLN accounted for 77.5%.

Frost & Sullivan forecasts that the installed capacity of coal-fired power plants in Indonesia will increase from 26,300 MW in 2015 to 57,652.0 MW in 2022, at a CAGR of 11.9%. The Government of Indonesia's effort to meet rising electricity demand is reflected in the "Pengelolaan Energi Nasional 2005–2025" Plan released in 2005, which aimed to achieve an electrification ratio of 95.0% by 2025. To achieve this target, the Government plans to increase the availability of the electricity supply infrastructure with the inclusion of the APG Plan.

Indonesia's commitment to develop the energy sector is evident by the release of the General Plan of Electricity RUKN 2008 - 2027 that was released in December 2008 and subsequent updates to RUKN thereafter. RUKN 2008 - 2027 proposed to achieve electrification ratio of 79.0% in 2015, 90.0% in 2020 and 95.0% by 2025 and also to resolve the electricity supply crisis.

The Draft RUKN 2012 - 2031 aims to eliminate the shortage of power supply, diversify energy sources and reduce the utilisation of oil fuel for power generation. The Government of Indonesia is actively promoting private sector investments to meet the energy needs of the country. There are also plans to introduce investment schemes in order to encourage the development of renewable energy, to fulfil the country's power needs while reducing emissions. According to this draft, additional power capacity of 237.0 GW will be required based on the projected electricity consumption by 2031. The electrification ratio of 100.0% is expected to be achieved by 2031.

The Government has released the latest draft RUKN 2015 - 2034 released in July 2015, where the reserve margin is to be capped at 35.0% for all the provinces, for the duration 2015 - 2034.

In 2014, Indonesia's power reserve margin was critically low at 10.0% of its total electricity generation capacity (recommended minimum reserve margin is 30.0%)[152].

Indonesia's electricity sector is highly reliant on coal-fired power plants, contributing nearly 50.0% of the total installed capacity of 52,889.2 MW in 2015. The decline in global coal demand especially from China and subsequent decline in coal prices since 2012 have driven export-oriented Indonesian coal mining companies to diversify into other businesses including coal-fired power generation plants. Coal mining companies' entry into the power generation sector augurs well in Indonesia as coal mining companies have large and abundant reserves of coal and the country is shifting towards efficient coal-fired generation capacity. Developing mine-mouth coal-fired power plants by coal mining companies enables the coal mining companies to continue their business operation and ensures market availability for their production amidst low commodity prices. Further, coal processed domestically is unlikely to be subject to new export taxes. Coal mining company Adaro Energy is looking to reduce its dependence on coal mining and invest US$6 billion to develop three coal-fired power plant projects[153]. The share of coal production consumed by the domestic market is likely to witness an increasing trend to meet the rising demand for electricity and the Government's ambitious target to increase the electrification ratio.

6.3.1 Competitive Landscape

IPPs have been operating in Indonesia since the early 1990s. Certain IPPs, particularly in recent times, have also operated pursuant to a more general set of PPP arrangements. A PPP scheme is, in a general sense, a collaboration between the private and public sectors which utilises the efficiencies from the private sector to reap better value for the public.

The first IPP implementation era in Indonesia was the First Generation IPP which occurred in 1992 – 1998. During that period, IPPs were assigned based on the Law No. 15 of 1985 and Decree No. 37 of 1992, with the primary goal of developing these IPPs to face the fast growing economic development of Indonesia during the twilight years of the Soeharto regime. The country encouraged private sector participation in the power sector due to the inability of the central Government and PLN to finance such capital heavy projects. During that period, 27 IPP projects were planned but 17 IPP projects were completed, with a success ratio of 62.9%. Notable coal-fired IPP projects that were developed during that time include:

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[152] KATADATA News & Research

[153] 'The Jakarta Post' dated 4th June, 2015

Name of the Power Plant	Name of the IPP Company	PPA date/year	Plant Installed Capacity (MW)
PLTU Paiton I	PT. PEC (Paiton Energy Company)	12 February 1994	1,230.0
PLTU Paiton II	PT Jawa Power	3 April 1995	1,220.0

Source: Platts

The global financial crisis in 1998 also impacted Indonesia's power market. IPP projects were designed using US$ as the currency and the devaluation of Indonesian Rupiah against the US$ turned these projects highly unprofitable. As a result, many of the planned IPP projects had to be delayed or terminated, which eventually affected the IPPs' growth prospects in the country.

The Second Generation IPP program was introduced in 2005 when the FTP 1 – 10,000.0 MW program was introduced. Coal-fired power plants still remained the preferred technology during this program. During this FTP 1 program, IPPs were met with moderate success, developing only 17 IPP projects out of the planned 45 IPP projects. One of the major issues during the period was the lack of structure for the pre-qualification of selected IPP developers. Notable coal-fired IPP projects that were developed during this phase include:

Name of the Power Plant	Name of the IPP Company	PPA date/year	Plant Installed Capacity (MW)
PLTU Cirebon	PT Cirebon Electric Power	Aug 2007	660.0
PLTU Jeneponto	Bosowa Energi	Nov 2006	250.0
PLTU Paiton III	PT. PEC (Paiton Energy Company)	Mar 2009	825.0

Source: Platts

While foreign companies like Sumitomo Corporation (Japan) and Marubeni (Japan) were still the major developers of coal-fired IPP projects, this phase saw the advent of Indonesian companies like PT Indika Energy Tbk and Bosowa Energi Corporation.

As a continuation of the FTP 1, in 2009, the Government of Indonesia introduced the FTP 2.PLN received a mandate from the Government of Indonesia to invite the private sector to build IPP projects under the FTP 2 and made various changes in the procurement process for the IPP. The most noticeable changes adopted by PLN included the tightening of the pre-qualification and investor/developer screening process. Through the extensive pre-qualification and screening process, PLN aimed to partner with experienced investors which have sufficient funding sources to mitigate financial risks on the development projects. Notable coal-fired IPP projects being developed during this phase include PLTU Banten Serang with a PPA agreed upon in July 2012 for its 660.0 MW power plant. Malaysian conglomerate Genting Berhad is developing the Banten Serang power plant which is likely to become operational in 2016.

The table below shows the list of top 5 independent power project developers in Indonesia that operate coal-fired power plants.

Table 6-3: Profile of Top 5 Coal-fired IPPs in Indonesia, 2014

No.	Power Plant	Equity Stake (%)	2014	
			Plant Capacity (MW)	Effective capacity based on equity stake (MW)
PT Paiton Energy Company (Paiton Unit 7 & 8)				
1	ENGIE	60.0%	1,230.0	732.0
2	Tokyo Electric Power Co (Japan)	26.0%		314.0
3	Mitsui	15.0%		185.0
PT Paiton Energy (Paiton Unit 3)				
1	ENGIE	60.0%	825.0	491.0
2	Tokyo Electric Power Co (Japan)	26.0%		210.0
3	Mitsui	15.0%		124.0
PT Jawa Power (Paiton Unit 5 & 6)				
1	YTL Corporation (Malaysia)	35.0%	1,220.0	427.0
2	Siemens	50.0%		610.0
3	PT. Bumipertiwi Tatapradipta	15.0%		183.0
PT Sumber Segara Primadaya (S2P) - PLTU Cilacap				
1	PT PJB	49.0%	600.0	294.0
2	PT Sumber Sakti Prima	51.0%		306.0
PT Cirebon Electric Power				
1	Indika Energy	20.0%	660.0	132.0
2	Marubeni	33.0%		215.0
3	Komipo	28.0%		182.0
4	Samtan	20.0%		132.0
PLTU Serang				
1	PT. Power Jawa Barat	100.0%	600.0	600.0

Source: Company Annual Reports

During the early phase of IPP market development, the market was dominated by European and Japanese companies forming consortiums and developing power projects. However during FTP 1 and FTP 2 the market witnessed the entry of Southeast Asian IPPs, such as YTL Corporation and Genting Berhad. Apart from this, Indonesian companies have become active in IPP development, both individually and also in partnership with foreign companies.

PT Paiton Energy

PT Paiton Energy is the country's largest IPP established in East Java, Indonesia in 1995. Equity is owned by Mitsui & Co., Ltd (40.5%), ENGIE (40.5%), **TEPCO** of Japan (14%), and PT Batu Hitam Perkasa of Indonesia (5.0%). Its power plants include Paiton Unit 3 (825.0 MW), Paiton Unit 7 (615.0 MW) and Paiton Unit 7 (615.0 MW). ENGIE manages the plant's operation through its 59.5% owned subsidiary PT IPOMI.

PT. Jawa Power

PT. Jawa Power owns a 1,220.0 MW coal-fired power station located at the Paiton power generation complex in East Java, Indonesia. Jawa Power is one of the largest IPPs in Indonesia with a 30-year PPA with PT. PLN Jawa Power is owned by Siemens of Germany (50.0%), YTL Power International and Marubeni Corporation (35.0%), and PT. Bumipertiwi Tatapradipta of Indonesia (15.0%). The design, EPC and commissioning start-up of the power station was undertaken by a consortium led by Siemens and YTL Power International's wholly-owned subsidiary, PT YTL Jawa Timur, is the O&M operator for Jawa Power.

PT Cirebon Electric Power

Established in April 2007, PT Cirebon Electric Power ("**CEP**") is an international consortium-led power generation project based on supercritical technology involving leading international players in the energy and infrastructure sectors in Asia. Shareholders of this project include Komipo (Korea), Axis Power Holdings B.V., a subsidiary of Japan's Marubeni Corporation, Samtam (Korea) and Indika Energy (Indonesia). Each shareholder brings their relevant industry and technical expertise, financial strength, local knowledge and market leadership. CEP owns a 660 MW coal-fired power plant located in Cirebon District.

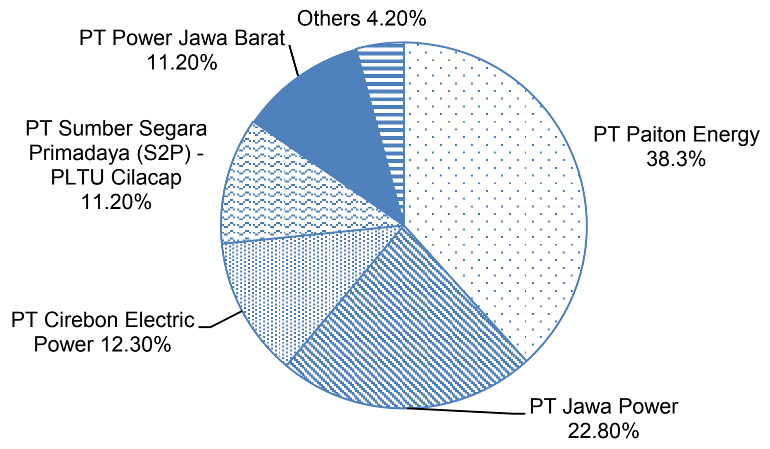
PT Sumber Segara Primadaya (S2P) - PLTU Cilacap

PT Sumber Segara Primadaya which is a JV of PT Power Jawa Bali, a subsidiary of PLN, with shares of 49.0%, and PT Sumberenergi Sakti Prima, with shares of 51.0%. PLTU Cilacap has an installed capacity of 600.0 MW. In December 2014, the construction of Unit 3 commenced and is scheduled for completion by end of 2016. In June 2015, it was reported that PT Sumber Segara Primadaya had signed an EPC agreement with Chengda Engineering Company of Chengdu, China to construct a 1,000.0 MW coal-fired power plant, which is likely to commence commercial operation by 2018.

6.3.2 Market Share and Ranking

In 2014, the total installed coal-fired power plant capacity in Indonesia was 25,810.0 MW, out of which IPP coal-fired power plant capacity was 5,358.0 MW. Based on the installed capacity of IPPs in 2014, PT Paiton Energy was the largest player in the IPP segment with a 38.3% market share followed by PT Jawa Power at 22.8%.

Chart 6-6: Market Share (%) of Coal-fired IPPs based on Installed Capacity (MW) in Indonesia, 2014



Note: Others include companies like Indika Energy, PT Gregory Energi, Bosowa Group, etc.
Source: Company Annual Reports

6.4 Relevant Laws and Regulations

Ministry of Energy and Mineral Resources[154]

In May 2015, the Government of Indonesia released a program to develop an additional 35,000.0 MW of power capacity by 2019 to mitigate the impact of acute electricity shortages affecting country's economic growth. According to this program, 10,000.0 MW of capacity would be developed by PLN and the remaining 25,000.0 MW capacity would be developed through private sector participation in the power sector. Furthermore, out of the planned 35,000.0 MW capacity, coal-fired power plants will represent the largest share at 20,000.0 MW. This regulation also discusses Purchasing Power and Standard Price of Power Purchase of Mine Mouth Power Plant, and the establishment of coal- fired power plants, gas-fired power plants, and hydropower plants by PLN through Direct Selection and Direct Appointment.

This regulation is expected to have a major impact on each power generation market player and will definitely alter PLN's capability in responding to the growing electricity demand in Indonesia. This is because this regulation serves as an invitation for the private sector to participate in the power generation sector. This regulation also enables critical power generation projects to receive a preferential treatment to be developed faster. Furthermore, it enables PLN to adopt a more flexible way to directly appoint the IPP project developer, based on the proposal's attractiveness.

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[154] Regulation No. 03 Year 2015

Presidential Regulation of the Republic of Indonesia[155] (Indonesia's Negative Investment List – 2014):

The Negative investment list outlines a list of sectors, such as infrastructure including power plants, pharmaceutical, advertising, etc. of which foreign direct investments are either prohibited or restricted with low ownership proportion. Nonetheless, according to this regulation, power plant developer for IPP larger than 10.0 MW capacity is eligible for a maximum foreign ownership of 95%. The ownership may be raised up to a maximum of 100.0% under PPP during the concession period.

Directorate General of Mineral & Coal Law[156]

The Directorate General of Mineral and Coal Law No. 644.K/30/DJB/2013 constitutes the reference price of coal in Indonesia and oversees the cost included in selling, transporting and unloading coal to be sold. The law also stipulates the shipping insurance requirements for the sales, transportation and distribution of coal in the region of Indonesia.

Indonesian Coal Royalties

Coal Type	Current Royalties	Proposed Royalties
< 5,100 cal/gr[157]	3.0%	7.0%
5,100-6,100 cal/gr	5.0%	9.0%
>6,100 cal/gr	7.0%	13.5%

Source: Indonesia-investments.com

In early 2015, the Government of Indonesia planned to increase the royalties for coal mining companies that hold a Mining Business Permit (Izin Usaha Pertambangan, abbreviated IUP) by revising Government Regulation[158] on Tariff and Types of Non-Tax Revenue in a move to generate more state income. In July 2015, however, the Government decided to postpone its plan to raise the royalties for the country's coal mining companies due to the low global coal prices. There are also concerns that the proposed hike may lead to closure of more coal mining companies. However, the Government plans to impose a 1.5% income tax on coal exports starting from 8th August, 2015 to boost state revenue and to retain more coal to meet domestic power demand.

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[155] Presidential Regulation of the Republic of Indonesia, Number 39 of 2014
[156] No.644.K/30/DJB/2013
[157] Calorific value of coal in terms of calories per gram
[158] Government Regulation No.9 – 2012 on Tariff and Types of Non-tax Revenue

New Mining Regulation on Divestment of Foreign Investment Company in Indonesia[159]

Under Article 3 (a) PP No. 24/2012, a Mining Business Permit ("**IUP**") is able to be issued by the Minister, governor or regent/mayor for Indonesian Limited Liability Companies established under the framework of domestic investment and foreign investment. However, IUPs for foreign investment companies can only be granted by the Minister.

Further, under Article 97 of PP No. 24/2012, foreign investment companies which hold anIUP shall divest the share gradually so that Indonesian shareholders have a minimum shareholding of 20% by the end of sixth year of the business operation, which is required to progressively increase to 51% in the tenth year.

Furthermore, in Article 98 of PP No. 24/2012, the shares of an Indonesian shareholder shall not be diluted to less than the number of shares as set out above if there is an increase of the capital amount by the foreign investment company. Under Article 7 (b) PP No. 24/2012, IUP is permitted to be transferred to another company as long as the IUP transferring company holds at least 51% or more share of the total issued shares in that company. This provision also applies to the SOE ("**BUMN**"), where the assignment must be approved by the Minister.

Minister of Trade Regulation No. 39/M-DAG/PER/7/2014 of 2014 regarding Provisions on Coal Export and Coal Products:

If a company wants to export coal and coal products, then it must first be recognised as a Registered Coal Exporter (Eksportir Terdaftar Batubara – "ET-Batubara") by the Minister.

In order to do so, an application must be submitted to the Director General of International Trade (**"Director General"**) with the following supporting documents:

1. Copy of the applicant's Mining License;

2. Copy of its Taxpayer Registration Number;

3. Copy of its Company Registration Certificate; and

4. Recommendation letter from the Director General of Minerals and Coal.

A recommendation letter will be valid for three years, but will be evaluated each year. The Director General will issue an ET-Batubara certificate within 5 business days of receiving a complete application. An ET-Batubara certificate is valid for 3 years. This is a similar regime to the technical requirements for export licences which had been put in place for the minerals sector in 2012, although it lacks a number of more punitive features of that regime.

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[159] Government Regulation Number 23 of 2010 ("PP No. 23/2010") on Implementation of Mining Business Operations is amended by Government Regulation Number 24 of 2012 ("PP No. 24/2012"). There are some matters covered in PP No. 24/2012.

6.5 PROSPECTS AND OUTLOOK

The Government of Indonesia launched a new 35,000.0 MW power plan in May 2015 to meet the growing demand for electricity. PLN will develop 10,000.0 MW of the capacity addition, while IPPs will be undertaking the remaining 25,000.0 MW capacity addition. The greater proportion of capacity increase dedicated for the IPPs is intended for PLN to focus more on strengthening the country's T&D grid infrastructure. Coal-fired power plants will account for nearly 20,000.0 MW according to the power plan. The Government of Indonesia's introduction of single window clearance for business permit through BKPM is expected to address challenges such as prolonged licensing procedures, land acquisition issues and delays in Government backed loans, which were faced by FTP 1 and FTP 2.

The Government of Indonesia has been restructuring the electricity subsidies, with the electricity tariff for middle and high end customers increasing by 34.0% since the beginning of 2014. This is expected to reduce the burden on the state budget and thus enable the Government of Indonesia to utilise the savings on subsidies for other infrastructure investments.

Indonesia has also planned to implement two other changes to tariff mechanism from the beginning of 2015, though both of these have been delayed as of the publication of this report:

- The introduction of an “adjustment tariff” mechanism for medium and high end customer segments. The adjustment will have three components namely Indonesian Rupiah exchange rate variation, international crude oil price change and inflation
- Restricting subsidies only to low end customers and small industries.

The Indonesian coal price of US$59.14 per tonne as at September 2015 represents a drop of US$11.5 per tonne or -15.86% year-on-year because of the decline in global demand. The 35,000 MW power plan could potentially offset the reduced international demand for Indonesian coal.

The Government has also been liberalising regulations on the development of mine-mouth power plants. The Energy and Mineral Resources Ministry has issued a regulation allowing PLN to directly purchase electricity produced by mine-mouth coal-fired power projects without an approval from the ministry concerned, so long as the price is within the range stipulated in the regulation. The new regulation also requires mine-mouth power companies to be formed as a consortium with the mine owner having at least 10.0% stake in order to provide security of a fuel supply.

PLN is also likely to encourage mine-mouth power plant owners to develop transmission lines that will connect to PLN's existing grid. This interconnection may be acquired by PLN later, thus accelerating the development of mine-mouth capacity. Moreover the proposed installation of a high voltage direct current transmission line from Sumatra, which has significant mine-mouth power plant potential, to Java, which is the major demand centre, also augurs well for coal-fired IPP development.

A combination of factors such as weak international coal demand, low coal prices, excess capacity in the Indonesian coal mining industry, reduction in domestic electricity subsidies and the Government's 35,000.0 MW power plan, augurs well for coal to become a stable and long term source for Indonesia's power generation needs.

7 TECHNOLOGICAL OUTLOOK OF POWER GENERATION TECHNOLOGIES

According to the IEA[160], the global demand for electricity is set to grow by nearly 80.0% between 2012 and 2040. As the global population projected to increase from 7.2 billion in 2014 to 9.6 billion by 2050 by the UN[161], the desire of Governments to attain economic growth and stability meant that energy security particularly for power generation is an increasingly important political theme.

Sustainable development could only be achieved if there is long-term security in the provision of energy services. However, in many developing countries, there are competing needs of extending provision of adequate, affordable and reliable energy services to its population, while addressing environmental impact through investment and deployment of cleaner power generation technologies. According to the New Climate Economy Report 2015[162], at least US$270.0 billion was invested in renewables in 2014, of which US$130.0 billion in energy efficiency.

In recent years, there have been significant innovations on the supply-side technologies that significantly improved its commercial viability, thus improving access to cleaner energy. According to the World Energy Council ("**WEC**"), electricity generation technology developments are driven by the need to:

a. Ensure that countries are never short of power to meet their growth requirements (Energy Security);
b. Keep power generation costs as low as possible (Energy Equity); and
c. Produce as less emissions as possible (Environmental Sustainability).

Invariably, the question of the trilemma drives power generation technologies to use minimum resources and maximise the power generated which is an increase in the efficiency of the power generation cycle. Technology outlook for power generation technologies is a combination of growth in equipment technology and process technology aiming to maximize efficiencies and reducing emissions.

7.1 COAL TECHNOLOGY

Given its abundance, coal continues to remain a prime source of power generation fuel for many of the developing countries due to the lower power generation costs. In the Organisation for Economic Co-operation and Development (**"OECD"**) countries, there is an increasing focus on "clean coal technologies" to reduce the emissions from coal to compete against the other less polluting sources for power generation. According to IEA, coal accounted for 40.0% of the world's electricity in 2012 with 1,617.0 GW of global capacity. Subcritical makes the majority of the global capacity with 75.0%, followed by supercritical (22.0%) and ultra-supercritical (3.0%).

Subcritical is the least efficient and most polluting form of coal-fired generation. It requires more fuel and water to generate the same amount of power, and creates more pollution as a result.

[160] World Energy Outlook 2014, based on the New Policies Scenario.
[161] Concise Report on the World Population Situation in 2014
[162] World Resources Institute

The average subcritical coal-fired power station ("**SCPS**") uses 67.0% more water and emits 75.0% more carbon pollution than an average Advanced Ultra-Supercritical ("**AUSC**"), which is the most up-to-date form of coal-fired power station.

According to the World Coal Association[163], supercritical plants can be found in 18 countries by end of 2014 and is now the norm for new plants in industrialised nations[164]. The global average for energy efficiency of coal-fired power generation is about 35.0% in 2011[165]. With the deployment of more efficient coal-fired generation technologies, the IEA[166] expect the global average efficiency to increase by 4.0% between 2012 and 2022.

Table 7-1: Coal-fired Energy Efficiency (%) and Environmental Effects by Generation Technology, Base-level = 100

Technology	Energy Efficiency	Carbon Intensity	Air Pollution	Water Stress
Old Inefficient Subcritical	n.a	100	100	100
Old Efficient Subcritical (SCPS)	n.a	84	84	85
New Subcritical	34	68	68	70
Supercritical	38	57	57	60
Ultra-Supercritical (USC)	41	52	52	55
Advanced Ultra-Supercritical (AUSC)	47	48	48	51

Source: IEA and University of Oxford's Smith School of Enterprise and the Environment

Major technologies for achieving improvements in the generation efficiency of the coal power plants[167] are:

a. Advanced Ultra-Supercritical operation of Steam cycles (AUSC);
b. Fluidised Bed combustion ("**FBC**"); and
c. Integrated Gasification Combined Cycle ("**IGCC**").

Advanced Ultra super critical operation of steam cycles

Under supercritical[168] conditions, the efficiency of the ranking cycle[169] increases. Currently Power plant equipment providers are looking to operate steam cycles at temperatures of 700°C or higher, referred to as AUSC operation.

Current modern coal-fired power plants operating at ultra-supercritical conditions (temperatures of 650°C) achieve efficiencies of around 45.0%. With AUSC technology, coal-fired plants are expected to achieve up to 50.0% efficiency by 2020.

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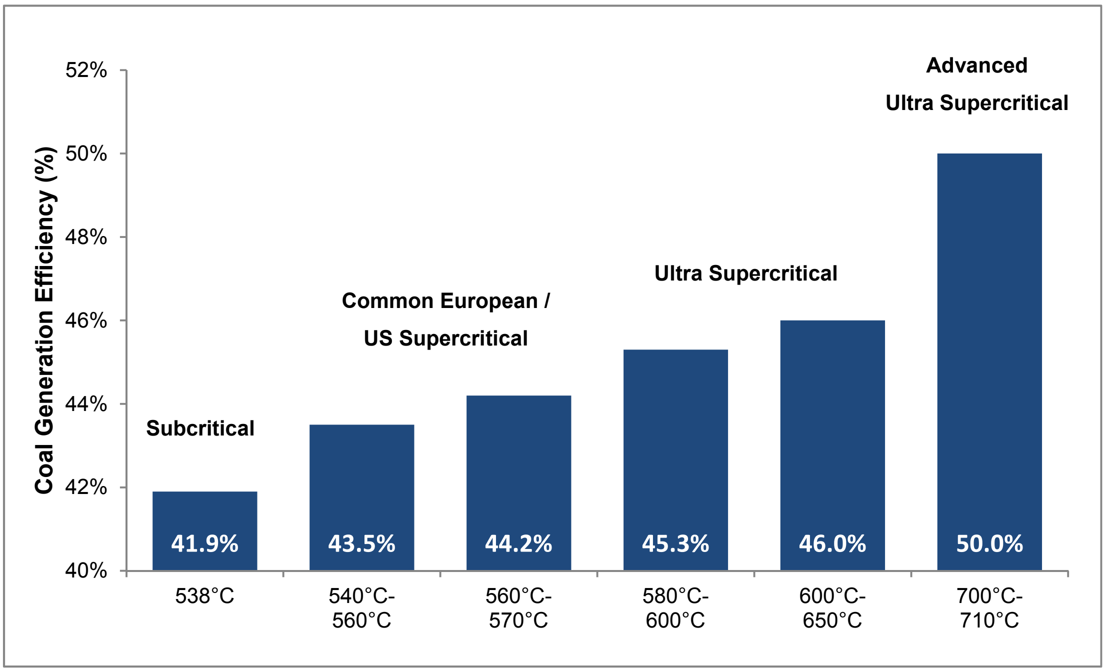
[163] Official Journal of World Coal Industry, Spring 2015
[164] OECD countries
[165] ECOFYS – International Comparison of Fossil Power Efficiency and CO2 Intensity – Update 2014
[166] High-Efficiency, Low Emissions (HELE) Technology Roadmap
[167] World coal association, Primary research, websites of power plant equipment providers
[168] At pressure levels of more than 3206.2 psi (221.2 bar) and corresponding saturation temperature 705.4°F (374.15°C), the vapour and liquid are indistinguishable. This level is called the Critical Point.
[169] A model used to predict the performance of steam turbine system. It idealised thermodynamic cycle of a heat engine that converts heat into mechanical work.

For Advanced Ultra-Supercritical operation, research is mainly focused on designing steam generator, steam turbine, and piping systems with suitable modern chrome and nickel-based super alloys that can withstand prolonged exposure to steam at high pressure and temperature. Super critical operation also helps to reduce the particulates, Nitrogen Oxides ("**NOx**") and Sulphur Oxide ("**SOx**") in the flue gas.

Chart 7-1: Comparison of Coal Generation Efficiency (%) By Technology



Source: Frost & Sullivan Analysis

Fluidised Bed Combustion ("FBC")

FBC is a very flexible method of electricity production that reduces the environmental impact of coal-based electricity, reducing SOx and NOx emissions by 90.0%[170]. Pressurised FBC systems operate at elevated pressures and produce a high-pressure gas stream that can drive a gas turbine, creating a more efficient power generation process of more than 40.0%.

Integrated Gasification combined cycle (IGCC)

IGCC is an innovative technique to increase efficiencies of coal power generation is to gasify the coal and use the gas to generate power in a combined cycle, usually used for natural gas. The IGCC efficiencies typically reach around 40.0% to 45.0%. Recent designs are pushing towards efficiencies of 50.0% and higher. which makes IGCC a promising technology. As IGCC is still under commercial development with on-going modification to its design to improve its reliability, deployment of the technology demands a team of specialised and experienced operators According to the IEA[171], cost has also been an issue for the wider uptake of IGCC as they have been significantly more expensive than conventional coal-fired plant.

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[170] World Coal Association
[171] Projected Costs of Generating Electricity (2010 Edition)

7.2 OTHER RENEWABLE ENERGY TECHNOLOGIES

7.2.1 Solar Technology

Recent technology growth in solar power generation has tended to focus on Concentrated Solar Power ("**CSP**") which utilises solar energy as the heat source in a thermodynamic cycle to produce power. These systems can supply the needed thermal energy for a conventional steam turbine (Rankine cycle), and even for a gas turbine (Brayton cycle) or a Stirling engine in the case of higher concentration factors. CSP technologies have much in common with fossil fuel power plants. The main difference is the source of the heat, which is solar in one case and the result of combustion in the other.

The most advanced CSP technology today is the parabolic trough power plant. Parabolic trough power plants could also integrate a thermal storage system, which accumulates heat from the solar field in sunny hours to release it later for power generation. The receiver technology is a very important research topic in power tower development. Molten salt has been then applied in a receiver composed of vertically located tubes. The salt is then used for direct power generation or for thermal energy storage ("**TES**").

The application of CSP and TES technology has continued to evolve and expand that it now drives competitive edge of current and future power producers - with the application of hybridised CSP technology. Integration of CSP and thermal generators at the process level allows higher power output with incremental heat available and higher thermodynamic efficiency[172]. Furthermore, the abundance of solar energy during the central hours of the day where electricity demand is also at its peak allows power producers to ramp up the plant's capacity factor without consuming additional fuel.

The versatility of this hybrid model also allows its integration with fossil fuel plants and with other renewables such geothermal. Along with its many advantages in reducing carbon emissions, improving economics of fossil fuel plant and ultimately enhancing viability of solar investment, the hybridised CSP technology is expected to become mainsteam in the near future.

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[172] Conversion of energy to power output.

7.2.2 Others Renewables

Some of the major trends for each of the other sources of Renewables include:

Source	Developments
Wind Energy	• Development of synchronous generators • Development of floating foundation off shore wind turbines • Off shore cabling : High-voltage direct current (HVDC) cables to reduce transmission losses
Biomass Energy	• Development of high efficiency Fluidized Bed combustion • Development of Anaerobic digestion processes (Landfill gas generation and Digesters) and Gasification processes that enhance the process efficiency
Geothermal	• Enhanced Geothermal Systems (EGS) that involve extraction of heat from engineered reservoirs through fluid injection into deeper hotter rock. • Development of Fiber optic temperature sensors and flow sensors that can help develop the EGS technology
Marine Energy	• Development of sensors that can collate data which can be used to identify potential sites of tapping into marine energy • Material to construct devices and equipment that can be used for setting up systems to tap into the abundant marine energy

8 PROSPECTS AND OUTLOOK FOR BANPU POWER

Coal-fired market is estimated to be the largest contributor in terms of MW additions to the overall power generation market in SEA. SEA accounted for 35.4 GW (2.2%) of the world's coal-fired capacity of 1,605.0 GW during 2010 and is likely to increase substantially to 114.9 GW (5.2%) of the world's estimated coal-fired capacity of 2,211.0 GW by 2030. Thailand, increasingly dependent on gas imports, is also building more coal-fired plants, including Hongsa Power Plant, an export-oriented plant in neighbouring Laos commencing full operation in March 2016. Thailand's fairly high share of gas-fired power and its relatively limited gas resources make coal the ideal fuel for future base load power generation. The fuel mix proportion for lignite and imported coal in Thailand is expected to increase from 10.6% share and 9.6% share in 2015 to 12.5% share and 12.0% share in 2020 respectively. Driven by the promotion of clean coal technology, the share of import coal as electricity generation source is also expected to further increase to 16.9% in 2035.

Thailand

In Thailand, the electricity generation is forecasted to be 234,654 GWh in 2021 with a CAGR of 3.7% from 197,891 GWh in 2016. There will also be additional installed capacity of 15.3 GW from 2015 to 2020, of which 8.7% or 1.3 GW will be contributed by coal-fired power generation. The power generation industry in Thailand is expected to be driven by factors such as supportive government policies and the expansion of regional supply and demand potential in the power utilities sector as a result of planned interconnection of transmission network in Thailand with its neighbouring countries in ASEAN.

Meanwhile, solar power generation market in Thailand has undergone positive development since the introduction of new FiT tariff and the revised Renewable Energy Policies beginning 2013. Frost & Sullivan expects that the installed capacity of solar power plants to grow at a CAGR of 12.2% from 1.5 GW in 2015 to meet the target of 3.0 GW by 2021.The growth of solar power generation beyond 2021 is also expected to be healthy as the revised Alternative Energy Development Plan ("AEDP") 2015 (draft) has outlined the target of installed capacity of solar power plant to reach 6.0 GW by 2036 with the strategies to continue promoting renewable energy.

Laos

Laos is an attractive market for investments in the power sector mainly as the country possesses large untapped hydropower potential, conductive business climate with a stable political setup, special economic zones, low risk from natural disasters and low labour costs which make it an attractive destination in Southeast Asia. Laos' installed capacity has been derived solely from hydropower plants. However, this situation has changed with the full commercial operation of the first coal-fired power plant in the country, the Hongsa Power Plant in 2016, in which Banpu Power owns a 40% stake. Lignite used for the Hongsa Power Plant is sourced from the lignite mine located nearby the Hongsa Power Plant site. As of June 2014, reserve status of the lignite mine in Hongsa, Xayaboury province is 487 million tonnes of which 371 million tonnes are required for the operation of the power plant for 25 years. While the country has plans to increase its installed capacity additions by 5,582 MW at a CAGR of 20.9% between 2015 and 2020, no other coal-fired power plant has been planned for construction during this period. Moving forward, the country has plans to increase its installed capacity, between 2015 and 2020, mainly through developing hydroelectric power projects along its major rivers. Upon completion, majority of the capacity generated from these hydropower plants are likely to be exported to countries neighbouring such as China (Yunnan province), Vietnam, Myanmar, Thailand and Cambodia.

China

In China, electricity consumption has rapidly increased since the economic reform in the early 1980s from 300,500 GWh in 1980 to 5,545,411 GWh in 2014 at a CAGR of 9.0% and is forecast to continue to grow at a CAGR of 4.0% from 2015 to 2020 to reach 7,016,714 GWh. Continued industrial process and economic growth in the country have been the major growth drivers in the demand of electricity in China. The power generation industry in China is expected to further benefit from the gradual market deregulation in the industry to be market driven as well as the Government of China's initiatives to develop and strengthen grid networks in the effort to eliminate off-grid population.

Hebei, Shanxi and Shandong provinces, in which Banpu Power has presence, have high electricity consumption due to strong presence of heavy industry and industrial sectors. The installed capacity in Hebei, Shanxi and Shandong is expected to expand by 39.1 GW, 98.1 GW and 140.1 GW respectively between 2015 and 2020. Frost & Sullivan notes that coal-fired power generation will remain as the largest power generation by fuel type in all 3 provinces in the forecast period between 2015 and 2020.

At the same time, since 2013, Government of China has launched a series of policies and regulations to encourage the solar PV power generation projects, as a way to tackle climate change challenges, reduce thermal coal's share in fuel mix, and meet the electricity demand in off-grid areas. With the financial subsidies from Central Government in place combined with regional supportive mechanism, improving regulatory framework, and a nascent market, Frost & Sullivan believes large-scale solar PV power generation is expected to experience rapid growth. The installed capacity of solar power generation in China is forecast to grow at a CAGR of 24.8% from 33.1 GW in 2015 to 100.0 GW in 2020. Frost & Sullivan opines that the Sales and Purchase Agreements to acquire 4 solar projects recently entered into by Banpu Power augur well with solar PV development in China.

Japan

Japan will continue the pace of moving towards balanced combination of power sources. Even though Japan has posted a decline in total power generation from 2013 to 2014, electricity generation in Japan is expected to experience steady growth due to economic recovery and preparation works for the upcoming 2020 Summer Olympics in Tokyo during the period between 2015 and 2020. In addition, solar power generation market in Japan has undergone positive development since the introduction of new FiT program in 2012, which allowed large scale solar power plant of over 500kW to be eligible in the program. Government incentive will motivate the development of solar power plant and attract increasing number of investors. As such, from 2015 to 2020, solar power installed capacity is expected to increase by 36.4 GW at a CAGR of 18.3% from 2015 to 2020.

India

Electricity consumption in India is expected be driven by growing manufacturing sector, increasing urbanisation and improvement in rural electrification. In view of this, the GOI has been ambitious in its target for renewables particularly solar as it aims for grid-connected installed capacity of solar power to reach 60.0 GW by 2022. Existing policy which allows 100% foreign direct investment activities in power generation projects including renewable energy without prior approval either from the GOI or the Reserve Bank of India, along with various tax incentives and generation based incentive scheme that have been put in place are expected to continue to sustain international investors' interest in the power generation sector particularly of renewables and solar. These measures along with a vibrant renewable energy ecosystem make India a favourable renewable energy investment destination. With this, Frost & Sullivan expects that between 2015 and 2020, installed capacity of solar power alone will increase ten folds from 1.7 GW to 16.6 GW, contributing the largest growth in new installed capacity of renewables.

Indonesia

In Indonesia, the Government launched a new 35.0 GW power plan in April 2015 to meet the growing demand for electricity, of which IPPs will be undertaking 25.0 GW of the capacity addition. Coal–fired power plants will account for nearly 20.0 GW according to the power plan. The Government has also been liberalising regulations on the development of mine-mouth power plants. The Energy and Mineral Resources Ministry has issued a regulation allowing PLN to directly purchase electricity produced by mine-mouth coal-fired power projects without the approval from ministry concerned, so long as the price is within the range stipulated in the regulation. Moreover, the proposed installation of high voltage direct current transmission line connecting Sumatra, with significant mine-mouth power plant potential, with Java, which is the major demand centre, will also augurs well for coal-fired IPP development and existing coal-mining players like Banpu PCL, who also possesses the experience in co-developing integrated mine-mouth power plants.

Philippines

The Philippine Energy Plan 2012-2030 provides the roadmap for future demand and capacity addition. As per the plan, installed capacity is expected to increase to 25.8 GW by 2030 from 17.9 GW in 2014. Additional capacity is likely to be achieved by adopting coal-fired power plants and geothermal power plants. Meanwhile, the Philippines is forecasted to register a moderate electricity consumption growth with CAGR of 4.2% from 71,379 GWh in 2015 to 87,844 GWh in 2020. Electricity demand from the commercial sector continues to remain high due a robust services sector.

As one of the most liberalised electricity market in SEA, transparent of electricity purchase structure and the Government of the Philippines' continuing effort in further privatising the power generation sector makes Philippines an attractive consideration for foreign investors.

Banpu Power's Power Business

The above industry trends augur well with Banpu Power's presence in the IPP businesses in coal-fired power generation in Thailand, Laos and China. The demand for electricity in these countries is also expected to increase in line with population growth and rising industrial activities. The governments of all these three countries have also put forward sizeable planned addition in power generation capacity. Meanwhile, Banpu Power's effective capacity has been boosted by the commercial operation of all three power plant units in Hongsa Power Plant as of June 2016, the only integrated mine-mouth power plant in Laos, in which Banpu Power owns 40% equity stake. Furthermore, Banpu Power's current involvement in the solar PV power generation in Japan, as well as future business plan to explore solar PV power generation in Thailand and China is also in line with respective governments' target to increase share of renewable energy in the fuel mix. The solar PV power generation industries in these countries are expected to have promising growth due to various supportive policies and incentives put forward to spur the growth of the industry. As of June 2016, Banpu Power had a gross capacity of 1,863.0 MWe in operation, comprising 1,711.2 MW of coal power, 813.0 tph of steam and 6.6 MW_{AC} of solar power and 551.8 MWe of equity installed capacity under development, comprising 438.5 MW of coal power, 255.0 tph of steam and 67.7 MW_{AC} of solar power.

9 RESEARCH METHODOLOGY

9.1 INTRODUCTION

Frost & Sullivan has refined its research methodology over many years of experience, having researched diverse markets in many different life cycles—from the embryonic to mature. Frost & Sullivan's reference publication, Industrial Market Engineering (Publication 5168-80), explains the research methodology in great depth.

Frost & Sullivan's Market Engineering system

- Focuses on challenges, problems, and the needs of industry participants
- Is based on primary market research, and not on secondary or previously published ones
- Focuses on detailed, comprehensive, "bottom-up" data collection techniques
- Is based on measurements

9.1.1 Market Engineering Forecasting Methodology

9.1.1.1 Overview

One of the most common questions that Frost & Sullivan receives from its clients is, "What is your forecasting methodology and how can I assess its level of credibility and accuracy?" This section on Frost & Sullivan's proprietary Market Engineering forecasting methodology has been added to answer this question.

This methodology integrates several forecasting techniques with the Market Engineering measurement-based system. It relies on the expertise of the analyst team in integrating the critical market elements investigated during the research phase of the project. These elements include:

- Expert-opinion forecasting methodology
- Delphi forecasting methodology
- Integration of market drivers and restraints
- Integration with the market challenges
- Integration of the Market Engineering measurement trends

- Integration of econometric variables
- Integration of customer demographics

The Market Engineering forecasting methodology is a seven-step system that maximizes the credibility and accuracy of the forecasts. These are:

9.1.1.2 Market Engineering Research Process Completed

The Market Engineering research process provides the navigational measurements of current market position and trends, which become the basis of the forecast.

9.1.1.3 Measurements and Challenges Analyzed over Time

Measurements and challenges are analyzed over time to provide additional insights into their potential impact on the market size and development.

9.1.1.4 Identification of Market Drivers and Restraints

At this stage, the analyst specifies the factors that will drive the market forward in terms of revenues and determines the elements that will inhibit growth.

9.1.1.5 Expert-Opinion Integration with Analyst Team

The interview process includes a variety of industry experts: competitors and key customers. These experts' opinions on the direction of the market are integrated with the data and analysis already created.

9.1.1.6 Forecasts Calculated

At this stage, analysts collect the market data needed to create the initial forecast scenarios. Each scenario is assessed to determine the most probable outcome for the market size. For example, the forecasts are matched to the leading economic indicators and drivers for each specific industry.

9.1.1.7 Delphi Technique Integration, If Needed

If data and forecast scenarios conflict, it becomes necessary to again discuss the market forecasts with the industry experts interviewed in the research process.

9.1.1.8 Quality Control within Research Department

Once the forecasts are integrated into the market section, they are verified by the other team members in the industry research group (IRG), and the research director. The forecasts are also ensured for mathematical accuracy and internal consistency by the final review preparation department and the editing department.

9.1.2 Strategic Significance of the Market Engineering Forecast

The Market Engineering forecast can have a significant impact on the business in several areas. Therefore, it should be integrated into business planning, strategy development, and decision-making.

9.1.2.1 Judging Credibility and Accuracy of Market Engineering Forecasts

Frost & Sullivan forecasts integrate the key elements that typically have an impact on market growth and size. No one can consistently make accurate forecasts, but market research has a proven track record in making accurate projections of market trends and growth rates.

The key test of credibility is whether the analyst team had integrated all the critical elements of the market into the forecast. If all such elements are included in the analysis, then the forecast has strong credibility.

The accuracy of a forecast to within a 10.0 percent range over a three-year period is not vitally important. What is important is that the overall trend be forecast correctly, because it drives the appropriate strategy and subsequent decisions. The Market Engineering forecasting methodology has consistently proved to be an accurate and reliable forecasting tool, particularly for high technology and industrial markets.

All the currencies reported are specified in US dollars, unless indicated otherwise.

Over the last 40 years, Frost & Sullivan has had an impressive track record in forecasting emerging markets, new technologies, and shifts in existing markets. Unexpected events have significantly changed the marketplace, but these do not occur often, and they merely delay the development of the market, rather than destroy it.

Frost & Sullivan always advise clients that its forecasts should not be the exclusive basis for decision-making at their companies. It should be an additional source of input and a support tool for their work in investigating the market and creating a winning strategy.

In the final analysis, decision-making is based on the general trend of the forecast, not its absolute accuracy.

It is important to accurately determine the range of the forecast, as it will have the greatest impact on the investment or strategy decision. Typically, the decisions revolve around questions such as:

Should the company enter the market?

Should the company increase or decrease its investment?

Should the company improve its performance in the market?

These decisions do not require accuracy within a few percentage points. They require accuracy in the determination of the general trend category. All business decisions carry some risk. Market Engineering increases the probability that the decisions will be correct, but it does not eliminate all risks.